ON THE EFFECTS OF IMMIGRATION
ON HOST COUNTRIES

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Immigrants in destination countries: an introduction

1.1 Introduction

Recent data on international migration prove the importance of this phenomenon on the world economy. According to the International Organization for Migration the estimated total number of international migrants has increased over the last 10 years from 150 mil. in 2000 to about 214 mil. persons in 2010. The Department of Economic and Social Affairs of the United Nations estimated that in the last ten years the worldwide annual rate of change in the stock of migrants was 1.8%. These facts, and the growing interest of national governments in setting up new migration policies, suggest that the effect of migration on destination countries will be one on the burning points of the future world economy.

For a long time economic research focused on the labour market effect of immigration (Card 2001, 2005; Borjas 2003; Dustmann, Fabbri and Preston 2005; Aydemir and Borjas 2007) and the main conclusion of this stream of literature is that the effect of immigration on wages in destination countries is negative, even if very small. Only recently economic research is focusing on other channels through which immigration may affect destination countries' economic performances: (i) immigrants are supposed to have an effect on per capita income, physical capital accumulation and total factor productivity in destination countries (Ortega and Peri 2009); (ii) immigrants may induce a shift in destination countries' technologies toward

labour intensive processes (Lewis 2005); (iii) the increased endowment of migrants in certain regions may change the optimal international organization of production by firms (Ottaviano, Peri and Wright 2010). Among all these possible effects of immigration, this work focuses on the effect of immigration on income in destination countries and on the relation between immigration and offshoring. In particular we will analyse the effect of high skilled immigrants on income in destination countries.

The skill content of migration, by changing the degree of substitutability with natives, is a crucial point in determining the effect of immigration on income in destination countries. This is probably the reason why governments are recently looking at skill selective immigration policy setting. Immigrants endowed with a high educational level are supposed to bring along them a high human capital level allowing for a gain in income in destination countries, on the contrary unskilled immigrants having a low human capital content induce a loss in per capita GDP in destination countries (through the human capital dilution). The importance of the skill content of immigrants has been recognized in theoretical literature on migration (Benhabib 1996), but it has not yet been taken into account in empirical literature. In this work we want to account for the skill level of immigration in determining its effect on per capita GDP in destination countries.

The second point that this work intends to analyse is the relation between immigration and offshoring, in particular when employers in destination countries have not perfect information on the ability of immigrants. Up to now, theoretical models on this stream of literature have assumed perfect information about foreign born workers. The debate on the relation between migration and offshoring is still open: some empirical works found complementarity between migration and offshoring (Kugler and Rapoport 2005; Javorcik *et. al* 2006); in this view immigrants in destination countries increase the information level on their origin countries, stimulating outward foreign direct investment by domestic firms. On the other hand, some studies found substitutability between immigration and offshoring (Barba Navaretti, Bertola and Sembenelli 2008; Ottaviano, Peri and Wright 2010) providing evidence of the traditional idea that immigration deters offshoring because it induces an increase in the return on capital in destination countries (due to the reduction in capital labour ratio). In our view when a migrant arrives in his destination country, he cannot bring along his informational structure,

for this reason the link between migration and offshoring has to be analysed assuming imperfect information about foreign born workers, and this is what we did in the fourth chapter of this work.

1.2   Stylized facts on the settlement of migrants

In the spirit of this introductory chapter, before going in deeper in the literature on international migration, we propose a short view of some stylized facts concerning the international movement of labour to better understand the relevance of the phenomenon. Although in a globalized economy, labour may appear as mobile as other production factors (such as physical capital), it is important to notice that labour has been considered for long time less mobile that capital for different reasons: (i) linguistic and cultural differences between countries may discourage labour flows; (ii) free flows of capital are supported by strong policy consensus (for its supposed positive effects on host economies) while labour is subjected to more political restriction and to more or less explicit barriers. Nevertheless, data show the rapid increase in the worldwide migration flows. The post industrial period of migration started in the 1960s, and from this period on, the international migration flows had a constant increase up to the end of the 20th century: between 1960 and 2005 the number of international migrants in the world more than doubled, passing from an estimated 75 mil. in 1960 to 191 mil. in 2005[1].

In figure 1.1 you may notice the jump in net migration between 1980 and 1990, the stock of world's migrants passes from 99 mil. to 155 mil. of individuals, this is probably the effect of the disintegration of some countries: about 27 mil. of that increase was due to the reclassification of individuals moved inside USSR before the 1990 as internal migration and that became international migrants after the USSR disintegration.

With respect to figure 1.2, the world stock of migrants as percentage of total population in 1960 was about 2.5%, becoming just about 3% in 2005; by contrast, the same measure for more developed countries passed from 3.5% in 1960 to almost 10% in 2005, proving the

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[1]Notice that about a fifth of this increase is the result of the transformation of internal migrants into international migrants when some countries disintegrated (for instance USSR in 1991, Yugoslavia in 1992, Czechoslovakia in 1993).

Figure 1-1: Stock of international migrants at mid-year (both sexes)
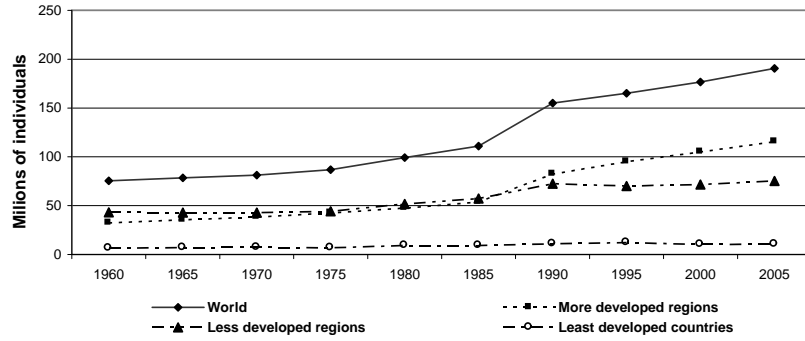
Figure 1-2: International migrants as a percentage of the population
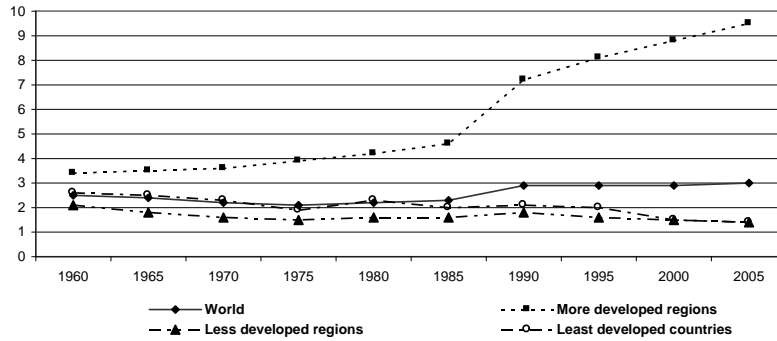
south-north peculiarity of migration in these years. An interesting feature of international migration concerns the pattern of the flows along years, as shown in figure 1.1, from 1980 the pattern of international migration changes: the more developed countries surpassed the less developed countries in terms of stock of migrants as a measure of the change in the migrants' flows direction. Analyzing the labour flows in/from Europe, since the 1970s European countries traditionally considered as sending countries, like Italy, Spain, Greece and Portugal, became receiving countries (World Development Report 2009). Poor and middle-income countries now send the highest share of the world migrants, among the top sending countries in 2000 there were: Mexico, Afghanistan, Morocco, Algeria, Turkey, India and China. However Italy, United Kingdom and Germany are still top sending countries (World Development Report 2009). The pattern of the international migration is also changing from south-north to south-south. Even if among the top-5 receiving countries there are United States, Germany and France, among the top-20 destination countries (reported in figure 1.3) there are India, Pakistan, United Arab Emirates, Hong Kong and China, Kazakhstan, Côte d'Ivoire and Jordan representing the changed pattern in international migrants' flows. United States of America and Russian Federation remain the most two receiving country both in 1990 and 2005; among European countries, Germany, France, Spain, United Kingdom and Italy in 2005 are in the top-20 ranking. Looking at the historical data on international migrants stocks figure 1.4, Europe, Northern America and Asia are the most migrants endowed continents but, in term of density of migrants Oceania has the highest migrants-total population ratio (only in 2005 Northern America reaches a similar quota), figure 1.5.

Focusing on Eu-15 countries, in figure 1.6 one may notice that Germany, France, United Kingdom and Spain have the highest stock of international migrants in absolute value; while in terms of migrants-total population ratio Luxembourg, Austria, Ireland and Sweden have the highest ratios (respectively 37.4%, 15.1%, 14.1% and 12.4%). Finally we want briefly provide some very recent data on migration flows. Figure 1.7 shows the migrants population for six geographic areas in 2010; as you may notice, North America and Oceania are still the most immigrants endowed areas (in terms of share over total population); while in absolute values the most immigrants endowed countries are United States, Russian Federation, Germany, Saudi Arabia and Canada (figure 1.8). Up to now we showed the endowment of destination countries

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Figure 1-3: Top 20 countries or areas with the highest number of international migrants, 1990 and 2005

Rank	Contry or Area	1990		Contry or Area	2005	
		Number of migrants (mil.)	As percentage of total		Number of Migrants (mil.)	As percentage of total
1	United States of America	23.3	15	United States of America	38.4	20.2
2	Russian Federation	11.5	7.4	Russian Federation	12.1	6.4
3	India	7.4	4.8	Germany	10.1	5.3
4	Ukraine	7.1	4.6	Ukraine	6.8	3.6
5	Pakistan	6.6	4.2	France	6.5	3.4
6	Germany	5.9	3.8	Saudi Arabia	6.4	3.3
7	France	5.9	3.8	Canada	6.1	3.2
8	Saudi arabia	4.7	3.1	India	5.7	3
9	Canada	4.3	2.8	United Kingdom	5.4	2.8
10	Australia	4	2.6	Spain	4.8	2.5
11	Iran	3.8	2.5	Australia	4.1	2.2
12	United Kingdom	3.8	2.4	Pakistan	3.3	1.7
13	Kazakhstan	3.6	2.3	United Arab Emirates	3.2	1.7
14	Hong Kong, SAR China	2.2	1.4	Hong Kong SAR China	3	1.6
15	Côte d'Ivoire	2	1.3	Israel	2.7	1.4
16	Uzbekistan	1.7	1.1	Italy	2.5	1.3
17	Argentina	1.6	1.1	Kazakhstan	2.5	1.3
18	Israel	1.6	1.1	Côte d'Ivoire	2.4	1.2
19	Kuwait	1.6	1	Jordan	2.2	1.2
20	Switzerland	1.4	0.9	Japan	2	1.1

Source: United Nations, Trends in Total Migrant Stock: the 2005 Revision.

Figure 1-4: Stock of international migrants at mid-year (both sexes)
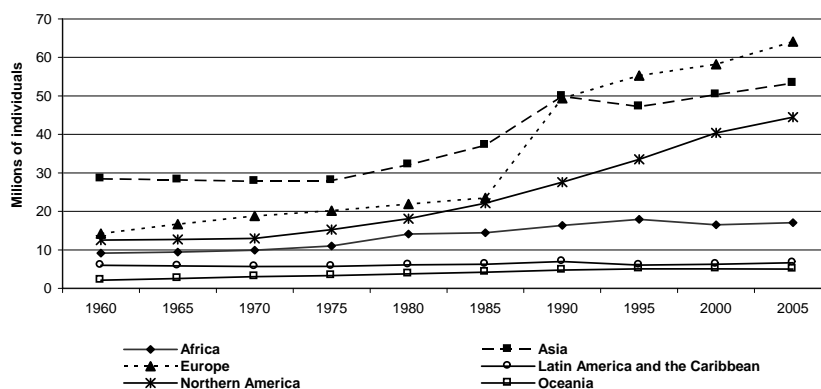
Source: United Nations, Department of Economic and Social Affairs

Figure 1-5: International migrants as a percentage of the population

Africa — ◆

Asia — ■

Europe — ▲

Latin America and the Caribbean — ○

Northern America — ✳

Oceania — □
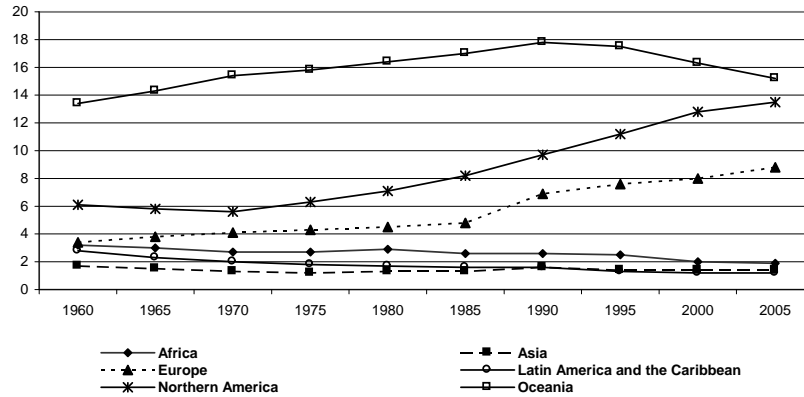
Source: United Nations, Department of Economic and Social Affairs

Figure 1-6: Presence of international migrants among EU15 countries

		1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
	Austria	0.10	0.13	0.17	0.22	0.28	0.28	0.47	0.72	0.93	1.23
	Belgium	0.44	0.54	0.68	0.77	0.87	0.89	0.90	0.91	0.88	0.72
	Denmark	0.08	0.10	0.12	0.14	0.16	0.19	0.22	0.25	0.30	0.39
	Finland	0.03	0.03	0.03	0.04	0.04	0.05	0.06	0.10	0.13	0.16
	France	3.51	4.45	5.21	5.57	5.89	5.96	5.91	6.09	6.28	6.47
	Germany	-	-	-	-	-	-	5.94	9.09	9.80	10.14
Number of	Greece	0.05	0.07	0.09	0.12	0.17	0.31	0.41	0.55	0.73	0.97
international migrants	Ireland	0.07	0.09	0.13	0.17	0.22	0.23	0.23	0.26	0.38	0.59
(mil.)	Italy	0.75	0.83	0.91	1.01	1.11	1.22	1.35	1.48	1.63	2.52
	Luxembourg	0.04	0.05	0.06	0.08	0.09	0.10	0.11	0.14	0.16	0.17
	Netherlands	0.45	0.34	0.26	0.34	0.49	0.76	1.19	1.39	1.56	1.64
	Portugal	0.04	0.06	0.10	0.16	0.27	0.35	0.44	0.53	0.63	0.76
	Spain	0.24	0.29	0.37	0.30	0.24	0.41	0.77	1.01	1.63	4.79
	Sweden	0.29	0.39	0.54	0.57	0.61	0.65	0.78	0.91	0.99	1.12
	United Kingdom	1.66	2.54	2.95	3.20	3.47	3.62	3.75	4.20	4.76	5.41
		1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
	Austria	1.5	1.8	2.3	2.9	3.7	3.7	6.1	8.9	11.4	15.1
	Belgium	4.8	5.7	7	7.9	8.8	9	9	9	8.5	6.9
	Denmark	1.8	2.1	2.4	2.7	3.2	3.7	4.3	4.8	5.7	7.2
	Finland	0.7	0.7	0.7	0.8	0.8	1	1.2	2	2.6	3
	France	7.7	9.1	10.3	10.6	10.9	10.8	10.4	10.5	10.6	10.7
	Germany	-	-	-	-	-	-	7.5	11.1	11.9	12.3
International	Greece	0.6	0.8	1	1.4	1.8	3.1	4.1	5.1	6.7	8.8
migrants as a	Ireland	2.6	3.3	4.4	5.4	6.6	6.4	6.5	7.3	10.1	14.1
percentage of the	Italy	1.5	1.6	1.7	1.8	2	2.2	2.4	2.6	2.8	4.3
population	Luxembourg	13	15.8	18.2	21	25.5	28.3	30.2	33.4	36.9	37.4
	Netherlands	3.9	2.8	2	2.5	3.5	5.3	8	9	9.8	10.1
	Portugal	0.4	0.7	1.2	1.8	2.7	3.5	4.4	5.3	6.2	7.3
	Spain	0.8	0.9	1.1	0.8	0.6	1.1	1.9	2.5	4	11.1
	Sweden	3.9	5.1	6.7	7	7.3	7.8	9.1	10.3	11.2	12.4
	United Kingdom	3.2	4.7	5.4	5.8	6.3	6.5	6.6	7.3	8.1	9.1

Source: United Nations, Department of Economic and Social Affairs

Figure 1-7: Stock of migrants and its share over total area's population, 2010

Geographic area	Migrants (milions)	% of the Area's population
Europe	69.8	9.5
Asia	61.3	1.5
North America	50.0	14.2
Africa	19.3	1.9
Latin America	7.5	1.3
Oceania	6.0	16.8

Source: International Organization for Migration, regional and country figure.

in terms of immigrants, but in order to provide a clear picture of the immigrants' settlement in receiving countries, we would supply some information about the concentration of immigrants among regions in destination countries and on the skill content of immigrants.

1.2.1 High skilled immigrants endowment by destination countries

As better shown in the next chapters, a crucial point to assess the effect of immigration in receiving countries is the human capital content of them. So coherently with the descriptive purpose of this chapter, we now briefly describe the high skilled immigrants endowment by host countries. By approximating the human capital content of immigrants using their education attainment, in figure 1.9 we show the share of primary, secondary and tertiary educated over total immigrants stock for 30 OECD countries. As you may notice Australia, Canada, New Zealand, Ireland, United States of America are the main tertiary educated immigrants endowed countries; while Austria, Czech Republic, Italy, Hungary have a very low tertiary educated immigrants' stock. Considering the average share across countries for each education level, we may conclude that OECD countries host mainly primary educated immigrants.

Immigration policy is one of the variables that may explain the differences between countries in terms of high skilled immigrants endowment. In facts, the main high skilled immigrants endowed countries, like Australia, Canada, New Zealand and United States are those that early set up selective immigration policies (figure 1.10 summarizes the immigration policies adopted by some destination countries).

Recent trend in migration policy is toward the attraction of skilled migrants; for example

Figure 1-8: Countries hosting the largest number of international migrants in 2010

Country	International Migrations (millions)
United States	42.8
Russian Federation	12.3
Germany	10.8
Saudi Arabia	7.3
Canada	7.2
France	6.7
United Kingdom	6.5
Spain	6.4
India	5.4
Ukraine	5.3

Source : International Organization for Migration, regional and country figure.

in 2007 Czech Republic set the "Green Card" policy which points to attract tertiary educated immigrants, similarly in 2007 Denmark attempted to attract high skilled workers with the policy called "Danish a good place to work". Also the French policy is going into a high skill selective policy, by promoting the program called "competencies and talent" which in facts separates the list of immigration between high and low skilled migration. These new high skilled oriented migration policies, with the old well consolidated selective policies by United States (H1-B visa), Australia, Canada and New Zealand, confirm the trend by government in attracting high skilled immigrants more than unskilled immigrants. In this direction moves also the recent tendency by governments to add in traditional preferential trade agreements provisions regarding the free movement of some high skilled professionals between countries (Horn, Mavroidis and Sapir 2009).

Thus, as happened for inward FDI, governments are trying to attract high skilled immigrants. But, is this interest supported by empirical evidence of the positive effect of high skilled immigrants on economic performances in destination countries? This is one of the motivations underlying the third chapter of this work.

Figure 1-9: Share of primary, secondary and tertiary educated over total immigrants stock in 1991 and 2001 in 30 OECD countries

	1991			2001		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
Australia	0.34	0.32	0.35	0.35	0.24	0.40
Austria	0.58	0.33	0.08	0.47	0.40	0.13
Belgium	0.69	0.18	0.13	0.62	0.18	0.20
Canada	0.38	0.12	0.51	0.30	0.12	0.59
Czech Republic	0.49	0.45	0.06	0.39	0.50	0.11
Denmark	0.56	0.30	0.14	0.45	0.38	0.17
Finland	0.64	0.20	0.16	0.49	0.28	0.24
France	0.84	0.06	0.10	0.75	0.09	0.16
Germany	0.68	0.15	0.17	0.66	0.12	0.22
Greece of birth	0.44	0.40	0.15	0.45	0.40	0.15
Hungary	0.74	0.18	0.08	0.68	0.20	0.12
Iceland	0.38	0.38	0.24	0.30	0.39	0.31
Ireland	0.22	0.51	0.27	0.14	0.45	0.41
Italy	0.53	0.32	0.15	0.53	0.32	0.15
Japan	0.43	0.35	0.23	0.34	0.38	0.28
Korea, Rep. Of (South)	0.26	0.41	0.33	0.19	0.43	0.38
Luxemburg	0.55	0.28	0.17	0.45	0.34	0.22
Mexico	0.50	0.16	0.34	0.35	0.21	0.45
Netherlands	0.63	0.20	0.17	0.50	0.28	0.22
Norway	0.29	0.46	0.25	0.22	0.49	0.29
New Zealand	0.36	0.21	0.44	0.33	0.26	0.41
Poland	0.67	0.21	0.12	0.61	0.25	0.14
Portugal	0.61	0.19	0.20	0.60	0.22	0.19
Slovakia	0.62	0.30	0.08	0.49	0.36	0.15
Spain	0.34	0.49	0.17	0.29	0.53	0.19
Sweden	0.44	0.38	0.18	0.34	0.40	0.26
Switzerland	0.51	0.34	0.15	0.55	0.26	0.19
Turkey	0.77	0.11	0.11	0.60	0.19	0.21
United Kingdom	0.56	0.24	0.20	0.34	0.31	0.35
United States of America	0.39	0.20	0.41	0.38	0.19	0.43
South Africa	0.66	0.18	0.16	0.54	0.24	0.22

Source : Docquier, Lowell and Marfouk (2007)

Figure 1-10: Immigrants related policies among OECD countries

Country	Maastricht	Schengen	Quota System	Skill Selective Policy
Austria	Y	Y	Y	Y
Australia	N	N	N.A	Y
Belgium	Y	Y	N	N
Canada	N	N	Y	Y
Czech Republic	Y	Y	N	Y
Denmark	Y	Y	N	Y
Finland	Y	Y	N	N
France	Y	Y	N.A	Y
Germany	Y	Y	N	Y
Greece	Y	Y	Y	Y
Hungary	Y	Y	N	N
Ireland	Y	N	N	Y
Italy	Y	Y	Y	N
Japan	N	N	N.A	Y
Luxembourg	Y	Y	N	N
Netherlands	Y	Y	N	Y
New Zealand	N	N	N.A	Y
Norway	N	Y	N	N
Poland	Y	Y	N	N
Portugal	Y	Y	Y	Y
Slovak Republic	Y	Y	N.A	N
Spain	Y	Y	Y	N
Sweden	N	Y	N	N
Switzerland	N	Y	Y	Y
Turkey	N	N	N.A	N
United Kingdom	Y	N	N	Y
United States	N	N	Y	Y

Source : Author on Mayda(2008), Wanner and Dronkers (2005) and OECD International Migration Outlook 2010

Figure 1-11: Map of the immigrants localization among European regions

stock of immigrants in 2001 over population in 2001
■ (.0374091,.2135229]
▨ (.0169169,.0374091]
▧ (.0075659,.0169169]
▢ [.0003249,.0075659]
▢ No data
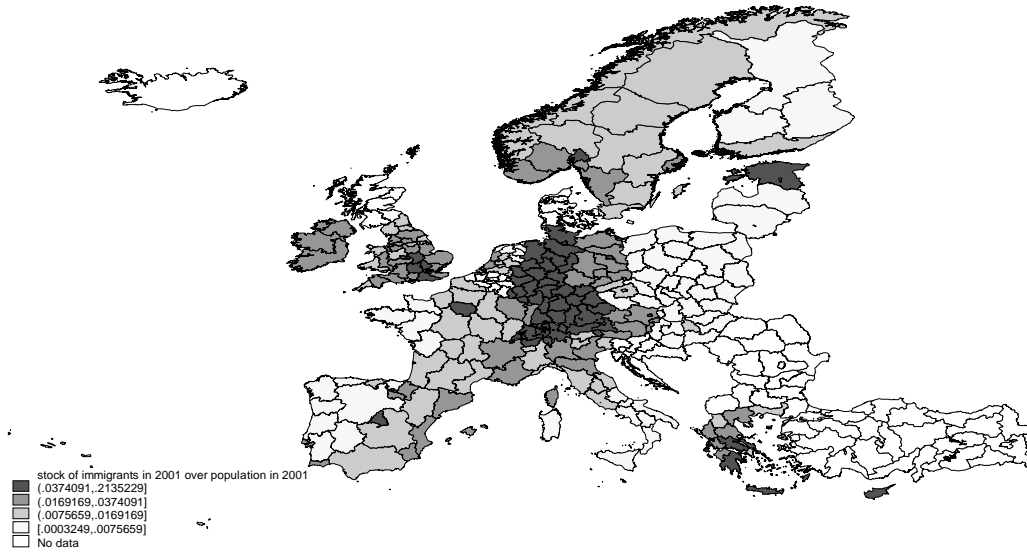
Source: Author's elaboration on Eurostat data.

1.3   Immigration, income and offshoring: descriptive evidence

Since the following chapters will focus on the relation between migration, income and offshoring in destination countries; here we want to provide early descriptive evidence on how these three variables combine themselves by using their geographical localization among European regions (NUTS 2 level). Figure 1.11 shows the values of the immigrants' stock over total population in 2001; the map confirms what we observed in the former section on the high immigrants endowed European countries (Germany, France, United Kingdom, Sweden, Switzerland, Luxembourg), but it also emerges that immigrants tend to settle in regions with big cities (see the areas around London, Madrid, Paris, Barcelona) confirming the idea that high population density is associated with high immigration flows (De Arcangelis, Jayet and Ukrayinchuk 2010)

By comparing figures 1.11 and 1.12 (where per capita income in 2001 has been charted), it emerges that immigrants in general tend to settle in high income countries. Obviously by this simple description we cannot conclude anything about the causal relation of the positive correlation between immigration and income in destination countries. Surely, it may be due to the fact that high income regions assure the highest probability to find a job for a new migrant;

Figure 1-12: Map of per capita GDP in European regions

per capita GDP in 2001, euro per inhabitant at current price
(24950,73400]
(21000,24950]
(13550,21000]
[3400,13550]
No data
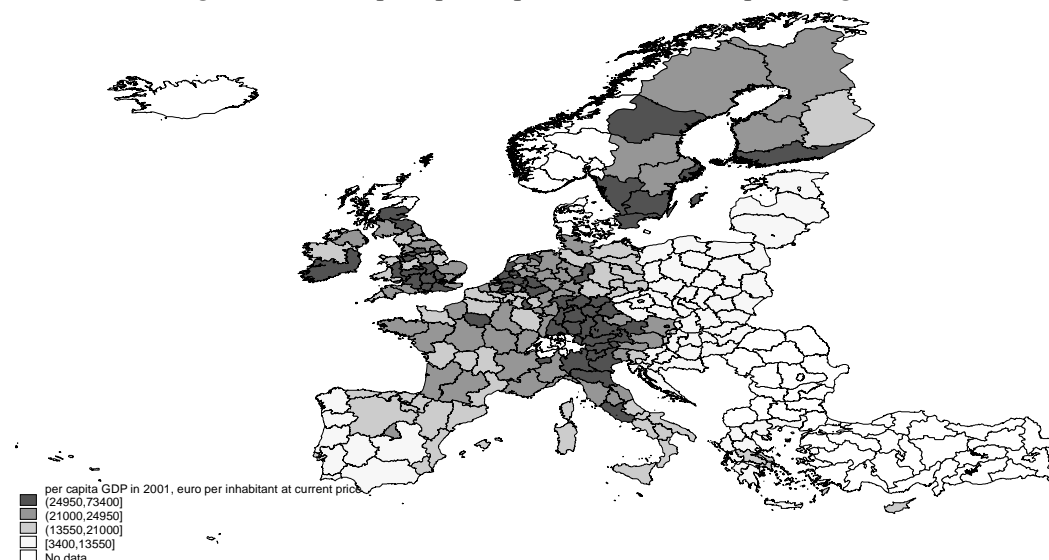
Source: Author's elaboration on Eurostat data.

moreover high income regions are those with a high existing stock of migrants so that network effect in migration works in attracting new immigrants. The fact that immigrants tend to settle in high income countries (or regions) implies the endogeneity problem in estimating the effect of immigration on income in destination countries (see paragraph 3.3).

The second point that we are going to focus on the rest of the thesis is the relation between migration and offshoring. One important stylised fact is that the location of factor movements is highly correlated. Figures 1.13 and 1.14 show the regional concentration of both inward and outward FDI among European countries. By making a comparison with immigrants localization in figure 1.11, it is particularly striking the strong and very significant correlation between migration and outward FDI (fairly good overlap between the high migration and the high offshoring regions). This is particularly true for some regions in Spain, France, UK, Italy, Sweden and Norway. On the other hand, it seems that there is not a good correlation between migration and inward FDI (this is clear by looking at Eastern Europe regions). This early evidence, by showing a kind of relation between immigrants and offshoring activities by firms, well motivates what we are going to do in the last chapter of the thesis.

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Figure 1-13: Map of the outward FDI projects among European regions

outward FDI in 2003, number of projects
(9,321]
(2,9]
(0,2]
[0,0]
No data
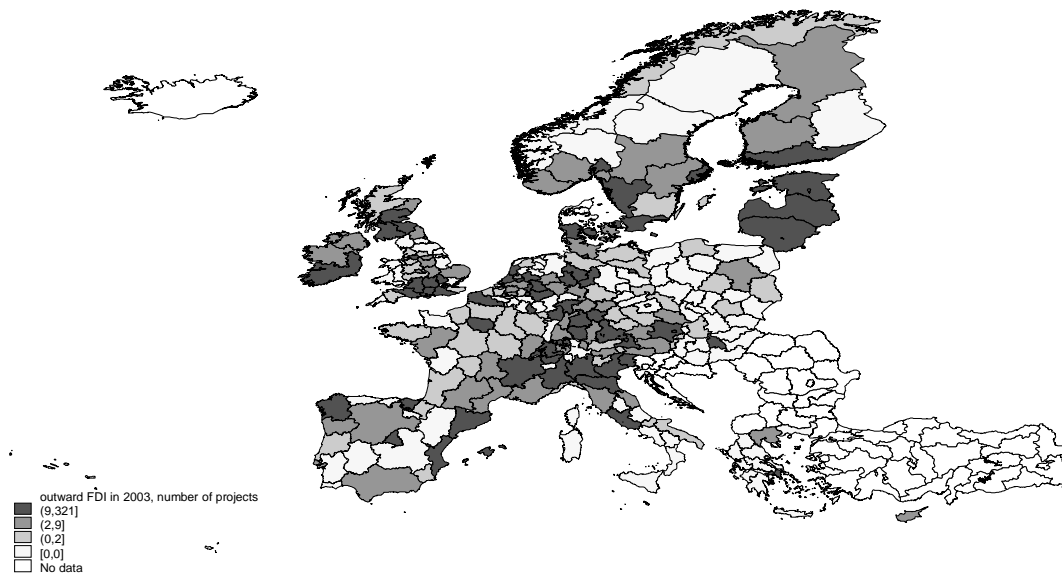
Source: Author's elaboration on OCOMONITOR data.

Figure 1-14: Map of the inward FDI projects among European regions

inward FDI in 2003, number of projects
(8,135]
(3,8]
(1,3]
[0,1]
No data
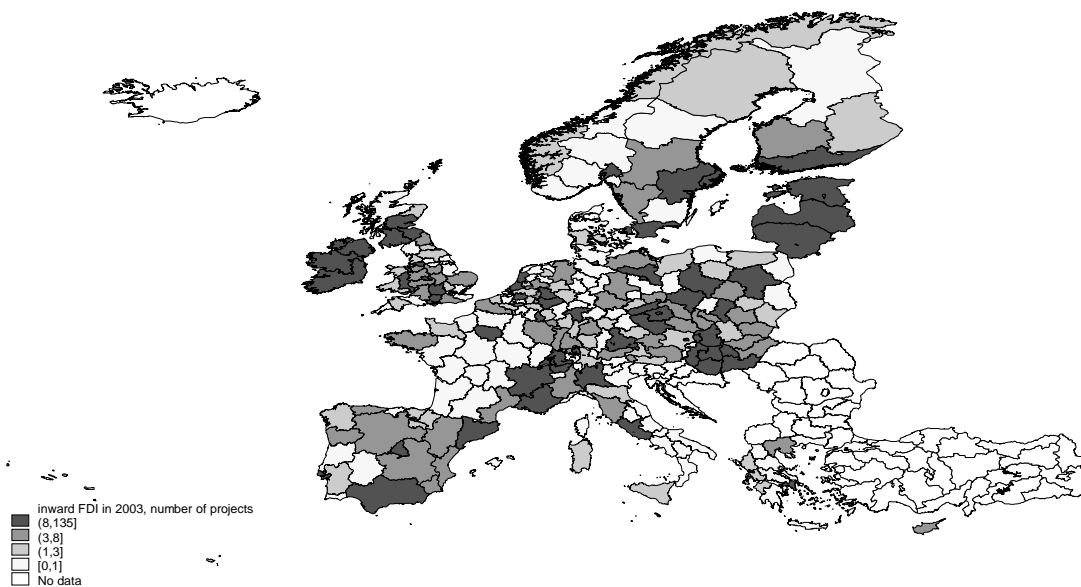
Source: Author's elaboration on OCOMONITOR data.

1.4   Plan of the thesis

Starting from the consolidated literature on the labour market effects of immigration (summarized in the second chapter in what follows) the aims of this work are: (i) to assess the impact of skilled immigration on income in destination countries (chapter 3) and (ii) to understand the relation between immigration and offshoring when asymmetric information about foreing born workers is assumed (chapter 4). So, the rest of the thesis is composed follows:

Chapter 2, *"The economic impact of migration on host countries: a survey"*, provides a survey of the literature on the effects of migration on the economic performances in host countries. The aim of the chapter is to provide a synthetic view of both theoretical and empirical literature to better understand how host economies are affected by changes in their foreign born population endowment. The chapter is intended to clear the ground for the following chapters.

Chapter 3, *"Skilled migration and economic performances: evidence from OECD countries"*, investigates the effects of immigration flows and their human capital content on per capita GDP variation in 24 OECD host countries. Theoretical models conclude that the effect of immigrants in host country's income depends on the human capital content of migrants (Benhabib 1996); empirically the question is still open and this paper contributes to make light on this. So we propose an empirical estimation of the effects of immigrants and their human capital content on per capita GDP variation. Using an IV model to solve the endogeneity problem we found that high human capital content by immigrants has a positive effect on per capita GDP variation, but it is not enough to fully compensate the overall negative effects of migration on changes in per capita output.

Chapter 4, *"Offshoring, migrants and natives workers: the optimal choice under asymmetric information"*, presents a theoretical model about the optimal choice for a firm between offshoring and hiring immigrant workers under asymmetric information about their ability and effort in production (symmetric information is assumed about home born workers). When a domestic firm hires an immigrant it doesn't know his ability; while when the firm goes abroad it uses local agent in order to buy additional information about workers, thus enforceable contracts may be set. We show that it is optimal for firms to produce low quality products offshoring the production abroad, while intermediate quality level products will be produced at home using foreign born workers. Finally, high quality products will be produced using native workers.

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Chapter 2

The economic impact of migration on host countries: a survey

2.1 Introduction

International flows of migrants are having an increasing role in the world economy: the total number of international migrants has increased over the last 10 years from an estimated 150 mil. in 2000 to 214 mil. persons in 2010;[1] in other words, today one of out of every 33 persons in the world is a migrant. These facts represent, in our view, both the importance of the topic and the main motivation for this chapter, which focuses on the effects of immigration on host countries' economic performances. The topic became a burning issue in the popular debate some years ago, when immigration appeared to have a negative effect on home born workers employment; moreover, the recent trend in immigration policies by countries, and the contemporaneous increase in offshoring activity by firms in developed countries, increased the research interest in investigating the economic effect of immigration and its relation with firms' offshoring decision.

Immigration has an effect on a lot of economic related aspects in both receiving and sending countries; but in this chapter we will focus only on its effect on host countries. In literature have been studied the effects of immigration on prices, employment, wages, physical and human

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[1]United Nations' trend in total Migrants Stock: the 2008 revision; http://esa.un.org/migration

capital accumulation, productivity, economic growth, offshoring decision by firms, etc; among them, in this chapter, we decided to have a survey of the existing literature on: (i) the effect of immigration on labour market, because of its importance in literature and because it is a crucial point for understanding all the other possible effects on immigration in receiving countries; (ii) the effect of immigration and its human capital content on income in destination countries, because of its policy implication in terms of skill selective migration policies; (iii) the relation between immigration and firms' offshoring decision in host countries, because of it is a burning point in the recent literature.

Traditionally, economists considered the labour market as the main channel through which immigration affects the host economy: immigrants increase the unskilled labour supply decreasing its price. Although the former proposition may appear a hard fact, unambiguous empirical evidence has not been found. Some studies, such as Aydemir and Borjas (2007), Card (2001; 2005) find negative (even if weak) effect of immigration on home-born workers wage, while Ottaviano and Peri (2008) and Peri and Sparber (2009) find a positive effect of immigration on local labour market. This ambiguity seems to be due to two main arguments that we will analyse in what follows: (i) immigrants and home-born individuals may be more or less substitute; (ii) empirical approaches present some problems to solve.

But the labour market is not the only channel through which immigration affects the host country, there is also a literature that looks directly at the effects of immigration on income level and growth in host countries. Dolado, Goria and Ichino (1994) set a growth model in which immigration contributes both to increase the population growth and to modify the human capital accumulation equation. They recognize the importance of the skill level of immigrants in determining their effect on income and growth in receiving countries, empirically they find an overall negative effect of immigration on both growth and income. On the other hand, Ortega and Peri (2009) by using the so called "accounting approach" find a positive effect of immigration on real GDP growth rate. The fact that has not been reached a consensus in literature on the effect of immigration on income, and its relevant role in immigration policy setting, pushed us to have a survey of this literature. The last stream of literature we are going to present in this chapter is about the relation between immigration and offshoring in immigrants receiving countries. This is a very recent literature and there are some ambiguous

empirical results: some works found a strong substitutability between immigrants' flows and outward FDI by host countries (Barba Navaretti, Bertola and Sembenelli 2008; Olney 2009a), some others found a kind of complementarity between the two phenomena (Javorcik et.al. 2006; Kugler and Rapoport 2005). We find useful to have a survey of this literature because, although it is very recent, it is growing very quickly.

The chapter is structured as follows: second paragraph summarizes the effects of immigration on economic performances in host countries, by looking in particular at the effect on labour market (paragraph 2.2.1) and on income (paragraph 2.2.2). In paragraph 3 we summarize the flourishing stream of literature on immigration and offshoring. The last paragraph concludes.

2.2 The economic effects of immigration on host countries

Stylized facts shown in the former chapter prove the importance of understanding the economic effect of immigration on host countries.

The effects of immigration on host countries have been theoretically tackled by several points of view and the conclusions strictly depend on the assumptions made in developing the model. As we will see in what follows the effect on the host countries theoretically depends on whether foreign and home born workers are assumed as perfect or imperfect substitutes and on whether immigrants are assumed to bring along them some human capital or not. By the empirical point of view, economists focused a lot on the labour market effect of immigration, considering the effect of immigration in receiving countries passing only through the labour market, but it is just one outcome of interest (Hanson 2008). This is the reason why there are several empirical works on the effect of immigration on labour market (Grossman 1982; Card 2005, 2001; Borjas 1995, 1999; Ottaviano and Peri 2006; D'Amuri, Ottaviano and Peri 2010). Most of them find a small, even if negative, effect on the home born workers' wage. But few empirical papers have been written on the general effect of migration on income and its variation in destination countries[2].

Given both the importance of the literature on the labour market effect of immigration and

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[2]Other stream of research focused on the effect of immigrants both on the host country's demand side and on the effects on the public expenditure.

its crucial role in understanding all other possible effects of immigration on receiving countries, we propose in what follows a brief survey of literature on the labour market effect of immigration, stressing the key point of whether immigrants are substitute or complements with natives in understanding their effects on employment and wages. In this section we also provide a survey of literature on the effect of immigration on income in receiving countries, focusing both on the nature of the studies (growth model or accounting approach) and on the skill composition of migrants in determining their effect on per capita GDP. The need for organizing this stream of literature originates from the lack in surveys literature on this particular effect of immigration (to our knowledge); but it is also useful to clear the ground for the next chapter.

2.2.1   The effects of immigration on local labour market

A lot of empirical and theoretical works have been written on the effect of immigration on local labour market (Grossman 1982; Card 2001, 2005; Borjas 1995, 1999; Ottaviano and Peri 2006; D'Amuri Ottaviano and Peri 2010); most of them concern the effect of immigration on US labour market (typically on micro data) and the main result of these works is that the impact of immigration on national wage is negative, rarely positive, but always small. The starting point for analyzing the debate on the effect of immigration on the host country is the Ryczynski theorem (1955): when a country (or region) is open to trade with other countries, exogenous change in labour supply (immigration) increases the output of product which employs labour relatively more intensively and decreases the output of the other good; this leaves relative factor prices unchanged. For this reason recent (mainly empirical) papers find modest degree of competition between immigrants and less skilled natives, namely immigrants affects only marginally the labour market of natives in USA (Altonji and Card 1991). Also Card (2001) concludes that immigration's effect on US labour markets is very small, moreover he finds that this is valid both for all workers and for the bottom of the skill distribution. Other works on other countries confirm this kind of evidence (De New and Zimmermann 1994; Pischke and Velling 1997; Winter-Ebmer and Zweimüller 1999). But this is just a part of the problem, because immigrants may be imperfect substitutes for natives.

Peri and Sparber (2009) set a model in which unskilled immigrated individuals do not compete with unskilled home born individuals, they have comparative advantage in different tasks

and thus unskilled immigration leads to a change in the productive specialization (increasing the overall labour productivity). In particular there will be a shift in the specialization of the host country: it will specialize in the task provided by immigrants, and wages for this kind of task will relatively decrease. In this setting immigration may influence the host economy performance increasing the labour productivity by task specialization. Peri and Sparber (2009) also provide empirical evidence of the fact that immigration changes the task specialization in the host country. Hanson (2008) set up a model where unskilled immigrants and unskilled home born individuals are mostly substitute, thus migration leads to the equalization of labour price: initially migration is not allowed and rich country's wages are higher than wages in poor country, when migration is allowed, unskilled workers will flow from poor to rich country and the wage in receiving country will decrease. Thus, the theoretical prediction about the effect of low skilled workers immigration depends upon: (i) whether the host country is open or closed to international trade, and (ii) the degree of substitutability between native and immigrants.

In a closed economy, immigration will lower the price of factors with which migrants are perfect substitutes and it will raise the price of factors with which they are complements. Assuming that in the host economy there are capital and both unskilled and skilled workers; if an unskilled flow of immigration occurs, the wage of this factor of production will decrease, and the effects on the other two factors are ambiguous. The fall in the unskilled wage will induce employers to substitute away from capital and skilled labour to unskilled workers; but the unskilled workers inflow means also that the optimal output is now greater; this scale effect will induce employers to use more of all inputs. This is what happens in a closed economy with no differences in native and foreign-born unskilled workers. If native and foreign workers are not substitutes, they work as different factors of production and native unskilled workers wage won't be affected by immigration flows. In an open economy (such as the traditional Heckscher and Ohlin models) trade is driven by difference in factor endowments and factor price equalization occurs. In this framework, immigration will lead to an increase in unskilled-labour intensive production (change in host country specialization) but wages will remain unchanged. This occurs because immigration leads the host country to export more low skilled intensive good. Obviously, when factor price equalization occurs, there is no reason for international migration. Immigration occurs if and only if a wage differential exists; but a wage differential exists if and

only if trade is not free (as in Mundell 1957) or when there are some wage rigidities. Otherwise a wage differential can be maintained by restrictions to international labour flows.

Since in the real world the assumption of closed economy is less plausible, the key question that allows us to discriminate between positive and negative effect of immigration on home-born workers wages is: are immigrants and home-born individuals substitutes or complements? To see how the assumption of substitutability/complementarity between immigrants and natives affects the prediction of theoretical models, we report results of Borjas (2009) who analyses the effect of immigration on domestic wages under the two possible assumptions on the relation between immigrants and natives. Author set a model in which only two goods are produced (one domestically and the other is imported), consumers have a quasy-linear production function and physical capital and labour contribute to the production of the domestic good following a CES production function. Initially foreign-born workers and natives are considered as perfect substitutes, and immigrants are shown to have a detrimental effect on national wage both in the short and in the long run[3]. The next step in Borjas (2009) is to assume heterogeneity of workers in production (high and low skill workers) and imperfect substitutability between immigrants and natives workers (in doing this he uses a nested CES function). Author shows that by considering heterogeneity of workers in term of their skill composition, the effect of immigration on wage is detrimental for the skill group with the higher supply shock due to immigration. This conclusion suggests the importance of the skill composition of immigrants in understanding the effect of immigration on the economic performance of receiving countries (this is a crucial point for the next chapter). Finally, when imperfect substitutability between immigrants and natives is considered, a positive effect is added to the overall change in wage level due to immigration shock: assuming that an immigration inflow doubles the pre-existing immigrants workforce, and that immigrants in the skill group i make a 10% of the total workforce; using the native-immigrants elasticity of substitution estimated by Ottaviano and Peri (2008) equal to 20, the native wages increase by 0.5%, while using an elasticity equal to 5.5 (as in Ottaviano and Peri 2006) the native's wage increases by 1.8%. This is basically what the theory of factor demand says, but as we will see in the next section, empirical literature found different effects

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[3]In the short run physical capital does not adjust to immigration shock and an increase in the return on capital is expected. In the long run physical capital adjusts to the immigrants shock, the return on capital comes back to its initial value and the effect of immigrants on wage is mitigated with respect the short run case.

of immigration on wages. The following paragraphs will show some empirical and theoretical literature on this topic, dividing studies finding complementarity between immigrant and native workers from those finding sustitutability.

Home-born and foreign born workers as imperfect substitute

As we argued in the former section, from a theoretical perspective, if we assume perfect substitutability between migrants and native workers we should expect a negative effect of immigration on domestic real wage, but if we assume imperfect substitutability a positive effect is allowed. This ambiguity reflects in empirical research; indeed despite a huge number of papers on the effect of immigration on local labour market have been written, literature has not reached any kind of consensus. There exist two main streams on this topic: (i) authors who find negative relation between immigration and low-skilled home born workers and thus perfect substitutability among them (such as Borjas 2003; Borjas, Grogger and Hanson 2008; Aydemir and Borjas 2007); (ii) authors who find positive relation between immigration and low-skilled home born workers and thus imperfect substitutability (such as Ottaviano and Peri 2006, 2008; Peri and Sparber 2009; and D'Amuri, Ottaviano and Peri 2010). This paragraph contains a survey of works that found imperfect substitutability between immigrants and home-born unskilled workers.

D'Amuri, Ottaviano and Peri (2010) using data for Germany found perfect substitutability between old and new immigrants but imperfect substitutability between immigrants and home born workers, this is coherent with the idea that immigrants and home born individuals do not compete for the same kind of occupation (tasks). The underlying idea is that immigrants and home born individuals have comparative advantage in different tasks (Peri and Sparber 2009). Firstly authors estimate the effects of new immigrants (1992 has been chosen as watershed between old and new immigrants) on the old immigrants employment, they found that when equivalent education is used to stratify workers, 10 new immigrants in German labour market cause the loss of 2 old immigrants jobs. They also estimate the effect of new immigrants on the native employment, and they find positive and robust effect of immigration: new immigrant workers in Germany don't crowd out native employment. Moreover, authors find strong evidence of imperfect substitutability between new immigrants and native workers. Finally,

D'Amuri, Ottaviano and Peri (2010) estimate the effect of immigration on native wages, they find that assuming imperfect substitutability between immigrants and native workers (elasticity of substitution equal to 16) immigration increase the natives' wage; while by assuming perfect substitutability immigration reduces a bit (closely to zero) the natives' wage.

Peri and Sparber (2009) show theoretically that immigration leads to an increase in the relative wage of home born individuals, by assuming that foreign and home born individuals have comparative advantages in different tasks. Immigration shifts the initial specialization to the task where immigrants have a comparative advantage. From the empirical point of view, Peri and Sparber (2009) estimate the following equation:

[2.1] $\ln \left(\frac{C_D}{M_D} \right)_{s,t} = \alpha_s + \tau_t + \gamma \left(share\_foreign \right)_{s,t} + \varepsilon_{s,t}$

where α_s measures the time invariant fixed effects, τ_t measures the time fixed effects and $\left(share\_foreign \right)_{s,t}$ is the share of foreign born individuals over the total population in region s at time t, C_D/M_D is the ratio between communication over manual tasks native worker labour supply. In order to see the effect of new immigration on old immigrants and native labour supply, authors estimate the two following equations (based on the previous one):

[2.2] $\ln \left(\varsigma_D \right)_{s,t} = \alpha_s^C + \tau_t^C + \gamma^C \left(share\_foreign \right)_{s,t} + \varepsilon_{s,t}^C$

[2.3] $\ln \left(\mu_D \right)_{s,t} = \alpha_s^M + \tau_t^M + \gamma^M \left(share\_foreign \right)_{s,t} + \varepsilon_{s,t}^M$

where ς_D is the average native-born supply of one kind of task (manual) and μ_D is the average native-born labour supply of a second task (communication). Using different sample of data, authors find robust evidence of the positive relation between foreign born workers share on the C_D/M_D ratio, so immigration increases the natives specialization in communication tasks (this confirms the assumed imperfect substitutability between native and foreign born workers). Coefficient associated to γ^C is positive and significant, while coefficient associated to γ^M is negative and significant. In particular a 1% increase in foreign born labour share brings to a 0.31% increase in natives' supply of communication tasks and to a 0.03% decrease in natives' supply of manual tasks. To solve the endogeneity problem authors use a traditional instrument in this literature, observing that new immigrants tend to move in the same region (or urban area) in which previous immigrants live, and that a large proportion of immigrants in

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USA from 1960 and 2000 came from Mexico, the location preferences of Mexicans was used as an instrument. It is time and region variant and it is uncorrelated with the changes in demand. Estimations with this instrument (using IV technique) give the same results as OLS: immigrants lead to a shift in native labour supply (from manual tasks to communication tasks), and to an increase in the natives' supply of communication task and to a reduction in the natives' supply of manual tasks.

Ottaviano and Peri (2008) answer to the critique by Borjas, Grogger and Hanson (2008) by re-estimating the elasticity of substitution between immigrants and native workers in production. They find robust evidence of the imperfect substitutability between immigrants and natives by using: (i) different sample of data (all people who worked for wages except self-employment and the former sample without people enrolled in school), (ii) different specification sample (men, women, overall) and (iii) different combination of fixed effects (education by experience, years, year by experience, year by education). In all these cases the estimated elasticity of substitution between natives and migrants is about five ($\sigma_{imm} \simeq 5$).

Other empirical estimations assessing a kind of complementarity between foreign and native workers are: Gavosto, Venturini and Villosio (1999) for Italy, Haisken-De New and Zimmerman (1999) for Germany, Dolado, Jimeno and Duce (1996) for Spain, Winter-Ebner and Zweimuller (1996) for Austria and by Carrigton and De Lima (1996) for Portugal.

Home-born and foreign born workers as substitutes

When natives and foreign born workers are assumed as perfect substitutes a detrimental effect of immigration on wages is expected. The assumption of perfect substitutability may be done under two circumstances: (i) one good with two kinds of labour (skilled and unskilled) , (ii) two goods and two kinds of labour.

Let's assume a one good production and two types of labour framework (skilled and unskilled), immigration increases only one skill group (for example unskilled one) which will suffer a wage reduction both in short and long run. But the other skill group will benefit from an increased wage. Finally, imagine a traditional Heckscher and Ohlin framework with two goods and two types of labour. Immigration increases the endowment of one skill group, for example unskilled one, this will reduce the wage of unskilled worker relative to skilled one in the short

run. Now the unskilled intensive industry becomes more profitable, it expands its output, and accordingly to the Rybczynski theorem, wages of the unskilled group increase relative to the skilled one. But in the long run wages are unchanged and the output mix shift towards the unskilled intensive industry.

The first work who found perfect substitutability between foreign born and native was by Grossman (1982). The author estimated the elasticity of substitution among factors, by assuming a production function where inputs are native workers, second generation immigrants workers, foreign born workers and the capital stock. He found that both second generation and foreign born workers are substitutes for native workers, while capital is complement with the all kind of labour (but the degree of complementarity is strongest with foreign born workers). Grossman (1982) argues that the effects of immigration have to be analyzed with respect to the time horizon: in the long run wages are flexible to adjust, while in the short run natives a wage rigidity occurs. In the short run, when natives wages are downwardly inflexible, a 10% increase in immigrants leads to a 0.8% decrease in native employment (firms switch away from natives) and to a decrease in immigrants wages by 2.2% but the return on capital increase by 0.2% attracting capital. In the long run when all wages are flexible, a 10% increase in immigrants leads to a 1% decrease in native's wage, to a 2.3% decrease in foreign born wages and to a 4.2% increase in return on capital. Altonji and Card (2001) found ambiguous results on the effect of immigrants on natives employment and wages. Using cross section analysis on 120 major SMSA's for the 1970 and 1980 Census, they found negative, even if small, effect of immigrants on the employment/population ratio among unskilled natives. But a positive effect of immigrants was found on the weekly wages: a 10% increase in immigrants leads to a 4.7% increase in weekly earnings. The first differences estimation shows different a result: immigration increases the native employment/population ratio (effect on wages isn't significant).

Card (2001) studied the effect of immigration on labour market outcomes, the main point of this work is the definition of an instrumental variable (widely used today in literature) in order to solve the endogeneity problem in new immigrants' localization[4]. Card (2001) finds that in

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[4]The basic idea is that new immigrants go where earlier immigrants waves are localized (network ethnic effect), so that the estimated immigrants inflows (*supply push immigration, SP*) can be calculated as:

[1.39] $SP_{jc} = \sum_g \tau_{gj} \lambda_{gc} M_g$

the short run an inflow of immigrants in the period 1985-1990 reduced the relative employment rates of natives and low-skilled service occupation by up to 1% and by up to 3% in immigrants intensive cities. Moreover, immigration reduced the relative wages of workers and less-skilled service workers in high immigrants cities by no more than 3%.

More recently Borjas, Grogger and Hanson (2008) starting from the paper by Ottaviano e Peri (2006) concludes that data do not allow the rejection of the hypothesis that equally skilled immigrants and natives in the United States are perfect substitutes. They tackle Ottaviano and Peri (2006) by two points of view: (i) by showing the sensitivity of the Ottaviano and Peri (2006) results to various methods of addressing the within-cell heterogeneity problem, (ii) by proposing alternative estimates of the elasticity of substitution after the corrections in the data set used by Ottaviano and Peri (2006). Borjas, Grogger and Hanson (2008) by replicating the estimates by Ottaviano and Peri (2006) find the weak robustness of the estimates of σ_{imm} but the sign and the average value are similar to those in Ottaviano and Peri (2006). Authors also correct[5] the data set used by Ottaviano and Peri (2006) to find new estimates for σ_{imm}; after these corrections they provide evidence of negative elasticity of substitution between immigrants and native workers reassessing the substitutability between foreign and home born workers.

Figure 2.1 summarizes the empirical evidence on the kind of substitutability that has been found in literature up to now.

2.2.2 The effects of immigration on host countries economic performances

The debate on immigration policies usually turns around a question: is immigration bad for the host country's economic performances? The previous paragraph reported some evidences on the effect of immigration on the local labour market, but a new stream of literature is growing in recent years (Ortega 2008; Ortega and Peri 2009; Bellini, Ottaviano, Pinelli and Prarolo 2009), it concerns the effects of immigration on economic performances in destination

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where M_g is the number of immigrants from an origin country g entered in US between 1985 and 1990; λ_{gc} is the fraction of immigrants from an earlier wave of immigration from country g living in city c; τ_{gj} represents the fraction of immigrants from g employed in occupation j. So SP is the estimated immigrants flows in absence of demand pull factors, for this reasons it is well correlated with the gross immigration inflows and uncorrelated with economic or labor market performance.

[5]Two main corrections concern: 1. the consistency of immigration status along the time horizon, 2.the restriction of the sample by excluding self-employed workers.

Figure 2-1: Summary table of empirical results on the labor market effects of immigration

Paper	Substitutability between native and foreign born workers	Effect of immigration on native's wage	Country
Aydemir and Borjas (2007)	perfect	negative	Canada
Altonij and Card (1991)	perfect	ambiguous	USA
Angrist and Kugler (2002)	perfect	-	EU
Borjas (2003)	perfect	negative	USA
Borjas, Grogger and Hanson (2008)	perfect	negative	USA
Borjas Freeman an Katz (1996)	ambiguous	ambiguous	USA
Card (2001)	perfect	negative	USA
Card (2005)	perfect	negative	USA
Carrington and De Lima (1996)	imperfect	negative	Portugal*
D'Amuri, Ottaviano and Peri (2010)	imperfect	positive	Germany
De New and Zimmerman (1994)	perfect	negative	Germany
Dustman, Fabbri, Preston and Wadsworth (2003)	imperfect	positive	UK
Gavosto, Venturini and Vollosio (1999)	imperfect	positive	Italy
Grossman (1982)	perfect	negative	USA
Hunt (1992)	perfect	negative	France*
Ottaviano Peri (2008)	imperfect	positive	USA
Peri Sparber (2009)	imperfect	positive	USA
Pischke and Velling (1997)	imperfect	-	Germany
Pope and Wither (1993)	imperfect	no effect	Astralia
Velling (1995)	perfect	no effect	Germany
Winkelmann and Zimmerman (1993)	perfect	negative	Germany

* This paper focused on the effect of repatriates

Source : Author

countries. Per capita GDP has been widely used as a proxy for economic performance of receiving countries. The importance of this topic is straightforward if one looks at the policy implication, nevertheless few empirical works has been written in solving this question. There are two main reasons for this lack in literature: (i) endogeneity problem (a detailed treatment in what follows); (ii) data problem. Recently data on migration become more reliable, so empirical works are now feasible (the endogeneity problem can be solved by using instrumental variable estimation). From a theoretical viewpoint, the economic effect of migration on receiving countries can be analyzed by using two different approaches: (i) traditional growth models and (ii) the accounting approach. Traditional growth models insert (both theoretically and empirically) immigration in well consolidated growth model to show the effect of immigrants flows into per capita GDP growth rate variation in receiving countries (Barro and Sala-I-Martin 1992; Dolado, Goria and Ichino 1994). The idea is that, starting from the extension of the traditional Slow-Swan model, and assuming immigrants endowed with zero human capital, immigration is like an increase in country's population so that immigration leads to a slower economic growth in per capita terms (because of the local capital dilution). But by assuming immigrants transporting some kind of human capital (Benhabib 1996), the dilution of local physical capital may be offset and some economic growth in per capita terms is allowed. The accounting approach consists of estimating the effect of immigration on per capita GDP by looking at the effect of immigration on each component of the per capita GDP function (Ortega and Peri 2009); this literature uses mainly static panel data model or a cross section approach (this stream of literature is having new lymph in recent years). Thus the two former approaches to the relation between immigration and per capita GDP are the main objects of this section; but before going in deep on their description, we need to briefly focus on two propaedeutic points to this literature: (i) the "immigration surplus" and (ii) some empirical problems arising when immigration is involved in estimating equations.

A first step toward the relation between immigration and income: the immigrants' surplus

The first step in understanding the potential effect of immigration on host countries is to provide an explanation of the so called "immigration surplus" as the overall receiving country gain from

immigration. In doing this we follow two papers: Borjas (1995) and Hanson (2008). Given a traditional production function with capital (K) and labour (L), the labour force is divided in home-born and foreign-born individuals. Initially let us ignore the possibility that immigrants might augment the host country's capital stock, and immigrants (M) and native (N) workers are perfect substitutes in production (so, $L = N + M$). Moreover the model assumes labour supply curve being inelastic. At the equilibrium the remunerations of production factors (w and r) are equal to their marginal production, and national income (GDP) is: $Q = rK + wN$.

Without migration, the national income is simply given by $w(0)BN$ in figure 2.2, but when immigration is allowed, the national labour endowment rises as far as L and the new internal equilibrium shifts to the point $L - W(1)$. As a result the national wage decreases, but the national income increases (if and only if the increase in workers is larger than the wages decrease). The difference with respect the initial equilibrium is the trapezoid $BCNL$. Since the rectangle $DCNL$ is the immigrants' income, the so called immigrants' surplus is the triangle BCD (as usual the increased area under the labour demand curve and wage level). The immigrants' surplus assumes the following form:

[2.4] $immigrants\ surplus = \frac{[w(0)-w(1)]M}{2} = -\frac{1}{2}sem^2$

Where s is labour's share of national income, e is the elasticity of factor price for labour, m is the fraction of the workforce that is foreign born. The elasticity of factor price is small when the labour demand is elastic, so we can conclude that the immigration surplus is small when labour and capital are easily substitutable. The elasticity of factor price is large when labour demand curve is inelastic. The immigration surplus, therefore, arises because of the complementarities that exist between immigrants and native-owned capital.

Hanson (2008) shows the welfare consequences of immigration allowing for different skill levels in the workforce (low-skilled and high skilled) and for simplicity (as in Borjas 1995) labour supply curve is inelastic. He also assumes that there are two countries in the model: one migrants sending country and one receiving country. Using the same graphical instrument as in Borjas (1995) we can analyze the effect of migration in sending and receiving country as in figure 2.3; where the horizontal axis is the total amount of unskilled labour $(\bar{L})$ in the two economies (home, h and foreign, f). At the initial equilibrium (point 1 in figure 2.3), L_1^h low-

Figure 2-2: Immigration surplus in Borjas (1995)
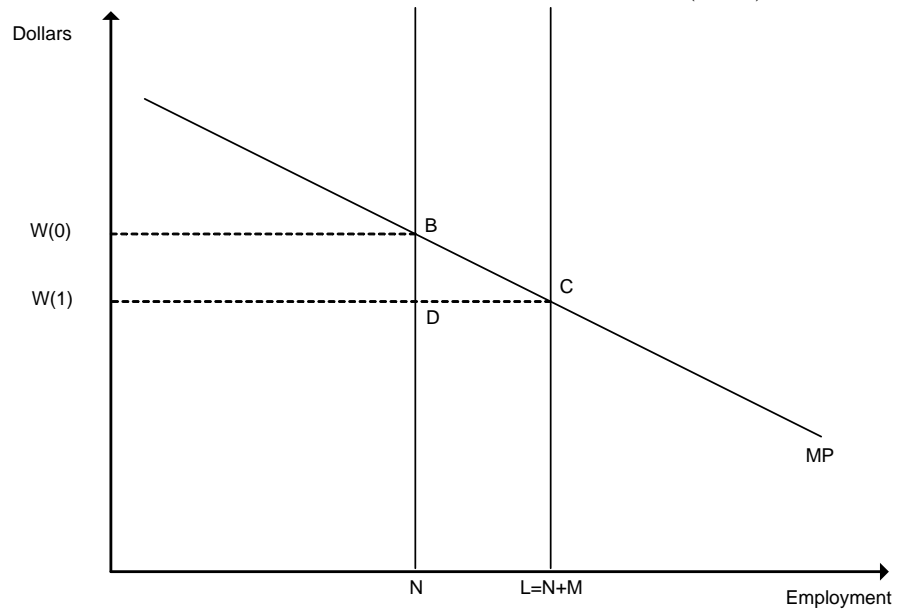
Source: Borjas (1995)

skilled persons work in receiving country, while $\bar{L} - L_1^h$ individuals work in the sending country. So, there exists a wage differential between sending and receiving country. When low-skilled workers are allowed to freely move between countries, there will be migration from low wage country to high wage country as far as the wage will equalize (point 2 in figure 2.3). In the receiving country home-born workers lose income-area A, while the gain in income for native high-skilled workers is given by A+B. The immigration surplus in the receiving country is the B area and it coincides with the gain in terms of GNP, while the gain in terms of GDP is the B+C+D+E area (because it includes the income that migrants receive in receiving country). In the sending country native high-skill workers have an income loss equal to D+F, not migrating workers gain the area F and migrating native low-skilled workers have an income gain equal to area C+D. The sending country gains in GNP by C and loses in GDP by D+E. World national income increases by B+C as migration eliminates differences in labour productivity between countries. In order to have a Pareto gain from international migration, home low-skilled workers have to receive an income transfer by A and sending country's high-skilled have to receive an income transfer by D+F. These transfers may derive from redistributive taxes.

From the description of the immigration surplus, we can conclude that receiving country gain in terms of GDP by hosting immigrant and that world's welfare is increased by south-north migration because of the clearing of labour productivities between sending and receiving countries. But notice that we cannot conclude anything by the point of view of per capita GDP in destination countries, to this purpose we refer to the following paragraphs.

Econometric problems

A second reason, other than theoretical assumptions, of why such ambiguity in empirical evidence about the effects of immigration is concerning empirical methods and strategies. A lot of approaches have been used in this literature, this is due to some problems that arise when one tries to estimate immigration's effect on host country: *(i) endogeneity from immigrants localization choice, (ii) composition effect, (iii) internal migration and factor price equalization, (iv) measurement errors.* In order to solve the former problems, a lot of devices have been used: *(i) using differences in cross-sectional analysis, (ii) using time series, (iii) separating labour*

Figure 2-3: Immigration surplus in Hanson (2008)
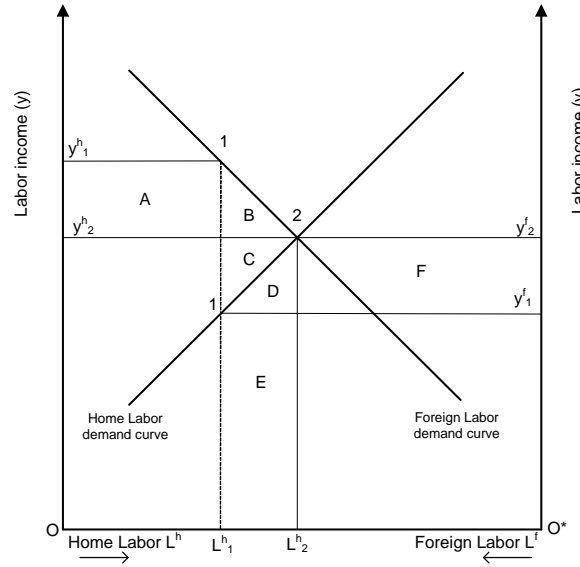
market outcome on the basis of the origin of labour, (iv) using internal migration flows, (v) using instrumental variable (both for endogeneity problem and measurement errors). Endogeneity arises if immigrants choose where to stay on the basis of higher regional wage or GDP, in this case it is not only that immigration drives economic performances (or labour market changes), but local economic performances drive immigration. This problem leads to a biased estimation. In order to solve this problem one can use data from two or more periods (the so called differences in cross-sectional analysis), the change in immigrants density will not be affected by the change in the local wage, and any correlation between those changes will be attributable to the effect of a change in immigrants density on the change in wages (Friedberg and Hunt 1995). On other way to remove endogeneity is to use instrumental variables: if one can find a variable correlated with the change in immigrants presence and uncorrelated with the local economic performance, the bias due to immigration choice can be removed. When immigrants choose the region where to stay, they can take into account also other aspects of a region, such as existing networks and the presence of community with the same culture and language. Thus, besides economic performance reasons, immigrants may tend to settle in regions with high density of immigrants or population in general (De Arcangelis, Jayet and Ukrayinchuk

2010). Since the stock of existing immigrants in a region is unlikely to be correlated with current economic shocks (notice that a sufficient time lag is necessary), historic settlement pattern may solve the endogeneity problem. Altonji and Card (2001) used the stock of immigrants in 1970 as an instrumental variable for the change in immigrants population between 1970–1980 in USA cities, the logic is the following: new immigrants tend to go where other immigrants already exist, but this variable is uncorrelated with local economy outcome or wages. They find that immigrants have a negative effect on participation rate and on the weekly earnings. A 1% increase in immigration reduces by 1.2% unskilled home-born wages. Pischke and Velling (1997) apply the same method as in Altonji and Card (1991) to German data for 1985 and 1989, and they find a weak detrimental effect of immigration on local wages.

An estimation technique which avoids any problem of endogeneity is the time series approach, in this way any bias due to localization choice may arise. Pope and Withers (1993) used this approach for Australia, finding no immigration's negative effect on local labour market.

Composition effect is due to the impossibility of discriminate between wage earned by immigrants in the region and wage earned by home-born workers in the same region (Friedberg and Hunt 1995). Thus, if immigrants earn less than native, regions with a higher presence of immigrants have a lower average wage even if immigrants have no effect on local labour market. This problem can be solved using individual-level census data with which one can control for many individual's characteristics (see LaLonde and Topel 1991).

Since regions are open economies, inter-regional migration flows are allowed and so the problem of internal migration and factor price equalization may arise: if factor price equalization occurs the regional effect of immigration can be removed although it exists at national level. Blanchard and Katz (1992) for USA and Decressin and Fatas (1995) for Europe, suggest that it is reasonable to seek the impact of immigration by using cross-sectional data at regional level, since the bias due to the factor price equalization toward zero (because it takes a lot of time to achieve). The problem of internal migration can be removed by instrumental variables (or obviously by controlling for the internal migration flows). In summary, one can assume that factor price equalization is not so rapid as to nullify cross-sectional analysis; however, it is important to use instrumental variables to solve the compensation problem of internal

migration.

An other approach to estimate the labour market effects of immigration is the so called *wage inequality literature;* this kind of studies use both cross sectional and time series analysis. The idea is to calculate the contribution of immigration to local unskilled labour supply and then the effect of the changed unskilled labour supply on their wages. Borjas, Freeman and Katz (1992) use time series data for USA from 1967-1987 and find that immigration implies 25% of the total 10% decline in the relative earnings of high school dropouts; in this period the immigration rose from 6.9% to 9.3%, so, 1% increase in immigration leads to 1.2% decrease in absolute wage of dropouts[6]. Borjas and Ramey (1995) used a cross sectional analysis, they found that a 1% increase in the fraction foreign-born reduces the wage of high school dropouts relative to college graduates by 0.6%. This kind of estimates overstates immigration effects because they suffer the composition problem: the results confound the immigration negative impact with the "algebraic" negative effect (the increased number of immigrants reduces the mean wage, because of the low wage earned by immigrants). In general, the wage inequality literature can be thought as an upper bound on the negative effect of immigration on wages.

Measurement errors in immigrants density plays a central role in studies on the effects of immigration in destinaiton countries; to the extent that it has been often recognized as the main motivation of the weak or null effect of immigration on labour market in destination countries (Aydemir and Borjas 2010). Measurement errors problem implies inconsistent and biased[7] OLS coefficient, but it may be solved by using IV estimation. The consequence of the bias in OLS estimation due to measurement error is amplified in small sample studies and often implies OLS coefficient being lower (in abosolute value) than IV coefficient: the OLS estimate is determined by the partial correlation between labour market measure and immigrants share, while the IV estimate is determined by the partial correlation between labour market measure and the component of the immigrants share explained by our instruments. Thus, mechanically, the fact that the OLS estimate is usually smaller than the IV estimate means that labour market partial association with the component of immigrants share that is not correlated with the instrument

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[6]This result is coherent with findings in Altonji and Card (1991).

[7]The bias is expected to be toward zero if measurement error involves only one right hand side variable. If the measurement error involves more than one explanatory variable, we cannot say *ex ante* that the bias is toward zero.

is weaker than its partial association with the component that is correlated (attenuation bias). This problem reduces using large sample of data such as national census (Dustman *et al.* 2003). The solution for the measurement error is to use instrumental variable, for example one can use other alternative measures of immigration from other surveys as instrumental variables of the regional immigrants density.

The main message of this paragraph is that when immigrants related variable is used as a determinant for certain economic performances, a lot of caution has to be paid in choosing the right (less biased) estimation method.

Migration in the growth literature

The first attempt to analyse the effect of immigration flows on per capita GDP in host countries was to consider immigration flows as a further source for population growth in both theoretical and empirical growth model. These early models inserted immigration in the basic Solow-Swan model framework, by assuming immigrants endowed with zero human or physical capital. Given this assumption immigration has the effect of reducing per capita income because of the local physical capital dilution. This point is evident by looking at the baseline Solow-Swan model in terms of prediction of investment rate (s) and population growth (n) on real per capita income in a given time (in logs):

[2.5] $\ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(0) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta)$

where as usual $\frac{Y(t)}{L(t)}$ is the per capita output in a certain time period t; A is the level of technology, g is the growth rate of technology, δ is the physical capital depreciation rate and α is the contribution of physical capital to the total output. Thus, assuming immigration as a simple exogenous increase in population (by increasing n), it has a negative impact on per capita GDP (Mankiw, Romer and Weil 1992). Similarly emerges the negative impact of immigration on per capita GDP growth under the former assumptions on technology and immigration. Notice that these models assume immigrants as perfect substitute for natives in production. Afterwards immigrants have been assumed as capital endowed workers, so potentially they are allowed to contribute to the human capital accumulation process in the augmented Solow-Swan model framework (Mankiw, Romer and Weil 1992); where human capital also contributes to

the production process. Thus if immigrants are assumed to bring a certain quantity of human capital along them, human capital dilution may be offset. It is simple to see the point by looking at the equation for income per capita in logs:

$$[2.6] \ \ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(0) + gt + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta)$$

where all symbols have the same meaning that in equation [2.5] but s_k in now the fraction of income invested in physical capital and s_h the fraction invested in human capital; β is the human capital share of output (Mankiw, Romer and Weil 1992). By looking at equation [2.6] immigration affects both the population growth side and the human capital accumulation side of [2.6]. Following this view, the crucial point is to understand how big is the threshold level of human capital endowment of immigrants in order to be growth enhancing (i.e. to offset the human capital dilution due to an simple increase in population). If immigrants own a low quantity of human capital, their impact is similar to a simple faster population growth in slowing per capita GDP (and growth). If immigrants' human capital is higher than natives', growth will be speeded up (Benhabib 1996; Friedberg and Hunt 1995).[8]

This is what emerges from the paper by Dolado, Goria and Ichino (1994), which modifies the Mankiw, Romer and Weil (1992) model by considering immigration as a source for working population growth rate and as a source of human capital accumulation.[9] In this paper authors consider a three factors production function (labour, physical and human capital) characterized by constant return to scale. Immigration enters into the model by modifying the population growth equation (by adding the net immigration rate), and the human capital accumulation equation by splitting the human capital sources into natives and immigrants led. They conclude that zero human capital endowed immigration has negative effect on output and growth in host country, while a higher human capital level owned by immigrants has a positive effect on both output in level and income growth rate.[10] In particular the overall effect of immigration on growth would be positive if the average human capital content of immigrants is higher than that owned by natives.

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[8] See Friedberg (2000) for more details on the portability of human capital by immigrants

[9] In this model immigrants do not contribute to physical capital accumulation

[10] This conclusion holds in the more realistic case in which immigrants own less aggregate human capital than natives

Similarly, in a very recent paper Azarnert (2010) set a model in which he distinguishes two different possible effects of high skilled immigration mass inflows. He found that high skilled immigration is growth enhancing for the destination countries, if their human capital content is enough to overweigh the immigration-induced adverse effect on educational incentives for natives.

So we may conclude from a theoretical perspective that, by modifying traditional growth model and assuming perfect substitutability between native and foreign born immigrants, the effect of immigration depends on the kind of immigrants: if immigrants own a low quantity of human capital they negatively affect both output in level and GDP growth; but the higher is their human capital content, the higher is their contribution on output and GDP growth.

Although theoretical models have been reached unambiguous conclusion about the relation between immigration and growth and about the role played by the human capital content by immigrants, only few empirical studies have been conducted and not a clear picture emerges from these. A very seminal paper on the effect of immigration on per capita income growth was by Barro and Sala-I-Martin (1992); authors regressed per capita income growth on the level of per capita income in 47 Prefectures in Japan and 48 States of the U.S. In this case coefficient associated to income level represents convergence between regions; by adding immigration variable to the estimated equation the convergence coefficient rises, moreover they obtain a positive coefficient for the immigration variable: a 1 percent point higher immigration is associated to 0.1 percent higher growth rate. When authors use instrumental variable estimation to solve the endogeneity problem, the coefficient becomes not significant and the convergence coefficient remains unchanged with respect the estimation without immigration. So they conclude that immigration has a little effect on income growth. Dolado, Goria and Ichino (1994) built a data set of 23 OECD countries from 1960 to 1985 and estimated a traditional empirical growth model by including the net immigrants inflows rate as a component of the total population growth rate, and the human capital content by immigrants as an additional source of the human capital accumulation process. They found a negative and significant effect of immigration on per capita income growth, concluding that the reason of such negative impact of immigration relies on the fact that immigrants in OECD countries own lower human capital than natives. Kim, Levine and Lotti (2010) after a simulation exercise conclude that migration of no-skill bias and skilled

migration (from low to high TFP regions) is in general beneficial for both the receiving country and the world growth rate by respectively 3% and 5%. But purely unskilled immigration has a negative impact on the world growth rate (-3.5%). But having a purely unskilled immigration is not likely since has been shown that immigration is always biased toward skilled workers.

A new approach to the relation between immigration and income: the "accounting approach"

The accounting approach consists of calculating the logarithm derivative of per capita GDP (after having specified the production function) and then analysing the effect of immigration on each component of the log total derivative of per capita GDP. For example, assuming a simple two factors Cobb-Douglas production function, the log derivative of per capita GDP has the following form:

[2.7] $\frac{\Delta y}{y} = \frac{\Delta A}{A} + \alpha \left(\frac{\Delta K}{K} - \frac{\Delta L}{L} \right)$

where as usual, y is the log of per capita GDP, A is the log of the total factor productivity, K is the log of physical capital and L is the log of the labour force employed in production. The idea is to see the effect of immigration on each component of equation [2.7]. For example immigration may affect TFP by increasing the efficiency of production process given its complementarity with native workers (Peri and Sparber 2009); on the other hand immigration may affect the physical capital accumulation because, in the short run, immigration by decreasing the capital-labour ratio may increase the return on capital in destination countries.

This is the approach used in the paper by Ortega and Peri (2009), which has also the merit to find a new way to solve the immigrants' localization endogeneity problem by using the estimated bilateral immigration flows. Thus they use a 2SLS estimation to analyse the effect of immigration on each component of the per capita GDP function. In particular they show that an increasing immigration leads to: (i) an increasing employment growth, (ii) an increasing physical capital growth and (iii) a null effect on TFP growth. Moreover they estimate the effect of immigration on per real GDP growth finding that a 1% increase in immigrants flows entails about a 1% increase in the real GDP growth rate. But the effect of immigration on per hour worked GDP growth is null. Ortega (2008) uses the population growth due to immigration as

an independent variable for per capita GDP and per hour worked GDP growth. He finds that a 10% increase in population growth (induced by immigrants) leads to a 6.7% increase in GDP, but to a reduction of 3.3% in per capita GDP growth and to a reduction of 4% in per hour worked GDP growth.

Felbermayr, Hiller and Sala (2010) use a cross section analysis to determine the sign of the relation between immigrants stock and per capita GDP in destination countries. They also control for institutional quality, trade and financial openness, finding that immigrants stock boosts per capita GDP in destination countries. In particular a 1% increase in the migrants stock leads to a 0.22% increase in per capita GDP (in level). Similarly Bellini, Ottaviano, Pinelli and Prarolo (2009) find that the share of foreigners over total population in destination countries has a positive effect on per capita GDP among EU destination regions. Sparber (2010) uses data on 48 US states from 1980-200 to explore the relationship between cultural diversity and per capita GDP variation. In this paper the racial diversity has been approximated using the fractionalization index (the complement to one of the sum over races of the squared immigrants' share in each state and time period). Instrumental variable estimation shows a positive and significant effect of diversity on per capita GDP by controlling for 8 economic regions[11], but using all the 48 state fixed effects to account for time invariant income explanatory variable (other that diversity), coefficient on diversity becomes insignificant. In the spirit of the accounting approach, Sparber (2010) also estimate the effect of racial diversity on TFP, finding again a positive and significant relation controlling for the eight regions fixed effects, and a null effect when controlling for all the 48 US states.

The empirical evidence on the relation between immigration and income (following the accounting approach)[12] do not take into account an important feature arising from theoretical growth models: the human capital content of immigrants. It seems that, although theoretical models highlight the importance of the human capital content of immigrants in determining their effect on per capita GDP (in both levels and growth), empirical papers did not take into account this dimension. This is one of the motivations of what we will do in chapter three.

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[11]New England, Middle Atlantic Coast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountains, Fae West.

[12]The other common characteristic of the all empirical papers following the accounting approach is that static fixed effects panel data model have been used

2.3 Relation between immigration and offshoring: a flourishing stream of literature

The aim of this section is to provide a survey of literature on the relation between migration and offshoring. From a theoretical point of view this link has been studied firstly by Ramaswami (1968) and by Bhagwati and Srinisavan (1983) who criticised the paper by Ramaswami (1968) because it relied on the assumption that the wages of immigrants in destination countries are lower than those earned by natives. Recently some empirical papers confirmed the idea that immigrants earn a lower wage than natives[13], giving in this way new lymph to the debate on the relation between immigration and offshoring. The central issue in the literature concerning immigration and FDI, is to understand if immigrant employment substitutes or pushes foreign direct investment. The importance of this relation lies in policy implications: it would be important for policy makers to know this relation in order to set global optimal rules on factor mobility. Indeed, if immigration is used by firms to reduce costs and to be internationally competitive, policy makers would relax quotas on immigration, also if it would reduce outward FDI.

The relation between immigration and offshoring is ambiguous both from a theoretical point of view and from the empirical results. In a traditional Heckscher – Ohlin (H-O) framework capital will flow to where it is less relatively abundant (so where its remuneration is higher), at the same way labour will flow to where it is relatively more paid. So under the H-O approach, immigration and FDI are substitutes: immigration leads to a reduction in capital labour ratio and to an increase in the home return on capital, this will deter outward FDI (offshoring) and will attract inward FDI. Conversely more recent models use a different approach: immigration (both skilled and unskilled) increases the home firms' information about the foreign countries (business networks); this reduces the foreign country risk and will induce home firms to offshore production abroad (by this viewpoint a kind of complementarity exists between immigration and offshoring). The paper by Kugler and Rapoport (2005) goes in this direction showing a positive relation between immigrants stock in US and offshoring activity by US forms. In order to put things simple, three kinds of relations may occur:

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[13] Antecol, Cobb-Clark and Trejo (2003); Butcher and Di Nardo (2002); Chiswick, Le and Miller (2008).

- the first effect of immigration is to reduce the number of workers in the foreign country, but it leads to a reduction of the capital labour ratio in home country and thus to an increase in the home return on capital, that deters offshoring by home firms and attracts inward FDI. By this point of view outward FDI and migration are substitutes, while inward FDI and immigration seem to be complements. But this viewpoint omits the skill composition of migration.

- a more unskilled immigration increases the proportion of unskilled in the home population and the proportion of skilled in the origin country, so it also relatively increases the capacity of the foreign economy to adopt new technologies (in other words it increase the efficiency of workers) and it will stimulate FDI outflow by home firms; thus immigration and outward FDI seem now complement (El Yaman, Kugler, Rapoport 2007)

- a third link between FDI and migration exists, skilled migrants usually take part in business network and unskilled migrants convey information on the characteristics of their native country, these aspects contribute to reduce the country risk and increase outward FDI flows.

2.3.1   Theoretical literatute on migration and offshoring

The complementarity between outsourcing and immigration was pointed out for the first time by Ramaswami (1968). The question that Ramaswami (1968) posed concerns the choice between two strategies for a developed country able either to send some of its capital abroad (FDI) or invite some foreign labour to work in the home country (assuming it could be obtained at a lower wage rate). Author shows that when national income is maximized, import of the scarce factor (labour) is preferable to export the abundant factor (capital), this is possible only if home country is able to attract foreign workers without disturbing factor prices abroad (Jones and Coelho 1985). In Jones (2005) outsourcing and immigration are both used by the firm to reduce the marginal cost of production, but since outsourcing is costly it will be optimal to use immigrants work for a little scale of production and outsourcing (or offshoring) when the scale is large. Bandyopadhyay and Wall (2007) set a model with one good, two factors and

two countries (home, foreign). Factors of production are physical capital and skilled workers, but home firms can use home skilled workers, immigrated skilled workforce and foreign resident skilled workforce (by means of offshoring). Here authors show that an increase in immigration brings to a decrease in outsourcing, so immigration and outsourcing seem to be substitutable.

In a recent paper Olney (2009b) set a model where immigration is incorporated in a trade in task framework; he assumes a two factors of production technology, low skilled and high skilled workers performing a continuum of tasks. Each task requires a certain amount of both low and high skilled labour. He also assumes that offshoring of high skilled tasks and the immigration of high skilled workers are negligible (and this is probably the weak point of the model, in particular with respect to those countries that, by selective immigration policy, host high skilled immigrants more than low skilled ones). In this model offshoring and immigration combine in determining their effects on national wage, in particular: (i) offshoring has a more positive effect on the wages of low-skilled workers than immigration; (ii) the impact of offshoring and immigration on wages becomes more similar as the workers' skill level increases.

In the theoretical section of the paper by Ottaviano, Peri and Wright (2010), it is proposed a model in which the final output is produced by using high skill and low skill intermediates in a Cobb-Douglas production function; while each intermediate input is produced by assembling horizontally differentiated tasks. In particular each low skilled task can be either realized at home by using native or immigrants workers or offshored in a foreign country (enjoying a lower wage). Since the three alternatives are perfectly substitutable, for each task the firm decides the optimal strategy minimizing the cost of production of the single task. The two crucial assumptions in the model are that the cost of tasks' offshoring is increasing in tasks' difficulty, and that the productivity of immigrants employed by firms at home is decreasing in tasks' difficulty. Deriving the marginal cost for each strategy, authors conclude that it would be optimal for the firm: (i) to offshore the easiest tasks abroad, (ii) realize very difficult task at home using natives and (iii) produce intermediate tasks (in difficulty) at home by employing immigrants workers.

2.3.2 Empirical literature on migration and offshoring

Empirical evidence is not unambiguous in solving the theoretical debate. Kugler and Rapoport (2005) find evidence of contemporaneous substitutability and dynamic complementarity between migration and FDI. Authors focus in particular on the importance of the skill composition of migrants: a more skilled emigration decreases the average level of human capital in migrants' sending countries and this deters the inflows on FDI (because the reduction in human capital reduces the capacity of the economy to adopt new technologies).

Kugler and Rapoport (2005) estimated the following equation

[2.8] $\Delta K_{i,t} = \alpha_0 X'_{i,t-1} + \alpha_1 M'_{i,t-1} + \alpha_2 \Delta M'_{i,t} + \epsilon_{i,t}$

where $\Delta K_{i,t}$ is the change in capital stock in country i financed by FDI from the United States between 1990 and 2000, $X'_{i,t-1}$ is a set of control variables, $M'_{i,t-1}$ is the stock of migrants coming from country i in the United States by educational attainment in 1990, while $\Delta M'_{i,t}$ is the rate of change in the components by educational grade completed US immigrants between 1990 and 2000. Results show that unskilled emigration from country i to United States stimulates the flows of FDI from US to the country i, confirming the idea that immigrants in US by increasing information about their origin countries, boost outflows of FDI from US to origin countries. Replicating the same estimation for only FDI in the service sector, authors find contemporaneous substitutability ($\alpha_2 < 0$) and dynamic complementarity ($\alpha_1 > 0$) between skilled emigration from country i to US and the FDI outflows fro the US.

Javorcik et al. (2006) concludes that migrants in US and FDI outward are positive correlated, in particular for highly-educated migrants. Estimating an equation in which the dependent variable is the stock of US FDI in a certain country i (as the value of total assets of non-bank affiliates of non-bank Us parents), they find a strong evidence of the positive effect of both total and tertiary educated US stock of immigrants coming from country i on the stock of US FDI. More precisely a one percent increase in the total stock of immigrants in US form country i implies a 3% increase in the stock of US FDI in country i. Again the skill level of immigrants matters in determining the relation between FDI and migration: a 1% increase in the stock of tertiary educated immigrants in US is associated with a 4% increase in the stock of US FDI. Docquier and Lodigiani (2007) with data for 114 countries from 1990 to 2000 find

that the elasticity of FDI growth rate to skilled migration is about 2%. Buch, Kleinart and Toubal (2006) using bilateral data for Germany for the period 1991-2002 find a positive relation between the stock of inward FDI and the stock of immigrants coming both from the same country and from other countries (but the coefficient associated to the stock of immigrant from the same country is close to zero). This suggests some agglomeration effect among foreign factors from different countries. This agglomeration effect concerns only high-income countries, this is due to a positive coefficient associated to an interaction variable as per capita GDP (of source country) and the stock of immigrants from the same country.

Barba Navaretti, Bertola and Sembenelli (2008) by using data on 4289 manufacturing Italian firms in the period 2001-2003 found a negative relation between offshoring and the share of foreign born workers (over total firm's employees); more interestingly they also put the firm's skill workforce composition as the share of white collar over total employment; so they are able to capture the average effect of offshoring on immigrants share and the indirect effect of offshoring on immigrants share through the share of skilled workers (white collar). They find that offshoring on average substitute for immigrants in production, and that the higher is the skill level in firm's employment (i.e. the higher is the firm's need for competences that immigrants on average do not own), the lower is the immigrants workers share in production, this means that immigrants are less well endowed with the skills that are used intensely in the domestic activities of offshoring firms.

Ivlevs and De Melo (2008) find empirical evidence of the complementarity between emigration and inward FDI: a reduction in the relative supply of skilled labour (emigration) attracts inward FDI (i.e. complementarity between immigration and offshoring). In particular from the OLS estimation results that a 1% reduction in skilled labour supply (emigration) is associated with a 0.019% of net inward FDI (as percentage of the GDP). Ivlevs and De Melo (2008) in order to avoid endogeneity problem provided also an IV estimation (using the stock of migrants in USA and Canada in 1980 as instrumental variable), obtaining that a 1% decrease in skilled labour supply leads to a 0.022% increase in net inward FDI.

El Yaman, Kugler, Rapoport (2007) focused in particular on the skill composition of migrants finding complementarity between outward FDI and skilled immigration and substitutability between unskilled immigration and outward FDI. In a recent paper Olney (2009b) set a

simple model to understand how firms respond to exogenous immigration shock in terms of re-location of job; he concludes that low skilled immigration and offshoring are substitutes, that is, an increase in low-skilled immigration leads to a reduction in the relocation of jobs (offshoring). On the other hand, high skilled immigration leads to an increase in the relocation of jobs, so high skilled immigration and offshoring are complements in production. Using data on 192 US Metropolitan statistical Areas from 1998 to 2004; he estimates the relocation behaviour of firms in terms of firms' net birth rate[14] and firms' expansion rate[15] as response to an exogenous change in high and low skilled immigration. Controlling for time and industry fixed effects he shows that low skilled immigration has a significant positive effect and high skilled immigration has a negative significant effect on the net birth rate of firms, confirming the idea that low skilled immigration substitutes for offshoring, while high skilled immigration complements for offshoring (the same results emerge when author use the expansion rate as dependent variable). By using IV econometric estimation[16], he finds that a 1% increase in the share of low-skilled immigrants leads to a 0.11% increase in the net birth of firms in the metropolitan area (so offshoring is deterred), while a 1% increase in the high-skilled share of immigrants leads to a 0.26% decrease in net birth rate of firms (offshoring is stimulated). This paper introduces (even if only from a theoretical point of view) an important dimension in the relation between immigration and offshoring: are home firm's tasks offshorable? If yes, immigration and outward FDI are substitutes and the optimal choice collapses to a better relative cost choice. If some tasks (say tasks housework, social services, restaurants waiter) are not offshorable, FDI and immigration may be complements and immigrants may add some information on their origin country reducing the FDI's risk.

On this direction moves the paper by Ottaviano, Peri and Wright (2010). From their theoretical model derive two testable implications: (i) a reduction in the offshoring cost increases

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[14]$net\_bitrh\_rate_{c,t} = \frac{est\_birth_{c,t} - est\_death_{c,t}}{est_{c,t}}$

where $est\_birth_{c,t}$ is the number of new firms in metropolitan area c at time t, $est\_death_{c,t}$ is the number of death firms in metropolitan area c at time t, while $est_{c,t}$ is the total number of firms.

[15]$net\_\exp ansion\_rate_{c,t} = \frac{est\_\exp anding_{c,t} - est\_contracting_{c,t}}{est_{c,t}}$

where $est\_\exp anding_{c,t}$ is the number of firms whose employment expanded in metropolitan area c at time t, $est\_contracting_{c,t}$ is the number of firms whose employment contracted in metropolitan area c at time t, while $est_{c,t}$ is the total number of firms.

[16]He follows Card (2001) in defining the instrumental variable: the predicted share of immigrants is constructed by assigning immigrants in the current year to the cities where previous migration waves from the same origin country were located.

the number of offshored tasks through a reduction in the number of tasks assigned to immigrants and natives at home; (ii) a reduction in migration costs increase the number of tasks assigned to immigrants through a reduction in tasks offshored or assigned to natives at home. So they estimate the following equations:

$$[2.9] \quad s_{D,s,t} = \phi_s^D + \phi_t^D + b_{DO}(imputed\_offsh_{s,t}) + b_{DI}(imputed\_immi_{s,t}) + \varepsilon_{s,t}^D$$

$$[2.10] \quad s_{M,s,t} = \phi_s^M + \phi_t^M + b_{MO}(imputed\_offsh_{s,t}) + b_{MI}(imputed\_immi_{s,t}) + \varepsilon_{s,t}^M$$

$$[2.11] \quad s_{O,s,t} = \phi_s^D + \phi_t^D + b_{OO}(imputed\_offsh_{s,t}) + b_{OI}(imputed\_immi_{s,t}) + \varepsilon_{s,t}^O$$

where $s_{D,s,t}$, $s_{M,s,t}$, $s_{O,s,t}$ are respectively the shares of less skilled employed native and immigrants workers at home and the share of offshored employment; ϕ_s^j and ϕ_t^j are respectively the individuals and time fixed effects for each j strategy; $imputed\_offsh_{s,t}$ is an index for the offshoring activity in each sector; similarly $imputed\_immi_{s,t}$ is an index for the immigrants presence in sectors. Coherently with their theoretical implications, they find that an increase in the ease of offshoring ($imputed\_offsh_{s,t}$) implies a reduction in the share of native and immigrants employments and a significant increase in the share of offshored employment; while an increase in immigration ($imputed\_immi_{s,t}$) has no effect on natives' share employment, a negative effect on offshored employment and a positive effect on the share of immigrants employment. One interesting implication is that, relying on these results, a barrier to immigration (restrictive policy for example) implies that immigrants are more likely to be substituted by offshore workers than by natives ones. From empirical studies on immigration and offshoring it emerges an interesting regularity: it seems that micro level data studies found substitutability between migration and offshoring while macro level data studies found complementarity between migration and offshoring.

2.4 Conclusion

The aim of the chapter was to articulate the existing literature on the effects of immigration on host countries by different points of views. To this end we summarized the existing literature on the effects of immigration on both labour market and the economic performances in terms of per capita GDP and growth. We may conclude that does not exist a consensus in giving a

Figure 2-4: Summary of existing literature on the relation between migration and offshoring

Authors	Relation between migration and offshoring	Nature of the study (theoretical/empirical)	Data (macro/micro level)
Bandyopadhyay and Wall (2007)	substitutability	theoretical	-
Barba Navaretti, Bertola and Sembenelli (2008)	substitutability	empirical	micro
Barry (2002)	complementarity	theoretical	-
Buch, Kleinart and Toubal (2006)	complementarity	empirical	macro
Docquier and Lodigiani (2007)	complementarity	empirical	macro
El Yaman, Kugler and Rapoport (2007)	substitutability	empirical	macro
Gao (2003)	complementarity	empirical	macro
Ivlevs and De Melo (2008)	complementarity	both	macro
Javorcik, Ozden, Spatareanu and Neagu (2006)	complementarity	empirical	macro
Kugler and Rapoport (2005)	complementarity	empirical	macro
Murat and Paba (2004)	substitutability	empirical	micro
Olney (2009a)	substitutability	empirical	micro
Ottaviano, Peri and Wright (2010)	substitutability	both	micro
Ramaswami (1968)	substitutability	theoretical	-
Tong (2005)	complementarity	empirical	macro

Source : Author

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sign to the effect of immigration on labour market outcome; from an empirical point of view, a negative (rarely positive), but even small effect of immigration has been found on wages in host countries. This is coherent with the main conclusion of theoretical models concerning the labour market effects of immigration: it depends on the assumption about perfect/imperfect substitutability between immigrants and native workers. If immigrants are assumed as perfect substitutes for natives, thus a detrimental effect of immigration on wages is derived; while if immigrants are assumed as imperfect substitutes for natives, a positive effect of immigrants on wages is allowed and it depends on the degree of substitutability.

Literature on the effects of immigrants on host country's performances (per capita GDP) has been divided into two main streams: (i) the one adopting the growth model framework, (ii) the other adopting the accounting approach. In both cases the existing literature is not wide because of problems in data availability and econometric problem on the endogeneity of immigrants setting. But one main message can be clearly derived from this literature: the effect on per capita GDP depends on the assumption about the human capital content of immigrants and on the time horizon. If immigrants are assumed as new born babies (zero capital endowment) the effect of immigration on per capita GDP will be negative, while if immigrants are endowed with some human capital, a positive effect on per capita GDP is allowed. So the skill composition of immigration is a crucial dimension that has to be considered in analyzing the effects of immigration; because more skilled immigrants bring along them high human capital content and the human capital content dilution by immigration may be offset. The time horizon is important in analyzing the effect of immigration: in the short run physical capital is fixed and immigration produces a high physical capital dilution and so a negative effect on per capita GDP is expected, while in the long run physical capital is free to adjust to the labour supply shock and the effect on per capita GDP may be null.

In the last section of the chapter we analysed the relation between immigration and offshoring by firms. If under the traditional Heckscher-Ohlin framework immigration deters offshoring (because of an increase in the return on capital), some recent theoretical models and some empirical works find a positive relation between immigration and offshoring. The underlying idea is that immigrants reduce the cost of offshoring (by providing information about their origin countries) and thus stimulate offshoring. Moreover it is interesting to notice that

(figure 2.14) empirical papers using micro level data found substitutability between migration and offshoring while papers using macro level data found complementarity between migration and offshoring.

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Chapter 3

Skilled Migration and Economic Performance: evidence from OECD countries

3.1 Introduction

The aim of the paper is to investigate the effect of immigrants' inflows on host country's standard of living, by considering the effect on per capita GDP variation. Looking at the simple correlation between immigration flows and per capita GDP in host countries, we notice a strong positive relation between them, but it is not easy to identify the direction of causality. In this chapter by using instrumental variable estimation we are able to determine the effects of immigration flows and their human capital content on host country's economic performances in terms of changes in per capita GDP. If a positive effect of skilled immigrants may be found, interesting policy implications on skill selective policies can be drawn.

Growing international labour migration suggests the importance of this topic in international economics: the percentage of foreign-born population over total population residing (legally) in North America increased by less than 10% in 1990 to more than 14% in 2010 (estimated)[1]. In Europe the stock of international migrants as a share of total population was 8.8% in 2005

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[1]United Nations, Department of Social affairs "Trend in total migrants stock: the 2005 revision" http://esa.un.org/migration

and it is expected to become 9.5% in 2010. Thus migration has, potentially, a crucial role for the comprehension of future economic development: does immigration affect per capita GDP in the host countries? Do tertiary educated immigrants affect positively per capita GDP in host countries? These are the main questions that the chapter intends to investigate. The debate on the effects of immigration on developed countries is wide and it concerns a lot of social disciplines, among them economics has the role to investigate the economic related effect of immigration. There is a flourishing literature on the effects of both international flows of capital and trade on income growth (Michaely 1977; Borenztein, De Gregorio and Lee 1998; Frankel and Romer 1999; De Mello 1999; Zhang 2001), but although migration can be similarly considered as an international factor movement, the link between migration and income variation has been scarcely analysed in literature. Up to now economists focused a lot, both theoretically and empirically, on the labour markets effect of immigration (Card 2001, 2005; Borjas 2003, Aydemir and Borjas 2007, Ottaviano and Peri 2008), because the effects of immigration have been considered passing through the labour market. This is certainly true but also restrictive: immigration, by increasing the labour force, will reduce capital labour ratio in the host country, increasing return on capital and so generating investment opportunities and physical capital accumulation (up to the point in which the marginal product of capital returns to its pre-immigration shock value). Moreover immigrants may affect total factor productivity in host countries, since they may promote specialization/complementarities (Ottaviano and Peri 2008) with natives increasing total factor productivity. Immigrants also bring new ideas reinforcing agglomeration economies (Sparber 2010). On the other hand it is possible that immigration induces the adoption of less productive technologies (unskilled labour intensive). For these reasons, the effect of immigration on host countries income cannot be analysed exclusively through the labour market channel. Ortega and Peri (2009) analyse the effect of immigrants on the growth rate of each component of the GDP function (total factor productivity, employment and physical capital used in production) and on the income growth itself. Finally immigration may increase the host countries' human capital endowment (according to their skill level) and so affecting per capita GDP variation (Dolado, Goria and Ichino 1994). This is the channel we want to analyse by investigating the effects of high skilled immigrants on host countries' changes in per capita GDP.

The importance of understanding the effects of immigrants and their human capital content on host economies concerns both policy implications, by clearing the consequences of skill selective immigration policies on income, and the welfare of natives in receiving countries. The underlying idea is that immigrants not only increase the country's endowment of low wage workers, leading to a decrease in per capita GDP (because of human capital dilution), but they also bring some human capital along them allowing for a potential positive effect on per capita GDP by increasing the human capital level in destination countries (Benhabib 1996; Kemnitz 2001). This chapter provides an econometric estimation of the impact of immigration flows and their human capital content on host countries' economic performances (in terms of per capita GDP variation about its time mean). In providing empirical evidence of the previous questions, in this paper we follow the procedure by Frankel and Romer (1999) (recently adopted by Ortega and Peri 2009). To build the instrumental variables for international migration we firstly estimate bilateral flows of migration using a gravity-style model, and then we aggregate the fitted values by destination countries. In the second part of the paper we use instrumental variables to investigate the effects of immigrants' flows on income variation. With respect the existing literature in this field, we try to keep the effect of immigration on changes in per capita GDP by stressing the role of the human capital content by immigrants. The rest of the chapter is organized as follows. Paragraph 3.2 provides a review of existing theoretical and empirical literature on the effects of immigration on income in host economy. Paragraph 3.3 is devoted to our econometric analysis. In particular paragraph 3.3.1 presents some stylized facts; paragraph 3.3.2 discusses some problems and solutions concerning the empirical strategy; paragraph 3.3.3 explains how we built the instrumental variables and how good they are (because this is a crucial point in this literature); while paragraph 3.3.4 presents respectively the effects of immigration flows on per capita GDP. Final paragraph concludes.

3.2   Review of literaure

From a theoretical point of view the effect of immigration on host country's income level and growth has been widely treated. Early models on the effect of labour mobility considered immigration in an extended version of the traditional Solow-Swan model. Using a simple

Cobb-Douglas production function where only physical capital and labour (in efficiency units) contribute to produce output, by assuming immigrants endowed with zero physical capital, immigration is like an increase in the country's unskilled population, so that everything else being constant, immigration leads to a lower per capita income because of the local physical capital dilution.

In the augmented Solow-Swan model framework (Mankiw, Romer and Weil 1992), where human capital also contributes to the production process, if immigrants are assumed to bring human capital along them, human capital dilution may be offset. In this case the key to assess the impact of immigration on per capita GDP is whether immigrants bring enough human capital to offset its dilution in the host country. If immigrants own a low quantity of human capital, their impact is similar to a simple faster population growth in slowing per capita GDP. If immigrants' human capital is higher than natives', income will be speeded up (Benhabib 1996; Friedberg and Hunt 1995).[2] Dolado, Goria and Ichino (1994) modified the Mankiw, Romer and Weil (1992) model by considering immigration as a source for both working population growth rate and human capital accumulation.[3] They consider an economy in which output is produced with labour, human and physical capital by using a Cobb-Douglas constant return to scale technology. Immigration has been introduced in the model by modifying the working population growth rate (including the net immigration rate) and by assuming immigrants endowed with some human capital that modifies the human capital accumulation equation. Using this setting authors conclude that immigration has negative effect on output and growth in host country, while a higher human capital level owned by immigrants has a positive effect on both output and income growth rate.[4]

So we may conclude from a theoretical perspective that, by modifying traditional growth model and assuming perfect substitutability between native and foreign born immigrants, the effect of immigration depends on the kind of immigrants: if immigrants own a low quantity of human capital they negatively affect output variation; but the higher is their human capital content, the higher is their (positive) contribution on per capita GDP variation.

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[2] For more details on the portability of human capital by immigrants, see Friedberg (2000).

[3] Notice that in this model immigrants do not contribute to physical capital accumulation.

[4] This conclusion holds in the more realistic case in which immigrants own less aggregate human capital than natives.

Although theoretical works have thrown light on the relation between immigration and per capita GDP, only few empirical studies have been conducted and not a clear picture emerges from these. A seminal paper on the effect of immigration on per capita income growth was by Barro and Sala-I-Martin (1992), they find that immigration has no effect on income growth. Dolado, Goria and Ichino (1994) using a panel of 23 OECD countries in the period 1960 - 1985, found a negative effect of immigration on per capita income growth, concluding that the reason of such negative impact of immigration relies on the fact that immigrants in OECD countries own lower human capital than natives.

Recently empirical papers on the effect of immigration on GDP have used the so called "accounting approach", which consists of analysing the effect of immigration on every component of per capita output (total factor productivity, physical capital accumulation, employment). The paper by Ortega and Peri (2009) adopts this approach and has the merit to find a new way to solve the immigrants' localization endogeneity problem by using the estimated bilateral immigration flows (without wage differential or other economic determinants of migration). They use 2SLS estimates to analyse the effect of immigration on every component of the per capita GDP function. In particular they show that an increasing immigration leads to: (i) an increasing employment growth and (ii) an increasing physical capital growth. They also estimate the effect of immigration on per capita GDP growth finding that a 1% increase in immigrants flows entails about a 1% increase in per capita GDP growth rate. Ortega (2008) by estimating the effect of immigration on per capita GDP and labour productivity (per hour worked GDP) finds that a 10% increase in immigration induced population growth leads to a 3.8% increase in GDP but to a 6.2% and 6.7% reductions in GDP per capita and per hour worked GDP. Felbermayr, Hiller and Sala (2010) investigate the effect of immigrants (by using the stock of immigrants in destination country) on per capita GDP in the host countries. Using a IV cross-section approach and controlling for institutional quality, trade and financial openness they find positive correlation between immigration and per capita GDP: a 1% increase in the migrants stock leads to a 0.22% increase in per capita GDP. Similarly Bellini, Ottaviano, Pinelli and Prarolo (2009) find that the share of foreigners in total population has a positive effect of per capita GDP in EU destination regions.

Sparber (2010) uses data on 48 US states from 1980-200 to explore the relationship between

diversity (that can be seen as a measure of immigrants employment)[5] and per capita GDP variation. Instrumental variable estimation shows a positive and significant effect of diversity on per capita GDP, but using state fixed effects to account for time invariant income explanatory variable (other that diversity) coefficient becomes insignificant.

The former empirical investigations on the effects of immigrants on per capita GDP do not take into account an important feature arising from theoretical growth papers: the human capital content of immigrants. It seems that, although theoretical models suggest the importance of the human capital content of immigrants in determining the effect of immigration on per capita GDP, empirical papers did not take into account this dimension in estimating the effects of immigrants flows on income. This is the reason why we decided to estimate the effects of immigration flows on per capita GDP variation taking into account the human capital content of immigrants.

3.3   Empirical strategy

The main finding of theoretical models in literature is that the effect of immigration on income depends on the human capital content of immigrants. So, by increasing the human capital owned by each immigrant, host countries may mitigate the expected negative effect of immigration on per capita GDP. In this paper we approximate the human capital content of immigrants by their skill level. Thus we analyse the effect of immigrants' inflows and their skill level on income in destination countries:

$$[3.1] \ln y_{d,t} = \eta_d + \beta_1 \ln(immi\_share_{d,t}) + \beta_2[\ln(immi\_share_{d,t}) * \ln(immi\_skill_d)] + \varepsilon_{d,t}^{6}$$

Where $y_{d,t}$ is per capita GDP in destination country d and at time t, $immi\_share$ is the share of immigrants inflows over total population and $immi\_skill$ is a measure of the human

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[5]Index of diversity (racial fractionalization) has been computed as:

$$RF_{s,t} = 1 - \sum_r employment\_share_{r,s,t}^2$$

where s is the state, t is time and r is the race of employees (Asia, Blacks, Hispanic, Whites, Others).

[6]The variable $\ln(immi\_skill_d)$ could not be put in the estimated equation because it is time invariant and it is perfectly correlated with the fixed effects η_d. Since the effect of the skill proportion of immigrants is kept by η_d we do not incur in omitted variable problem. Moreover, we tried to estimate a LSDV model (that produces the same coefficient as a within estimation) in order to be allowed to insert the $\ln(immi\_skill_d)$ variable, but the associated coefficient was not statistically different from zero.

capital content of immigrants inflows. The fixed effects η_d controls for unobserved structural differences between countries that are time invariant (for example the initial level of technology, resource endowments, climate institutions). The human capital content of immigrants has been approximated in two ways: (i) as the share between tertiary educated over total immigrants stock; (ii) as the share between tertiary over primary educated immigrants stock (the so called "selection ratio"). Since we used a fixed effects panel data model (within estimator)[7] to estimate equation [3.1], by looking at β_1 coefficient we are able to assess the effect of an increase in the immigrants inflows (with respect to its time mean) on the variation of per capita GDP about its time mean, conditioned to a zero skill content of immigrants. By looking at β_2 coefficient we also know how being skilled among immigrants changes the effect on per capita GDP variation.

This kind of empirical works are not common in literature, exceptions are Dolado, Goria and Ichino (1994), Felbermayer, Hiller and Sala (2010), Ortega and Peri (2009) and Bellini *et.al.* (2009), because of a series of econometric problems such as endogeneity from migrants localization, internal migration[8] and data availability.[9] To this end the empirical strategy consists of two main parts, in the first we build the instrumental variables using the Frankel and Romer (1999) approach also used by Ortega and Peri (2009) to solve the endogeneity problem. In the second part we estimate equation [3.1] by using a 2SLS panel data model.

3.3.1   Data and descriptive evidence

In this chapter we combine an international panel data set on bilateral flows of migration from 86 poor and developing countries to 24 OECD countries with some macroeconomic and geographical variables concerning both origin and destination countries. Data on migration

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[7]We could not estimate a simple first difference panel data model, because the lagged dependent variable would be endogenous implying to insert an instrument for it among the other instrumental variables. This does not allow us to solve for the immigrants localization endogeneity.

[8]The problem of internal migration does not affect our analysis because it will be conduct at country level. Internal migration introduces a negative bias in sub-national level estimations (Hanson 2008).

[9]Low quality data problem can be solved by providing some reasons for caution in using the foreign born by total residents: (i) a considerable number of foreign born workers in manufacturing industries are skilled (and the education level is hardly comparable between host and origin country); (ii) not all native born workers are skilled and (iii) not all immigrants participate in the labor market, particularly following an intense process of family regrouping in recent years (Friedberg and Hunt 1995).

come from the International Migration Statistics (IMS) data set from OECD.stat[10]. Notice that this kind of data do not cover illegal migration. In this paper we use flows of migration from 1998 to 2007.[11] Macroeconomic variables such as per capita GDP[12], per hour worked GDP, population, number of patents, public and private expenditure in tertiary education[13] and bilateral aid have been taken from OECD.stat as well. From CEPII we take geographic variables such as the distance between countries, dummy variable for common language, past colonial relationship and contiguity of countries. Finally from Docquier, Lowell and Marfouk (2007) database we take data concerning the skill level of immigrants. This dataset contains the stock in 2000 and 1991 of immigrants and native workforce by education level and origin country. Before going to the econometric estimation we want to point out some descriptive evidence on the settlement of immigrants and their skill level.

Figure 3.1 shows the share of tertiary educated over total immigrants stock and the share of immigrants over total population in 2000 for each destination country; as one may expect the main immigrants endowed countries are Luxembourg, Australia and Switzerland; while Italy, Hungary, Portugal and Finland are the less endowed. By the point of view of the skill level of immigrants, Australia, Canada, Ireland, New Zealand and United States have the highest share of tertiary educated immigrants, this is certainly the consequence of skilled immigrants oriented policies.[14] It would be interesting to compare the human capital content of immigrants with those owned by natives, because as concluded by Dolado, Goria and Ichino (1994) immigration has negative effects on both per capita output and growth if the human capital level owned by immigrants is lower than those for natives. Second and third columns in figure 3.1 show respectively the ratio between tertiary educated over total immigrants and the same

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[10]Here immigrants are defined as the number of foreign born individuals entering in the country with a residence permit at least for one year. So our measure is unaffected by national naturalization policies.

[11]Notice that the disaggregated data on migration flows (by origin and destination countries) don't cover the 100% of total immigrants inflows in each destination countries, for example the total immigration inflow in Italy in 2007 by origin country is the 91% of the total immigrants inflows of immigrants; so the disaggregated data set contains some zeros for some origin-destination pairs. So some of these observations are truly zero flows, while others correspond probably to small flows.

[12]Per capita GDP is provided in USD at constant prices.

[13]Expenditure in tertiary education was initially provided in national currency at current price; but we transform them in USD by using exchange rates from UIC dataset and we clear for inflation but dividing for consumer price index.

[14]Immigrants selective immigration policies have been carried out in different ways by countries. For example United States adopts the so called H-1B visa to select skilled immigrants, but other systems are the Canadian or Australian "point system".

ratio for natives; the tertiary educated share for immigrants is higher than those for natives in Australia, Canada, Czech Republic, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Switzerland, United Kingdom.

A second feature arising from the data is the decreasing persistency of immigrants' inflows localization along time (figure 3.2). One may notice that the stock of immigrants in 1991 is well correlated (slope statistically different from zero) with the inflows of immigrants over total population in 1998, but not well correlated with the inflows of immigrants over total population in 2007. Figure 3.3 shows the positive and statistically significant correlation between the share of tertiary educated over total immigrants in 2000 and the stock of tertiary educated over total native workforce. It is interesting to notice that United States and Canada have the highest shares of tertiary educated immigrants and natives; on the contrary Portugal and Italy have the lowest share of tertiary educated immigrants and natives. Figure 3.3 also shows the relation between the share of tertiary educated over total immigrants in 2000 and the share of immigrants over total resident population, it seems that tertiary educated immigrants go in average where all other immigrants localize.

3.3.2 The empirical approach: problems and solutions

One main problem arises in empirical estimation when migration is involved as independent variable: *endogeneity from immigrants' localization choice.* Endogeneity arises if immigrants choose where to stay on the basis of country's wage or GDP differentials within origin and destination countries. Thus it is true not only that immigration drives economic performances (or labour market changes), but also that local economic performances drive immigration. This problem leads to a biased estimation of the effects of immigration on economic performances. The endogeneity problem can be solved by using instrumental variables: if one can find a variable correlated with the change in immigrants' presence but independent by the local economic performance, the bias due to immigration choice can be removed. When immigrants choose the country where to stay, they can take into account also other aspects of a region, such as existing networks and the presence of a community with the same culture and language. Thus, besides economic performance reasons, immigrants may tend to settle in countries (or cities) with high density of immigrants. Since the stock of existing immigrants in a region is unlikely to be

correlated with current economic shocks (notice that a sufficient time lag is necessary), historic settlement pattern may solve the endogeneity problem. Figure 3.4 shows not statistically significant, even if positive, correlation between the stock of immigrants in 1991 and the per capita GDP in 1998 and 2007.[15] Altonji and Card (2001) used the stock of immigrants in 1970 as an instrumental variable for the change in immigrant population between 1970 and 1980 in USA cities. The logic is the following: new immigrants tend to go where other immigrants already reside, but this variable is uncorrelated with local economic outcomes or wages. An alternative way to overcome the endogeneity problem was recently proposed by Mayda (2010) and used by Ortega and Peri (2009). They estimated the gravity-push bilateral immigration flows without economic determinants, and thus the fit of this regression was used as an instrumental variable (by aggregating data for each destination country). In this way the instrumental variable results to be well correlated with immigration flows and mainly independent from economic shocks.[16] In this chapter we follow the former approach.[17] Hence, our empirical approach consists of two steps; firstly we'll estimate the bilateral flows of immigrants (both total and skilled ones) by using geographic and strictly exogenous determinants of migration,[18] and we'll aggregate the estimated flows of immigrants from all origin countries for each destination country (in this way for each destination country we have estimated immigrants inflows not driven by economic performance as instruments).[19] The second step is to estimate the effects of immigration on host countries income as in equation [3.1] by using a 2SLS estimation.

3.3.3   Constructing the instruments

Our final purpose is to estimate the effect of both immigrants' inflow and its skill content on host country's income variation, thus we have two potentially endogenous variables in our main

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[15]We chosen 1998 and 2007 as starting and ending years of our panel.

[16]This is true under the condition that regressors used to estimate the bilateral immigration flows are independent from any economic shock.

[17]We also tried to use the instrument by Card (2001) using the stock of immigrants in 1990 as a base year for our instrumental variable. But we preferred the approach by Ortega and Peri (2009) because it better explains the actual immigration flows than the instrument à la Card (2001).

[18]For example we did not use wage differential between origin and destination country that has a strong explanatory power for migrants flows but it would introduce a bias in our estimates.

[19]We cannot put the determinants of immigrants flows directly as instrumental variables in the 2SLS procedure because most of them are time invariant and they would be perfectly correlated with the fixed effect in the first stage regression.

empirical equations [3.1]. So we need at least two instrumental variables to correctly identify the model and overcome the endogeneity problem. As anticipated in the former section we build these two instruments by estimating bilateral flows of both total and skilled migration using geographic and strictly exogenous determinants. An instrumental variable has to satisfy two requirements: it must explain quite well the endogenous variable (relevance) and it has to be orthogonal to the error process (validity). In what follows we build the instrumental variables and we will discuss the quality of the instruments providing both qualitative arguments on the exogeneity of variables used to build our instruments and formal test of relevance and validity of the so built instruments.

The bilateral migration flows equations

Our instrumental variables are the estimated immigrants' inflows resulting from the estimation of bilateral migration flows from poor countries to 24 OECD countries (figure 3.5 reports the countries of origin and destination used in the estimation). Although for the estimation of the empirical equation [3.1] we just need the inflows of immigrants in every destination country from all over the world, we decided to build instrumental variables by estimating bilateral immigration flows because it enables us to use strictly exogenous variable as migration determinants.[20] We used data at country level because, as Borjas and Katz (2007), and Ottaviano and Peri (2008) argued, the country is the appropriate unit with which to analyze the effects of migration. The reason is the high degree of mobility of workers and physical capital within country. In our setting we need two instruments, one should look at explaining the total bilateral migration flows from poor to destination countries, and the other looking at the skilled migrants flows (since the interacted variable in the main equation [3.1] points to measure the effect of being skilled among immigrants). So we estimated the bilateral inflows of immigrants by using two sets of explanatory variables: one set of variables explaining total immigration (both high and low skilled immigrants inflows), the other set explaining high skilled immigrants' inflows. In defining the set of variables explaining the overall bilateral migration flows (equation [3.2])

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[20]In fact geographic variables as distance, past colonial relationship, common language are shown being good migration determinants (Mayda 2008; Berthelemy, Beuran and Maurel 2009; Ortega and Peri 2009) and they could be used only by estimating bilateral immigration flows.

we use three main features in literature: (i) migration is positively correlated with bilateral aid (Berthelemy, Beuran, Maurel 2009); (ii) migration is positively correlated with past immigrants settlements (Card 2001; Beine, Docquier and Ozden 2009); (iii) geographic variables are important to estimate bilateral migration flows (Mayda 2010; Berthelemy, Beuran, Maurel 2009; Ortega and Peri 2009). Thus the overall bilateral flows for immigrants have been estimated by using the following equation:

$$[3.2] \ \ln(immi\_flows_{d,o,t}) = \alpha_{o,t} + \gamma_1 \ln(aid_{d,o,t}) + \gamma_2 \ln(immi\_stock_{d,1991}) +$$
$$+ \gamma_3 distance_{d,o} + \gamma_4 language_{d,o} +$$
$$+ \gamma_5 contiguity_{d,o} + \gamma_6 colony_{d,o} + \varsigma_{o,d,t}$$

To be sure about the exogeneity of the fitted immigration share from [3.2] we briefly discuss the exogeneity (and the intuition behind) of each regressor. It is straightforward to consider bilateral aid ($aid_{d,o,t}$) as independent from the destination country's economic performance because of bilateral aid is a political exogenous decision by national governments (as an example the overall aid expenditure by United States is lower than the aid expenditure of Portugal, Spain and New Zealand) and also depends on the goodness of political relation with the receiving country;[21] moreover bilateral aid does not affect directly per capita income in donors countries except for the attractiveness of immigrants. As in Berthelemy, Beuran and Maurel (2009) bilateral aid is expected to have a positive effect on bilateral migration flows through the so called "attraction" effect: more bilateral aid from a "rich country" (destination country in our setting) to a "poor country" (origin country in our case) intensifies the attractiveness of the donor for workers in the "poor countries"; moreover bilateral aid increases the information in poor countries about the donor and it will reduce migration costs. The stock of immigrants in destination country in 1991 ($immi\_stock_{d,1991}$) is expected to have a positive effect on bilateral migration because immigrants already living in the destination country reduce the cost of information on how to get a job in the new country, on social system, immigration policy and culture. The stock of immigrants in 1991 may be considered exogenous because of the sufficient time lag with respect per capita income in the main equation [3.1] (where the

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[21]Moreover the simple correlation index between per capita GDP and overall international aid by each destination countries is 0.196.

dependent variable goes from 1998 to 2007). Moreover, the stock of immigrants in a decade before has been used as instrumental variable in various papers in literature (Card 2001, Cortes 2008).[22] Evidence of the exogeneity of the stock of immigrants in 1991 with respect economic performance in 1998-2007 is provided in figure 3.4, where the correlation between the per capita GDP and the stock of immigrants is positive but not statistically different from zero. Finally, geographic variables concerning destination and origin countries are distance $(distance_{d,o})$,[23] the existence of a common language $(language_{d,o})$, the existence of a present or past colonial link $(colony_{d,o})$ and geographic contiguity $(contiguity_{d,o})$. All the geographic variables can be easily considered as exogenous. The distance between origin and destination countries may be considered as a proxy for the cost of migration, the further away are the two countries the higher is the cost for migration. Common land border is likely to encourage migration because of lower travel time (and costs). Past or present colonial relationship should increase bilateral flows of migration because of a strong political relation between the two countries.

The second instrumental variable comes from the estimated bilateral skilled immigrants flows as in the following equation [3.3]:

$$[3.3]\ \ln(skilled\_immi\_flows_{d,o,t}) = \alpha_{o,t} + \theta_1 \ln(edu\_exp_{d,t}) + \theta_2 \ln(patent_{d,t}) +$$
$$+ \theta_3 \ln(skilled\_immi\_stock_{d,o,1991}) + \theta_4 distance_{d,o}$$
$$+ \theta_5 language_{d,o} + \theta_6 contiguity_{d,o} + \theta_7 colony_{d,o} + \varsigma_{o,d,t}$$

where the skilled immigrants bilateral flows have been computed as the product between the bilateral flows of immigrants at time t and the share of tertiary educated immigrants stock in 2000:[24]

$$[3.4]\ skilled\_immi\_flows_{d,o,t} = immi\_flows_{d,o,t} * \left(\frac{skilled\_immi\_stock_{d,o,2000}}{immi\_stock_{d,o,2000}}\right).$$

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[22] The underlying idea is that unobserved factors determining that more immigrants decided to locate in country "A" rather than in country "B" in 1991 are not correlated with changes in the relative economic performances by the two countries.

[23] In our estimation we used the population weighted distance, where the distance in Km between the largest cities in the two countries (origin, destination) is weighted for the share of those cities over the total country's population (see Frankel and Romer 1999). This is because the larger is a country the farther is the distance from other countries, so if we do not weight the distance for the population we may end up with migration flows positively affected by distance.

[24] Data on the stock of migrants in 1990 has been used to compute the flows of skilled migrants up to 2001.

In order to estimate the skilled immigrants flows we used regressors explaining mainly tertiary educated immigrants flows. Destination countries with both a high expenditure in tertiary education[25] ($edu\_exp_{d,t}$) and an high number of patents[26] ($patent$) should attract in particular tertiary educated immigrants (similar reason for the stock of tertiary educated immigrants in 1991, $skilled\_immi\_stock_{d,o,1991}$). These variables may also be considered exogenous with respect per capita GDP because it is difficult to think that expenditure in education and patents could have relevant effects on income in the same year,[27] except through their impact on the attractiveness of skilled immigrants. Moreover, the expenditure in tertiary level education may be considered exogenous with respect per capita GDP because this kind of expenditure is mainly policy driven (it is not necessarily true that the more is the per capita GDP the more is the expenditure in tertiary level education). The number of patents depends upon the innovation activities by firms and institution and scarcely depends on the income in destination countries. Finally, the stock of skilled immigrants in 1991 may considered exogenous because of a sufficient time lag with respect economics performances in main equation [3.1]. After estimating equations [3.2] and [3.3] we have the fitted values for bilateral flows of immigration, then we can aggregate these flows for each destination country ending up with the estimated inflows of both total and skilled immigrants in each destination country form 1998 to 2007, and these will be our two instrumental variables.

Results

Equation [3.2] and [3.3] have been estimated by a fixed effect panel data model, the origin-time fixed effects capture any economic, demographic and cost determinant of migration out of country o which varies over time; these fixed effects capture the so called "push-factors" of immigration which depend only on the conditions in the countries of origin (they are independent of the destination countries' characteristics) such as the per capita GDP, wage level in the origin countries or the share of young over the total population. Since the fixed effect is origin country but also time specific, it will keep also some historical (exogenous) shocks in

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[25] It is the expenditure of public and private institutions.

[26] Number of patent applications to EPO per thousands of inhabitants in the inventor's country of residence.

[27] We know that in the long run expenditure in education and innovation activities bring to raise income, but in our estimation they are used at the same year of income.

the immigration flows. For example, the 2004 European Union enlargement probably caused a great increase in the emigration rate from new member countries toward old member countries (especially for those with common borders); this kind of shocks have been taken into account by the origin-time fixed effects. We decided to use origin country-time fixed effects because we want explicitly account for the geographic variables that are origin-destination specific; moreover we could not use destination-time fixed effects because they would keep some destination country's specific economic aspects. The geographic variables are destination-origin country specific and so capture the fixed bilateral cost of migration.

Figure 3.6 shows the results from the estimated equation [3.2].[28] All the explanatory variables are strongly significant and, as we expected, bilateral aid positively affects migration flows from origin to destination country, this is coherent with results in Berthelemy, Beuran and Maurel (2009). The stock of immigrants in destination countries in 1991 has a positive effect on migration flows confirming a well known result in literature (Card 2001). Geographic variables are significant. As we argued, common language, contiguity and colonial relationship affect positively bilateral migration flows, while distance negatively affects migration flows. This result is coherent with both Mayda (2010), Ortega and Peri (2009) and Berthelemy, Beuran and Maurel (2009). The fitted values of regression [3.2] are the estimated bilateral flows of immigrants from origin countries to destination countries. Notice that the set of destination countries has been removed from the set of origin countries.[29]

Figure 3.7 shows the results for estimated equation [3.3].[30] As we expected both the expenditure in tertiary level education and the number of patents in destination countries attract the inflows of tertiary educated immigrants (coefficients positive and significant). Coefficients associated to geographic variables have the same signs as in estimation [3.2] (except for colonial relationship which now is not significant). Origin countries are mainly poor or developing countries, so on the average with a worse educational system than in rich countries. For this reason,

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[28]Notice that although we have 24 destination countries, 86 origin countries and 10 years, we estimated equation [3.2] using just 4945 observations because of a huge number of missing values for bilateral flows of immigrants and international aid in OECD dataset.

[29]This choice has been forced by the fact that bilateral flows of aid in OECD database did not include destination countries as receiving aid countries.

[30]Notice that although we have 24 destination countries, 86 origin countries and 10 years, we estimated equation [3.3] using just 8447 observations because of a huge number of missing values for bilateral flows of immigrants in OECD dataset.

the estimated values of bilateral flows keep those migrants with a lower quality of education than natives even if formally they are tertiary educated as well. Since the bilateral immigration flows may be left censored at zero, as a robustness check we also estimated equations [3.2] and [3.3] by using a panel tobit model. The underlying idea is that the flow of immigrants is broadly a continuous variable but it is subject to a lower limit.[31] The result of the tobit estimation is shown in the last column in figures 3.6 and 3.7, the values of the coefficients are mainly the same as those for the within estimations, the correlation indexes between the fitted values using within (OLS) and tobit estimators are close to one. Moreover the agglomeration of zeros in the data set is negligible, so the bias due to a simple OLS estimation is negligible too. Because the agglomeration of zeros in the data set is negligible and the fitted values resulting from the OLS estimation are more similar to the actual values in term of magnitude, we use the fitted values of the OLS model as instrumental variable in our 2SLS estimation.[32]

The quality of the instruments

An instrumental variable must satisfy two requirements: it must be correlated with the endogenous variables (relevance) and orthogonal to the error process (validity). The former condition may be tested by looking at the fit of the first stage regressions; usually one should look at the R^2 or at the F-stat of joint significance of the instruments in the first stage regression. Unfortunately, these indicators may not be sufficiently informative because we have two endogenous regressors. Indeed it may be the case that only one of the two instruments is highly correlated with the two endogenous regressors and the other is just noise, giving however high first stage R^2 or F-stat in the first stage regressions, but the model is basically unidentified.

In order to show the relevance of the so built instrumental variables, in figure 3.8 we report the scatter plots of the actual values for immigrants' inflows, both total and skilled one, against the fitted values of respectively estimated equations [3.2] and [3.3]. The correlation between actual values and fitted values is positive and quite significant, so our instruments are good proxies for actual values of immigrants' inflows. To strengthen this evidence we also regress

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[31] See also Beine, Docquier and Ozden (2009) and Felbermayr, Hiller and Sala (2010).

[32] Results of the 2SLS procedure using the estimated bilateral immigrants flows using tobit estimation are equal to those by using OLS.

actual values of migration against the fitted values from equations [3.2] and [3.3] and a constant term, results are shown in figure 3.9. As expected the coefficient of the fitted values of total immigrants flows is significant and close to one in explaining the actual values of total migration flows; similarly the estimated values of skilled migration flows has a significant coefficient close to one in explaining the flows of skilled migrants. Finally we also look at the Kleibergen-Paap F statistic as a weak identification test (results are in figure 3.10) and we can reject the null of weakly identified first stage equation.

Unfortunately we cannot directly test the validity of the instrumental variables (Sargan or Hansen test) because the Hansen J test for overidentifying restriction is not valid in the just identified model (Cameron and Trivedi 2009). So firstly we rely on the former discussion about the exogeneity of the determinants of bilateral migration flows but for the estimation [3.1] where the endogeneity problem is crucial we also provide a formal overidentifying test by adding three most probably orthogonal (even if irrelevant)[33] instruments and test a subset of overidentifying restriction (Baum, Schaffer and Stillman 2003). The idea is to transform the model into an overidentified model, in order to have a group of orthogonal instruments and a group of suspect non-orthogonal instruments (i.e. our actual instruments described in the former section); thus we estimate a restricted model[34] with only the orthogonal instruments and an unrestricted model with all the instruments (containing the suspect instruments). If the inclusion of suspect instruments increases significantly the Hansen J statistics, we would have good reasons for doubting the orthogonality of our suspect instruments.[35] We could not reject the null of exogeneity of suspect instruments, so we may conclude that the estimated flows of total and skilled migrants (from equation [3.2] and [3.3]) are valid instruments for the estimation of equation [3.1].

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[33]We don't care about relevance of the added instruments because they are used only to test the exogeneity of our two actual instruments.

[34]Since the restricted model has to be identified as well, the number of added and surely orthogonal instruments has to be at least equal to the number of problematic variables.

[35]Practically, we added three orthogonal instruments with respect per capita GDP, from the OECD stat we choose the number of deaths for suicide and for diabetes per 100000 inhabitants and the alcohol consumption per capita.

3.3.4   Estimates of immigration's effects on income variation

Specification

Having our two instrumental variables, we are allowed to estimate the effect of immigrants and their skill level on per capita GDP by using equation [3.1]. In panel data context, it is often assumed that observations on the same individual (cluster) in two different time periods are correlated (Baum, Schaffer and Stillman 2003), but observations on two different individuals are not; so in estimating equation [3.1] we properly accounted for cluster robust standard errors. By estimating equation [3.1] using a fixed effects model, β_1 is the elasticity of a variation of unskilled immigrants inflows about its mean (conditional to having zero tertiary educated share of immigrants) on per capita GDP variation about its time mean; while β_2 gives us the effect of being tertiary educated among immigrants on per capita GDP variation. Thus, from what we know about the related theoretical literature, we expect $\beta_1 < 0$ and $\beta_2 > 0$. So potentially the effect of a selective immigration policy (aimed to increase the share of tertiary educated over total immigrants) on per capita GDP can be evaluated by looking at β_2. As a proxy for the human capital content of immigrants has been used the share between tertiary educated immigrants stock over the total immigrants in each destination country, this measure points to evaluate the effects of an increase in the human capital content by immigrants (due for example to a selective immigration policy). Notice that the role of the level of tertiary educated home born workers is kept by the fixed effect (the idea is that the lower is the endowment of native high skilled workers, the higher is the positive effects of a high skilled immigrants). As stated in the former section, an OLS model introduces a bias in our estimation, so we need an IV panel model (2SLS).[36] So in the first stage regressions we need at least two instrumental variables to correctly identify the model. Our instruments are two estimated immigrants inflows in [3.2] and [3.3], aggregated for each destination country and weighted for the population in each country. The destination country's fixed effect in [3.1] explains all those factors that are country specific and may influence per capita GDP; they reflect for instance differences in the initial level of efficiency or technology between countries.

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[36]Notice that part of the endogeneity problem due to the omitted variables problem is cleared out by the country's fixed effects.

Basic results

Figure 3.11 reports the estimation of equation [3.1] by using simple OLS model (fixed effects panel model) and IV panel model. The coefficients associated to the share of immigrants inflows are negative and significant for both OLS and IV estimation[37]. The coefficients associated to the interacted variable are positive and very significant. The results for the Durbin-Wu-Hausman test in figure 3.11 confirm the bias in the OLS estimation due to the endogeneity problem.[38] So we have to look at the IV estimation results, and we may conclude that a 1% increase in zero human capital endowed immigrants inflows variation leads to a 1.1% reduction in per capita GDP variation, but being skilled among immigrants mitigates this negative effect. Since the coefficient associated to the immigrants share is always greater than the coefficient associated to the interacted variable (skill content of immigration), we may conclude that *being tertiary educated among immigrants positively affects per capita GDP but not enough to clear the negative effect of immigration.*[39] With respect the paper by Mariya and Tritah (2009), which has the merit to accounting for immigrants' heterogeneity in determining the effect on per capita GDP, here we find strong and significant positive effect of being skilled among immigrants on host countries' economic performances.

Figure 3.10 reports the first stage regressions results, our instrumental variables explain well our problematic variables: all coefficients are statistically positive and different from zero, the R^2 of the first stages are quite good and the F-stat tests for zero slopes seem to confirm the

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[37] As one may easily notice from figures 3.11, 3.12 and 3.13 coefficients estimated using IV are greater than those estimated using OLS. This may be due to the so called attenuation bias: measurement error in the right hand side variables, this implies the inconsistency of the OLS estimatior and a bias in the coefficient toward zero. Since the IV estimation clears for this problem, the IV coefficient is expected to be higher (in absolute value) than the OLS coefficient for both immigration share and the interacted variable, and this in fact is the case in our estimation results. More intuitively, OLS estimate is determined by the partial correlation between income and immigrants share, while the IV estimate is determined by the partial correlation between income and the component of the immigrants share explained by our instruments. Thus, mechanically, the fact that the OLS estimate is smaller than the IV estimate means that income's partial association with the component of immigrants share that is not correlated with the instrument is weaker than its partial association with the component that is correlated.

[38] The Durbin-Wu-Hanson test investigates if the correlation between the actual flows of immigrants are uncorrelated with the error component (exogeneity). Under the hypothesis that actual immigrants flows are uncorrelated with the error term, the OLS estimation are unbiased (as IV estimation) and efficient; so OLS and IV coefficients differs only because of sampling error. Since we can reject the null hypothesis, we conclude that OLS coefficients differ from IV, so OLS estimation are biased because of endogeneity of actual immigrants flows.

[39] Even by assuming a share of tertiary educated immigrants equal to one, the overall effect on per capita GDP variation is still negative.

jointly significance of instrumental variables. But, unfortunately in presence of two endogenous variables (as in this case) the usual rules of thumbs may be misleading, so we computed the weak identification test (adjusted for the robust cluster heterogeneity) by using the Kleibergen-Paap F statistic, confirming that there are not problem on weak instruments.

The high negative effect of average immigrants on per capita GDP may have two possible explanations. A possible explanation relies on the fact that per capita GDP measure suffers of an increase in the number of inactive immigrants. This is a well known feature in migration literature: family reunion involves inactive foreign born individuals (such as children). A second possible explanation is the assimilation problem. When a migrant arrives in his destination country, he takes time before finding a job, so it strongly negatively affects per capita GDP. To solve for the inactive immigrants problem we replicate the same estimation as before by using per hour worked GDP (this measure does not suffer the inflow of inactive population and it has been often taken as a proxy for the country's macroeconomic labour productivity measure).[40]

Figure 3.12 shows results when the dependent variable is per hour worked GDP, it is interesting to notice that the coefficients associated to immigration share are all lower than those in figure 3.11 and not statistically different from zero, this confirms our intuition that per capita GDP suffers of inactive immigrants (this results is in line with the widely accepted idea in literature that immigrants have a small negative effect on wages in host countries). But the actual end of this paper is to understand if there is place for skill selective immigration policy, and the positive and significant coefficient for the interacted variable confirms that being skilled among immigrants has a positive effect on the host country's per hour worked GDP variation. Observing that per hour worked GDP can be considered as a measure for macroeconomic labour productivity, we may conclude that the inflows of tertiary educated immigrants have a positive effect on labour productivity variation. Moreover, since β_1 is not statistically different from zero, we may say that the overall effect of immigration on labour productivity variation is positive, confirming results in Sparber 2010 (this is not true in the limit case of zero human capital endowed immigrants).

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[40]Sparber (2010).

Robustness

As a robustness check we replicated the same estimation in [3.1] for two other sub-samples of data: (i) high income countries obtained by excluding the two poorest countries in the original sample (Poland and Slovak Republic); (ii) low income countries obtained by excluding United States and Canada. Results in figures 3.10-3.12. For these two others samples used, the effect of average immigration on per capita GDP variation is still negative and significant, and the effect of the interacted variable (in other words the effects of being tertiary educated among immigrants) is again positive and significant for both OLS and IV estimations. It is interesting to notice that the negative effect of average immigrants on per capita GDP variation for the high income countries sample is higher that for low income countries sample (while coefficient on the interacted variable remains roughly unchanged), this may be due to the fact that the inactive migrants problem in high income countries is stronger than in low income countries.[41]

As a further robustness check we replicate the same analysis by using the selection ratio to interact the immigrants flows. The selection ratio is the number of skilled over unskilled migrants, in our case it has been computed as the ratio between the stocks in 2000 of tertiary educated immigrants over primary educated immigrants. This variable is a proxy for the human capital structure of migration stock, but by interacting it with the flows of immigrants, we have a proxy for the human capital structure of the immigrants flows. For all the three samples used for the estimation, we obtain similar coefficient to the case in which the share of skilled immigrants was used to interact the immigrants flows. Figure 3.13 shows that an increase in the human capital structure of immigrants flows toward tertiary educated immigrants (e.g. an increase in the number of skilled versus the number of unskilled immigrants) would have a positive effect on per capita GDP (and on per hour worked GDP) variation, but again, the negative effect of average immigrants inflows[42] overcompensates this positive effect. The same results are obtained by using the two subsamples defined before (high and low income countries). This confirms the theoretical results in Benhabib (1996) that the impact of immigration strongly depends on the human capital structure of immigrants flows. Finally, this also gives a role to a

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[41] A more rigorous test for this hypothesis should be conducted by using variable concerning countries' regulation on family reunion policy.

[42] First stage regressions results for this new estimations are reported in figure 3.10 (b).

skill selective immigration policy (aimed to increase the selection ratio) in affecting positively income in host countries.

3.4 Conclusions

The aim of the chapter was to investigate the effect of immigrants flow and its human capital content on host country's income variation[43]. Negative effect of immigrants arises under a neo-classical production function where immigrants are considered as an increase in low productive workers. But allowing for the possibility that migrants can bring along them some human capital from their origin country, the human capital dilution given by the increased population may be offset. Under this setting the effect of immigration on host countries income depends on the human capital content of immigrants. So in the chapter we estimated the effects of immigrants and their skill level on host countries income variation. We provide evidence of the positive effect of being skilled among immigrants on per capita GDP variation about its mean by using instrumental variable panel data model (fixed effects for destination countries), but the overall effect of immigrants' inflows is still negative. In particular a 1% increase in the variation of zero human capital endowed immigrants inflows leads to a 1.1% decrease in per capita GDP deviation from its time mean, while being high skilled among immigrants contributes 0.45% positively on per capita GDP variation. Similarly, a 1% increase in the selection ratio of immigrants flows variation leads to a 0.29% increase in per capita GDP variation (but again it not enough to clear the negative effect of the overall immigrants inflows). So we may certainly conclude in favour of a skill selective immigration policy aimed to increase the share of skilled over unskilled immigrants. There are some possible reasons of why immigrants have a so negative effect on per capita GDP. Among them we decided to explore the problem of inactive immigrants that reduce itself per capita GDP measure. We solved this problem by using per hour worked GDP as dependent variable. By using the latter as a dependent variable we obtain some interesting results: (i) unskilled immigrants have a null effect on per hour worked GDP variation (that can be alternatively interpreted as a macroeconomic labour productivity mea-

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[43]In doing this, we pointed to stress the relevance and the validity of our instrumental variables because it is a crucial point in all the literature concerning immigration as independent variable.

sure); while (ii) being skilled among immigrants has a positive effect on per hour worked GDP variation. So we may conclude that in the limit case that immigrants have zero human capital content, their effect on labour productivity variation is null (this is not true when the selection ratio is used to interact the immigrants share); but allowing for some human capital content of immigrants (which is the most realistic case) their effect is positive on labour productivity variation.

Some other possible theoretical reasons for the so negative effect of immigrants on income variation is that the human capital content of immigrants (from poor countries, as in our estimation) is even lower than the human capital content of native workers in OECD countries (this is the idea by Dolado, Goria and Ichino 1994). An other explanation is that physical capital does not immediately adjust after immigrants inflows (this is the explanation given in literature for the negative effect of immigration on national wages); so a further step would be to consider inflows of foreign capitals as a possible help in the adjustment of physical capital after immigration inflows. Intermediate results of the paper are: (i) having found further evidence of the importance of geographic variables and bilateral aid as determinants of bilateral migration flows, (ii) having tested our instrumental variables for their relevance and validity, allowing them to be used in many other estimations involving immigration as independent variable.

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3.5   Tables and figures

Figure 3-1: Share of immigrants (stock 2000) over total population, share of tertiary educated over total stock of immigrants in 2000, share of tertiary educated natives workers over total

Country	Share of immigrants over total population	Share of tertiary educated immigrants	Share of tertiary educated native workers
Australia	21.2	40.3	30.9
Austria	10.2	12.7	14.6
Belgium	8.9	19.8	28.5
Canada	15.1	58.8	49.6
Czech Republic	4.0	11.5	10.7
Denmark	4.3	17.3	21.8
Finland	1.7	23.8	26.3
France	6.1	16.4	22.4
Germany	5.7	21.8	25.8
Hungary	1.1	11.6	12.0
Ireland	7.4	41.1	16.3
Italy	1.6	15.4	8.5
Japan	0.8	28.1	23.8
Luxembourg	22.9	21.7	30.3
Netherlands	11.3	22.0	21.9
New Zealand	13.8	40.9	21.6
Norway	5.0	28.7	21.2
Poland	1.9	14.0	11.0
Portugal	1.4	18.6	8.6
Slovak Republic	0.7	15.2	11.5
Spain	3.9	18.5	11.8
Sweden	8.6	25.7	27.7
Switzerland	20.9	18.6	16.6
United Kingdom	6.0	34.9	16.1
United States	8.6	42.7	52.5

Source : author on F.Docquier, A.Marfouk and B.L.Lowell (2007)

Figure 3-2: Relation between the inflows of migrants and the stock of immigrants in 1991

(a)

(b)
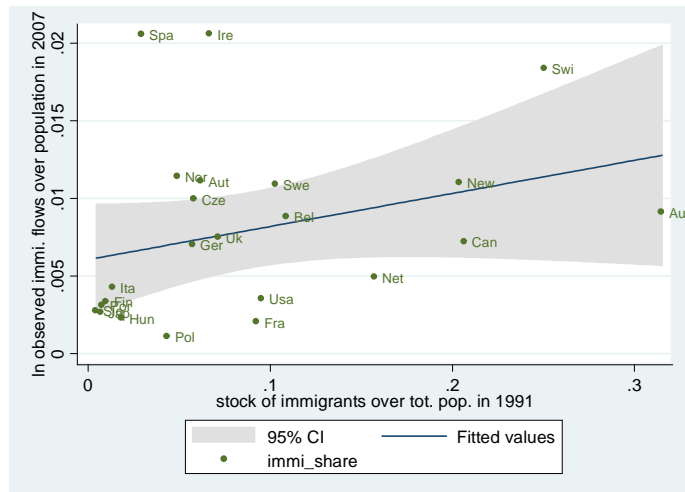
Source: F.Docquier, A.Marfouk and B.L. Lowell; and OECD.stat

Figure 3-3: Relation between the share of skilled immigrants in 2000 and: (a) the share of skilled native workers in 2000, (b) the share of immigrants over total population in 2000

(a)

(b)

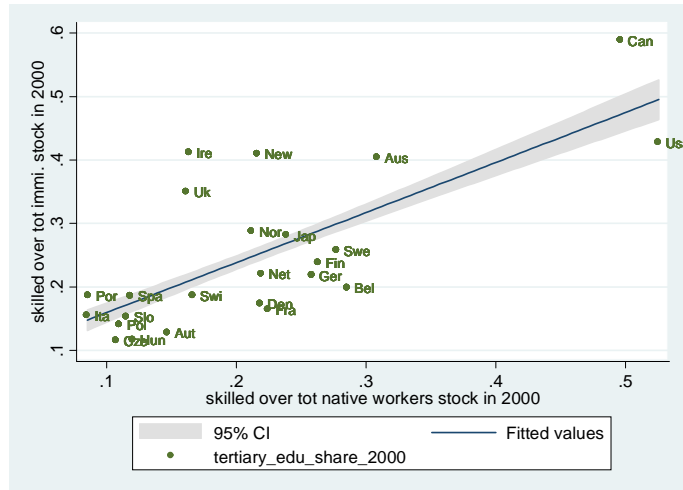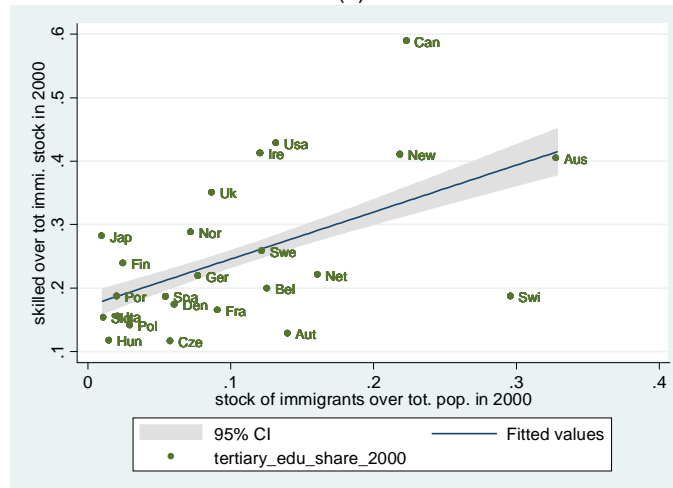*Source*: F.Docquier, A.Marfouk and B.L. Lowell; and OECD.stat

Figure 3-4: Relation between the stock of immigrants in 1991 and per capita gdp in 1998 (a) and 2008 (b)

(a)

(b)
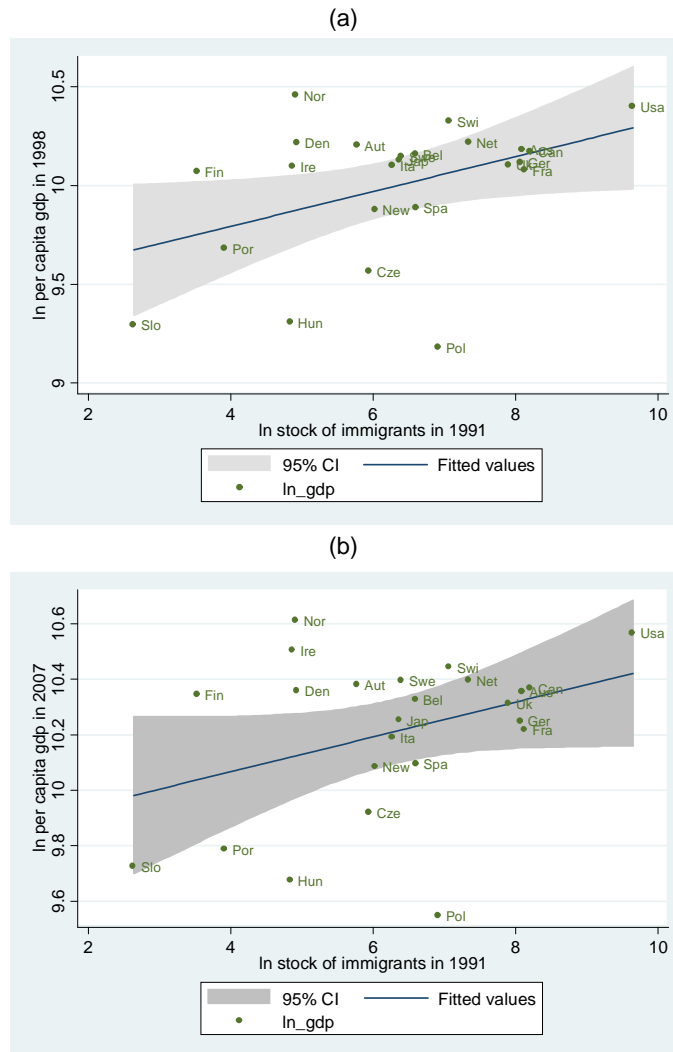
Figure 3-5: List of the destination and origin countries

Destination Countries	Origin Countries
Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom, United States	Albania, Algeria, Argentina, Bangladesh, Belarus, Bolivia, Brazil, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo, Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Georgia, Ghana, Guatemala, Guinea, Guyana, Haiti, Honduras, Hungary, Iceland, India, Iran, Iraq, Israel, Jamaica, Kenya, Korea, Lebanon, Liberia, Libya, Macedonia, Malaysia, Mali, Mauritania, Mexico, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Rwanda, Saudi Arabia, Senegal, Serbia, Sierra Leone, Singapore, Slovenia, Somalia, South Africa,Sri Lanka, Sudan, Suriname, Syria, Thailand, Togo, Tunisia, Ukraine, Uruguay, Venezuela, Viet Nam, Zambia, Zimbabwe.

Figure 3-6: Results for bilateral migration flows estimation: 1998-2007 in 24 OECD countries from 86 poor and developing countries

Dependent variable	Bilateral immigrants flows in ln			
	(1)	(2)	(3)	(4)
ln_aid	0.37	0.289	0.216	0.288
	(33.97)***	(25.45)***	(19.36)***	(17.41)***
ln_immi_1991		0.377	0.436	0.443
		(23.13)***	(25.74)***	(17.97)***
D_contiguity			1.757	1.964
			(5.97)***	(6.23)***
D_common_language			1.079	0.917
			(17.05)***	(11.34)***
D_colonial_relationship			0.470	0.353
			(6.32)***	(3.53)***
weighted distance			-0.850	-0.927
			(10.39)***	(17.97)***
Observations	4945	4935	4935	4935
Number of id_push	766	766	766	766
R-squared within	0.223	0.320	0.410	
rho				0.27***

Absolute value of t statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3-7: Results for bilateral skilled migration flows estimation: 1998-2007 in 24 OECD countries from 86 poor and developing countries

Dependent variable	Bilateral skilled immigrants flows in ln		
	(1)	(2)	(3)
Expenditure in tertiary edu (ln)	0.606	0.275	-0.034
	(25.91)***	(17.24)***	(1.19)
N°of patent (ln)	0.085	0.038	0.224
	(4.72)***	(3.31)***	(9.19)***
ln_skilled_immi_1991		0.430	0.523
		(46.51)***	(35.72)***
D_contiguity		0.098	0.012
		(1.70)*	(0.15)
D_common_language		0.867	0.530
		(20.40)***	(9.76)***
D_colonial_relationship		-0.063	0.096
		(1.25)	(1.58)
weighted distance		-0.697	-0.340
		(19.07)***	(9.40)***
Observations	8447	8402	8402
Number of id_push	1099	1099	1099
R-squared within	0.36	0.66	
rho			0.33***

Absolute value of t statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3-8: Relation between the actual immigrants inflows and the estimated inflows of immigrants as in model [3.2] and [3.3] in 1998 (a,b) and 2007 (c,d)
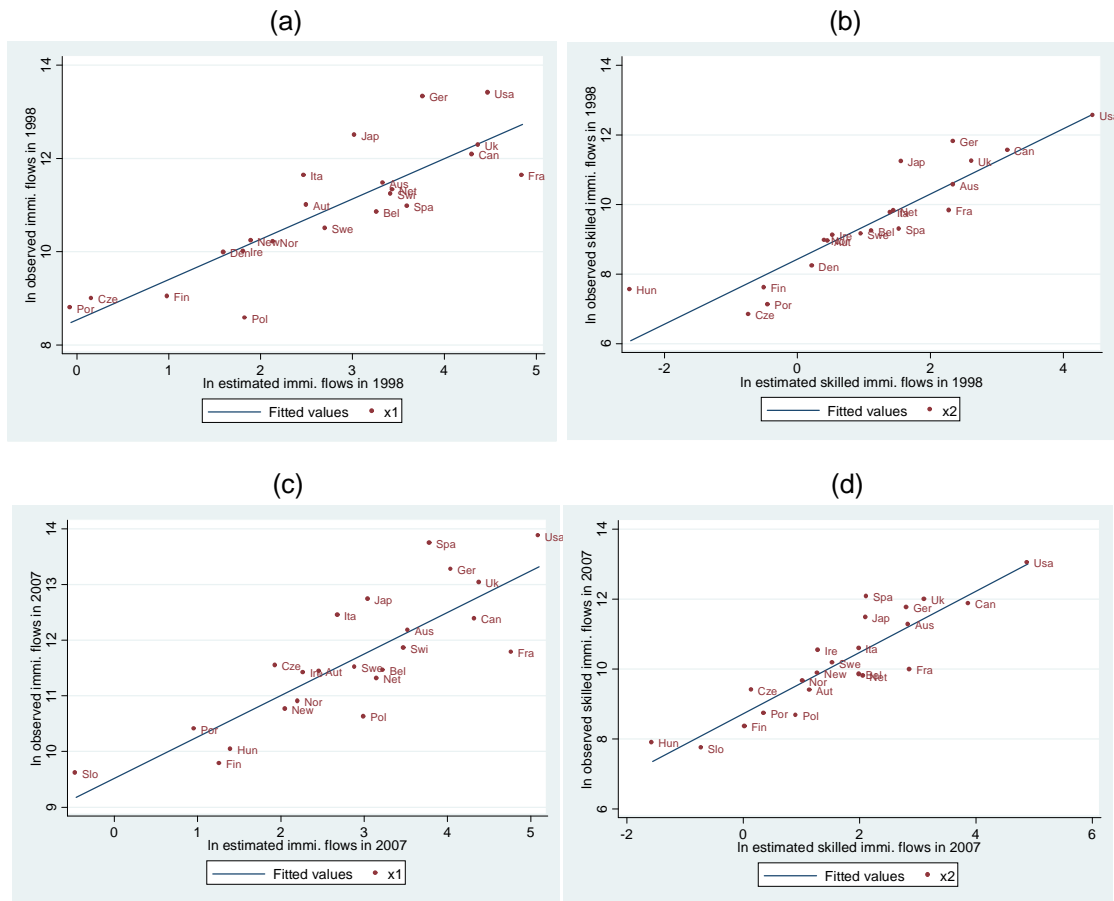
Figure 3-9: Relation between the actual and estimated flows of both immigrants and tertiary educated immigrants

Dependent variable	ln_immi	ln_skilled_immi
constant	8.122 (26.74)***	8.231 (54.71)***
ln_estimated_immi	1.145 (10.52)***	-
ln_estimated_skilled_immi	-	1.168 (10.48)***
Fixed Effects	Yes	Yes
R-sq	0.35	0.36
F-stat	110.73	109.89
Observations	229	219
Number of countries	24	24

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3-10: First stage regressions results

(a)

	Complete Sample		High Income Countries		Low Income Countries	
Dependent variable	ln_immi_share	ln_immi_share* ln_immi_skill	ln_immi_share	ln_immi_share* ln_immi_skill	ln_immi_share	ln_immi_share* ln_immi_skill
immi fit share in ln	0.686	1.681	0.847	2.092	0.681	1.651
	(2.94)***	(2.76)**	(4.32)***	(3.84)***	(2.85)**	(2.61)**
skilled immi fit share in ln	0.866	2.672	0.848	2.673	0.899	2.735
	(4.48)***	(4.56)***	(3.93)***	(4.11)***	(4.30)***	(4.30)***
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.443	0.423	0.451	0.429	0.444	0.419
F test exclu. Ins.	16.96	19.93	23.77	30.83	15.88	18.04
Kleibergen-Paap F	5.19		5.71		5.04	
Observations	214	214	199	199	196	196
Number of countries	24	24	22	22	22	22

Absolute value of t statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

(b)

	Complete Sample		High Income Countries		Low Income Countries	
Dependent variable	ln_immi_share	ln_immi_share* ln_select_ratio	ln_immi_share	ln_immi_share* ln_select_ratio	ln_immi_share	ln_immi_share* ln_select_ratio
immi fit share in ln	0.686	2.166	0.847	2.727	0.681	2.127
	(2.94)***	(2.73)**	(4.32)***	(4.25)***	(2.85)**	(2.59)**
skilled immi fit share in ln	0.866	3.567	0.848	3.616	0.899	3.661
	(4.48)***	(4.27)***	(3.93)***	(3.91)**	(4.30)***	(4.04)***
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-sq	0.443	0.409	0.451	0.42	0.444	0.406
F-stat	16.96	15.98	23.77	28.17	15.88	14.52
Kleibergen-Paap F	3.28		3.8		5.52	
Observations	214	214	199	199	196	196
Number of countries	24	24	22	22	22	22

Absolute value of t statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3-11: Per capita GDP as dependent variable: 2SLS results

Dependent: per capita GDP	Complete Sample		High Income Countries		Low Income Countries	
	OLS	IV	OLS	IV	OLS	IV
ln_immi_share	-0.132	-1.107	-0.189	-1.236	-0.123	-1.075
	(1.86)*	(-1.78)*	(2.88)***	(-1.94)**	(1.63)	(-1.65)*
ln_immi_share *	0.087	0.449	0.101	0.495	0.083	0.451
ln_immi_skill	(3.48)***	(2.17)**	(4.45)***	(2.33)**	(3.12)***	(1.99)**
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	79.89	13.08	72.22	10.46	72.89	11.23
DWH test	8.52		8.36		7.15	
Observations	238	214	218	199	218	196
Number of countries	24	24	22	22	22	22

Absolute value of z statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3-12: Per hour worked GDP as dependent variable: 2SLS results

Dependent: per Hour GDP	Complete Sample		High Income Countries		Low Income Countries	
	OLS	IV	OLS	IV	OLS	IV
ln_immi_share	-0.017	-0.919	-0.09	-0.955	0.004	-0.953
	(-0.26)	(-1.50)	(-1.44)	(-1.54)	(0.05)	(-1.43)
ln_immi_share *	0.042	0.388	0.061	0.394	0.034	0.403
ln_immi_skill	(1.74)*	(1.84)*	(2.82)**	(1.89)*	(1.31)	(1.73)*
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	63.99	10.41	52.95	9.09	58.26	8.68
DWH test	7.39		7.73		6.25	
Observations	238	214	218	199	218	196
Number of countries	24	24	22	22	22	22

Absolute value of z statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 3-13: Second stage regression results when the selection ratio has been used to interact the immigrants flows

(a)

Dependent: per capita GDP	Complete Sample		High Income Countries		Low Income Countries	
	OLS	IV	OLS	IV	OLS	IV
ln_immi_share	-0.085	-0.916	-0.178	-1.055	-0.076	-0.899
	(1.53)	(2.19)**	(3.35)***	(2.66)***	(1.33)	(-1.99)**
*ln_immi_share**	0.053	0.297	0.073	0.323	0.051	0.294
ln_selection_ratio	(3.61)***	(2.53)**	(5.31)***	(2.92)***	(3.30)***	(2.29)**
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	80.67	8.47	78.9	6.86	73.87	7.55
DWH test	5.09		5.29		4.32	
Observations	238	214	218	199	218	196
Number of countries	24	24	22	22	22	22

Absolute value of z statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

(b)

Dependent: per Hour GDP	Complete Sample		High Income Countries		Low Income Countries	
	OLS	IV	OLS	IV	OLS	IV
ln_immi_share	0.016	-0.778	-0.092	-0.811	0.029	-0.796
	(0.31)	(-1.90)*	(1.80)*	(2.03)**	(0.52)	(-1.79)*
*ln_immi_share**	0.022	0.257	0.046	0.257	0.018	0.263
ln_selection_ratio	(1.58)***	(2.20)**	(3.51)***	(2.33)**	(1.27)	(2.05)**
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	63.58	8.04	56.17	7.01	58.19	6.91
DWH test	4.62		4.88		3.97	
Observations	238	214	208	199	218	196
Number of countries	24	24	21	22	22	22

Absolute value of z statistics in parentheses

SE and statistics are robust to both arbitrary and intra-group heteroskedasticity

* significant at 10%; ** significant at 5%; *** significant at 1%

Chapter 4

Offshoring, migrants and native workers: the optimal choice under asymmetric information

4.1 Introduction

When a migrant arrives in his host country, he brings along a lot of things with him but he cannot transfer his homeland's information structure. Therefore the host country employers are not well informed about immigrant workers, their ability and effort. This is the reason why we decide to model migration under asymmetric information. Some works focus on the role of asymmetric information in determining the skill composition of migrants (Katz and Stark 1987), others study the role of information asymmetries on the decision to migrate. Recent papers on the optimal international organization of firms when both, offshoring and hiring immigrant workers are feasible options (Ottaviano, Peri and Wright 2010), consider perfect information about immigrants. But, since asymmetric information modifies the wage schedule for immigrants, asymmetric information can change the traditional trade-off between offshoring and hiring immigrant workers. Moreover because of imperfect monitoring (on both natives and immigrants) workers may not deliver on their promises about effort, so incentives must be provided to workers for their effort. This paper will not analyze the nature of the

relation between native and immigrant workers (complementarity or substitutability[1]). We start from a stylised fact: recent immigration flows into rich countries allow local employers to hire immigrants, this strategy potentially substitutes for the more traditional offshoring of production. Under asymmetric information about immigrants, employers don't observe the ability and the effort level by immigrants. Thus, foreign born workers will be paid the average of the overall immigrant workers output. The main result of the analysis is that it will be optimal to offshore the production when the firm decides to produce low quality goods, while it will be optimal to produce high quality goods at home using native workers. If the firm decides to produce intermediate quality level goods, it will be optimal to produce at home using immigrant workers.

The rest of the chapter is organized as follows. Paragraph 4.2 presents a review of existing literature. Paragraph 4.3 presents the baseline model; results are presented in paragraph 4.4. Paragraph 4.5 extends the baseline model to a continuum of types of workers. The final paragraph concludes.

4.2   Review of the literature

This paper relies on two main streams of literature: (i) one concerning the relation between migration and offshoring, (ii) the other concerning the role of asymmetric information in the economics of migration. Although traditional Heckscher-Ohlin models predict substitutability between immigration and offshoring[2], a consensus has not been reached in giving a sign to the relation between immigration and offshoring. The question was first analyzed by Ramaswami (1968), who argued that a capital abundant country can either offshore parts of the production abroad (enjoying higher return on capital and lower wages) or invite foreign workers paying them a lower wage than natives. Bhagwati and Srinivasan (1983) doubted the possibility of hiring foreign born workers at a lower wage than natives, but recent empirical studies show that immigrants earn less than natives (Antecol, Cobb-Clark and Trejo 2003; Butcher and Di Nardo 2002; Chiswick, Le and Miller 2008) giving new lymph to this debate. Recent theoretical works

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[1] See Ottaviano and Peri (2008), Peri and Sparber (2009), Borjas (2003), Borjas, Grogger and Hanson (2008).
[2] Immigrants increase the labor endowment in receiving countries, in the short run it reduces the capital labor ratio and thus it increases the return on capital. The increased return on capital deters offshoring.

by Jones (2005) and Ottaviano, Peri and Wright (2010) shed light on the relation between offshoring and immigration. The main conclusion in Ottaviano, Peri and Wright (2010) is that easy production tasks are offshored, intermediate tasks are covered by immigrants in the home country, while complicated tasks are covered by native workers at home.

Empirically, Javorcik et.al. (2006) find a positive relation between immigrants in the U.S. and the outward FDI by American firms, this kind of complementarity becomes stronger if we consider skilled immigrants (El Yaman, Kugler and Rapoport 2007). Indeed an increase in the number of immigrants increases the information about their country of origin reducing the cost of offshoring. On the contrary Barba Navaretti, Bertola and Sembenelli (2008) find substitutability between immigration and offshoring. Finally Ottaviano, Peri and Wright (2010) find empirical evidence of complementarity between offshoring and migration, because only easy tasks are offshored, while as tasks become more complex they are covered by immigrants, and finally the tasks at the upper end of complexity are assigned to natives.

This literature considers the characteristics of immigrants and their abilities perfectly known to employers in host country's firms. In our view, however, employers in host countries are not perfectly informed about the ability of new immigrants, due to their inability to assess the education level, the experience, and other dimensions related to cultural differences. This may potentially change the relation between migration and offshoring in theoretical models.

The basic idea underlying all works in the field of migration under asymmetric information is that when information on the ability of immigrants in unknown to receiving country's employer, all migrants will receive the same wage, based on the average product of the group of migrants. The seminal work in this field was by Katz and Stark (1984); they observed that employers in the immigrants receiving country have less information than employers in the country of origin as to the type of worker in terms of productivity and effort. The reason is that when a worker migrates, he cannot take his home country information structure. Katz and Stark (1987, 1989) argue that under asymmetric information (and without the possibility to invest in devices to identify migrant's skill level) the individual wage offered to immigrant workers is equal to the average product of the immigrant workers group.

4.3   The baseline model

Under symmetric information each worker receives a wage equal to his productivity; but under asymmetric information on foreign born workers and assuming immigrants do not engage in any "signaling" about their skill level, employers will pay an average (on the base of the skill composition of the labour force) wage to all migrant workers in production (Katz and Stark 1987). Thus a kind of discrimination in wages may arise between home and foreign born workers due to asymmetric information on immigrants ability[3]. Hence each firm can carry out two strategies (alternative to using native workers) to reduce costs: (i) stay at home and hire immigrants, (ii) localize a production plant abroad in order to enjoy a lower labour cost (offshoring).

The supply side of the economy is here described by a simplified Kremer (1993) production function[4], where the manufacture of a unit of final goods requires only labour and a number of tasks (at the end of each task the employer checks the quality of the intermediate output). Let's assume two tasks: a "communication intensive" task, unfeasible for foreign born workers because of lack in language skills, and a "manual intensive" task which in principle can be carried out by both native and foreign born workers[5]. The manual task requires n workers and the quality of the final output depends on the quality of the manual task.

Let's assume two countries, a rich country (R) and a poor country (P); two types of workers may be used in the manual task: the high skilled one α_H and the low skilled one α_L; where α_i is the skill type of workers. Each worker may choose his effort level $e_j = 1, 2$ in production. We also assume that every type of worker is represented in the pool of hired workers[6], but:

- the effort by immigrant and native workers in production (e_j) is private information

- the employer is not able to distinguish between types (α_i) of foreign workers in production

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[3]We assume symmetric information about native workers.

[4]The Kremer (1993) production function has the following form:

$E(y) = k^\alpha \left(\Pi_{i=1}^n q_i \right) nB$

where $E(y)$ is the expected output level, n is the number of tasks in production, B is the output per worker with a single unit of capital k, and q is the worker's skill (or quality) as the expected percentage of maximum value the product retains if the workers performs the task.

[5]The distinction between "comunicative" and "manual" tasks has been made by Peri and Sparber (2009).

[6]Results don't change if we relax this assumption.

- the employer is able to distinguish between types (α_i) of home born workers in production

To keep things simple let's assume only two workers in manual task (this assumption will be relaxed subsequentely) so the overall quality level depends on the workers skills in manual task production and on their effort level. Let q denote quality of the product, four quality levels can be produced:

$$[4.1] \quad q_i = \begin{array}{l} q_o = \alpha_H e_0 + \alpha_L e_0 \\ q_1 = \alpha_H e_0 + \alpha_L e_1 \\ q_2 = \alpha_H e_1 + \alpha_L e_0 \\ q_3 = \alpha_H e_1 + \alpha_L e_1 \end{array}$$

The quality level can be thought of as a joint probability of having more or less skilled workers in production exerting low or high effort in production. Assuming that, effort being equal, the productivity in terms of quality is higher for the high-skilled workers than for the low-skilled workers ($\alpha_H > \alpha_L$) we may conclude:

$[4.2]$ $q_0 < q_1 < q_2 < q_3$.

We assume that the firm has all the bargaining power in contracting, it makes a take-it or leave-it offer to the worker; the worker can accept or reject the contract. If he rejects the contract he receives a wage (w_u) provided by the government or alternatively by other firms in other sectors. The price of a unit of output is assumed to be increasing with the quality level and the wage for a comunication intensive task can be omitted because it does not make a difference among the three alternatives (producing at home using natives or immigrants, or producing abroad). Each firm at home will maximize a unit profit function, namely revenue less costs in the following form:

$[4.3]$ $\pi(q_i) = p(q_i) - 2w(q_i)$[7]

Similarly each worker maximizes utility as a function of wage and effort cost (e):

$[4.4]$ $u = w(q_i) - e$

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[7]Where only labor is assumed in production.

each worker of type α_i will choose the effort that maximizes his utility. In order for q_i to be attainable, wage schedules have to satisfy the following participation (IR) and incentive constraints (IC):

[4.5] (IR) $w(q_i) - e_j \geqq w_u$ $\qquad \forall q_i$

[4.6] (IC) $w(q_i) - e_j \geqq w(q_i^-) - e_{k \neq j}$ $\qquad \forall q_i$

where i stands for the quality level of the output, j stands for the effort level (1 or 2) required by worker H or L, as it applies, in order to achieve q_i; q_i^- is a quality level lower than q_i if the worker who receives the incentive produces a low effort, as a consequence $w(q_i^-)$ is the "punishing" wage provided by the employer if the actual quality level is lower than the expected one (see appendix for more details). Notice that the (IR) in [4.5] has to be binding, otherwise the employer could reduce the wage still satisfying the participation constraint. The (IC) constraint here assures that the worker who gets the incentive will exert a high effort level. Indeed, ex-ante the employer decides for how many workers he wants high effort (according to the quality level he wants to reach), so according to (IC) and (IR) the employer defines a contract (take it or leave it) for workers. If the employer decides to provide incentives to the workers, because of hidden actions, they may receive the incentive and shirk. This opportunistic behaviour is avoided by IC constraint (see appendix for details).

Let's start looking at what happens under perfect information about native worker types. If the employer knows the type of workers in manual task (but he still does not observe their effort level), he may set ad hoc wages and incentives according to each quality level, thus the following profit functions derive (effort is not observable):

[4.7] $\pi(q_0) = p(q_0) - 2w_r^{h,n}$

[4.8] $\pi(q_1) = p(q_1) - 2w_r^{h,n} - \Delta$

[4.9] $\pi(q_2) = p(q_2) - 2w_r^{h,n} - \Delta$

[4.10] $\pi(q_3) = p(q_1) - 2w_r^{h,n} - 2\Delta$

where $w_r^{h,n} = w_u^{h,n} + e_0$ is the reservation wage at home for native workers and $\Delta = e_1 - e_0$. Thus functions in [4.7] - [4.10] may be thought of as profits functions for every attainable quality level when natives are employed in production (because there is perfect information about the ability of natives).

But, if the firm hires immigrants, it cannot distinguish the type of immigrants in production and their effort level (asymmetric information) even if each individual knows his type and effort. Under asymmetric information about immigrants, each firm will pay immigrants a uniform wage as a function of the quality level that the firm wants to reach (see Kats and Stark 1984, 1987). If the firm wants to produce q_0 there is no reason for providing incentives and only participation constraints have to be satisfied:

$$[4.11] \ w^{h,m}(q_0) = w_u^{h,m} + e_0 = w_r^{h,m}$$

so when the employer wants to reach the lower quality level, he has to pay both workers the reservation wage. If the firm wants to produce a higher quality level, a high effort by the low productive worker is needed, so the firm has to provide incentive to him. From the incentive compatibility constraint we derive the wage:

$$[4.12] \ \ w^{h,m}(q_1) = w_r^{h,m} + (e_1 - e_0) = w_r^{h,m} + \Delta.$$

But because of asymmetric information about the type of the two immigrant workers in production (the employer is not able to distinguish among them in setting ad hoc contracts), the firm will pay an equal wage to both workers in production. This implies that in order to obtain a quality level higher than q_0 the firm has to pay the incentive to both workers. So that intermediate quality levels cost as much as the highest quality level (q_3), so they are dominated. Thus, if the firm wants to reach the higher quality level (q_3) it has to induce high effort by both workers paying them the following wage:

$$[4.13] \ \ w^{h,m}(q_3) = w_r^{h,m} + (e_1 - e_0) = w_r^{h,m} + \Delta.$$

So the firm can realize a higher quality level q_3 by spending the same wage cost as for q_1 or q_2. If the firm keeps production at home hiring immigrants in the manual task (enjoying the lower reservation wage by immigrants, as we will see in what follows) just two output strategies are not dominated: q_0 and q_3. Assuming $p(q_i) = q_i$ the profit functions associated to these strategies are:

$$[4.14] \ \pi^{h,m}(q_0) = q_0 - 2w(q_0) = e_0\alpha_H + e_0\alpha_L - 2w_r^{h,m}$$

[4.15] $\pi^{h,m}(q_3) = q_3 - 2w(q_3) = e_1\alpha_H + e_1\alpha_L - 2w_r^{h,m} - 2\Delta$

If the firm chooses to produce abroad, it has to pay a local agent[8] (costing ϕ) who reveals both the type of local workers and how to produce quality level higher than the minimum one abroad. This allows the firm to pay a customized wage. If the firm wants to produce q_0 abroad, it has to guarantee the participation contraint (as at home). The wage schedule and profit function will be[9]:

[4.16] $w^f(q_0) = w_u^f + e_o = w_r^f$

[4.17] $\pi^f(q_0) = q_0 - 2w(q_0) = e_0\alpha_H + e_0\alpha_L - 2w_r^f$

When the firm wants to reach a higher quality level, it has to provide an incentive to the low type to obtain q_1 or to the high type to obtain q_2. But as in the domestic case, the incentive provided to the high productive worker is the same as the incentive provided to the low productive worker, so that the strategy q_2 dominates the strategy q_1. Quality q_1 remains dominated as it is at home but the quality q_2 does not. Thus the wage schedule paid to the high productive worker for an intermediate output level (q_2) and the correspondent unit profit functions are:

[4.18] $w^f(q_2) = w_r^f + \Delta$

[4.19] $\pi^f(q_2) = q_2 - 2w_r^f - \Delta - \phi = e_1\alpha_H + e_0\alpha_L - 2w_r^f - \Delta - \phi$

Finally, if the firm wants to reach the highest quality level (q_3) it has to provide incentive to both workers ending up with the following profit function:

[4.20] $\pi^f(q_3) = q_2 - 2w_r^f - 2\Delta - \phi = e_1\alpha_H + e_1\alpha_L - 2w_r^f - 2\Delta - \phi.$

The following table summarizes the unit profit functions for each quality-strategy combination[10]:

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[8] The cost of information here is assumed as fixed (we will remove this assumption in paragraph 4.5) and it must be paid if the firm offshore the production abroad. This is why it would be too expensive for the employer to buy information about immigrants at home, indeed it would imply to pay an agent for each origin country by immigrants in production.

[9] Notice that because just a low effort level is requested by the firm, there is no reason to pay for the local agent to reveal the worker's effort.

[10] Remember that quality level q_1 is dominated for all the strategies.

	Natives	Immigrants	Offshoring
q_0	$e_0\alpha_H + e_0\alpha_L - 2w_r^{h,n}$	$e_0\alpha_H + e_0\alpha_L - 2w_r^{h,m}$	$e_0\alpha_H + e_0\alpha_L - 2w_r^f$
q_2	$e_1\alpha_H + e_0\alpha_L - 2w_r^{h,n} - \Delta$	$e_1\alpha_H + e_0\alpha_L - 2w_r^{h,m} - 2\Delta$	$e_1\alpha_H + e_0\alpha_L - 2w_r^f - \Delta - \phi$
q_3	$e_1\alpha_H + e_1\alpha_L - 2w_r^{h,n} - 2\Delta$	$e_1\alpha_H + e_1\alpha_L - 2w_r^{h,m} - 2\Delta$	$e_1\alpha_H + e_1\alpha_L - 2w_r^f - 2\Delta - \phi$

4.4 The baseline model results

Under symmetric information the employer knows the ability of workers at home (and abroad) and he also knows how to produce abroad, so that there is no need to pay a local agent abroad. Assuming that the reservation wage for workers at home is higher than workers abroad (this is plausible if the home country is richer and gives a higher unemployment subsidy than the poor country) producing abroad is always better than producing at home (remark that we assume no fixed cost for offshore the production abroad).

Let's assume now asymmetric information about immigrant workers, and assume $w_r^{h,n} > w_r^{h,m} > w_r^f$ [11] with $w_r^{h,n} - w_r^{h,m} > \Delta$ [12] ; the model in its simplest version gives to the firm an instrument to decide its optimal localization strategy given the level of quality it would produce. If a firm wants to produce q_0 it will be optimal for the firm to produce abroad, because there is no reason for paying the local agent and the reservation wage is lower than at home.

If a firm wants to produce an intermediate quality level (q_2), it has to compare profits for q_2 at home using either native or immigrant workers with profits obtained producing abroad. The strategy of using natives is dominated by immigrants, and then it will be optimal to produce q_2 abroad only if $\left(w_r^{h,m} - w_r^f\right) > (\phi - \Delta)/2$.

Finally, when a firm wants to produce the maximum quality level, the strategy of producing at home using natives is dominated again and it will be optimal to produce abroad q_3 if, and only if, $\left(w_r^{h,n} - w_r^f\right) > \phi/2$. Since the conditions under which it is optimal to produce abroad become more restrictive with the increasing quality level [13], we conclude that:

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[11] Reservation wage for immigrants is lower than for natives because w^u for immigrants is lower than for natives. This is clear if we imagine immigrant as a guest worker (the case of Turkish migration to Germany) who works, consumes and saves during his working age and consumes savings during the retired age enjoing the PPP in his origin country

[12] This means that home born workers have a reservation wage higher than the wage given to an immigrant worker who receive the incentive to produce a high effort.

[13] Notice that $\frac{\phi}{2} > \frac{\phi - \Delta}{2}$.

Proposition 1 *the higher the quality level required, the larger the range of circumstances under which the firm decides to keep production at home[14].*

In this model the role of the local agent's cost is crucial because it represents the cost of information. So now we go deeper in the role of ϕ in choosing the firm's optimal strategy. Up to this point we found that: (i) there is no place for a native workforce (except for the comunication intensive task), (ii) the quality level q_1 is dominated for all the strategies by the highest quality level (q_3), (iii) it is always optimal to produce the minimum quality level abroad. So we can restrict the analysis to the quality levels q_2 and q_3 comparing offshoring and hiring immigrants. When the firm wants to produce q_2 the profit differential between the immigrant and offshoring strategy can be written as follows:

[4.21] $\pi^{h,m}(q_2) - \pi^f(q_2) = 2\left(w_r^f - w_r^{h,m}\right) + \phi - \Delta$

thus when $\left(w_r^{h,m} - w_r^f\right) < \frac{\phi}{2} - \frac{\Delta}{2}$ the firm finds optimal producing at home, conversely when $\left(w_r^{h,m} - w_r^f\right) > \frac{\phi}{2} - \frac{\Delta}{2}$ the firm finds optimal producing abroad. Similarly when the output quality level is q_3 the profits difference will be:

[4.22] $\pi^{h,m}(q_3) - \pi^f(q_3) = 2\left(w_r^f - w_r^{h,m}\right) + \phi$

thus the firm will find optimal to produce at home when $\left(w_r^{h,m} - w_r^f\right) < \frac{\phi}{2}$ and to produce abroad if $\left(w_r^{h,m} - w_r^f\right) > \frac{\phi}{2}$. Notice that the migrants' productivity levels do not matter because they clear out in the profit difference $\pi^{h,m}(q) - \pi^f(q)$. So, given a certain difference in reservation wage between home and foreign country, the profits difference depends upon the cost of the local agent. The resulting situation can be represented by the graph in figure 4.1, where the dashed line represents the case in which the firm is indifferent producing q_3 at home or abroad, while the continuous line has the same meaning but in the case of q_2. The area under the line represents the circumstances for which it is optimal to produce at home using immigrants. It is easy to observe that an increase in the cost of the local agent makes producing at home more

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[14] *If the firm had the possibility to know the type of immigrants workers (symmetric information) and if producing abroad had a fixed cost (ϑ), under the assumption that $w_r^h > w_r^f$ it would be optimal to produce abroad if and only if $\left(w_r^h - w_r^f\right) > \vartheta/2$ for each quality level. So we can conclude that asymmetric information introduces new threshold for the intermediate quality level q_2 making it less likely to be produced at home.*

Figure 4-1: Relation between the wage differential and the cost of the local agent to have information about the workers effort
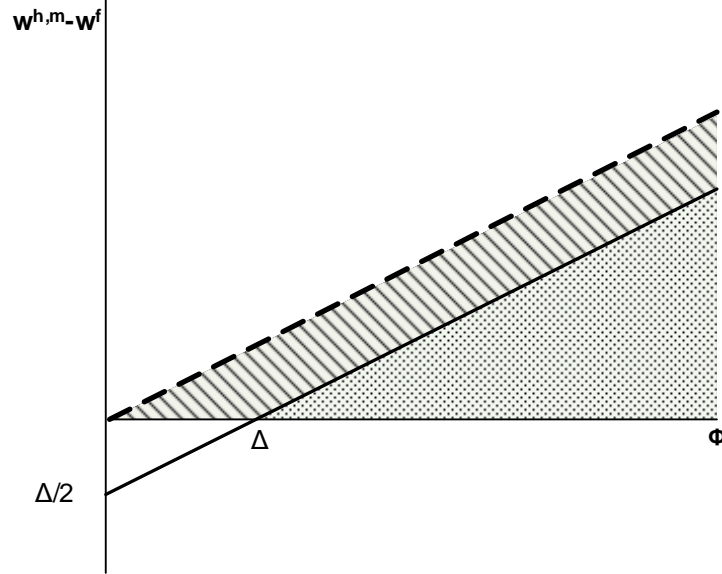
and more profitable. Comparing the areas under the two curves we can conclude that the higher the quality level, the greater the circumstances under which firm decides to keep production at home.

4.4.1 Lower productivity abroad

Up to now we assumed a worker exerting a certain effort level produces a quality level that is equal both at home and abroad. This may be a restrictive assumption if we imagine very different countries in our model. The organization of labour and the technological level may differ between countries, in particular between poor and rich ones. In order to take into account this issue, we simply assume that the effort level abroad produces a lower quality level than at home, in other words we assume that $\tilde{e}_i^f = ke_i$ (where $0 < k < 1$). Since the disutility by effort is not affected, the IC and the IR constraints remain unchanged. The parameter k can be seen as the similarity between home and foreign country in terms of organization of labour and technological level.

This assumption does not change the profit functions for the home strategy, but it changes

profit function in [4.17], [4.19] and [4.20] for the production abroad[15]:

$$[4.23] \ \pi^f(q_0) = \alpha_H \tilde{e}_0 + \alpha_L \tilde{e}_0 - 2w_r^f = k(\alpha_H e_0 + \alpha_L e_0) - 2w_r^f$$

$$[4.24] \ \pi^f(q_2) = \alpha_H \tilde{e}_1 + \alpha_L \tilde{e}_0 - 2w_r^f - \Delta - \phi = k(\alpha_H e_1 + \alpha_L e_0) - 2w_r^f - \Delta - \phi$$

$$[4.25] \pi^f(q_3) = \alpha_H \tilde{e}_1 + \alpha_L \tilde{e}_1 - 2w_r^f - 2\Delta - \phi = k(\alpha_H e_1 + \alpha_L e_1) - 2w_r^f - 2\Delta - \phi$$

Given these new profits functions, as in the former section, the strategy of using natives at home is still dominated, so we will consider the two other strategies in the rest of the paragraph. It would be optimal to produce quality q_0 at home using immigrants if $(w_r^{h,m} - w_r^f) < \frac{1}{2}[(1-k)(\alpha_H e_0 + \alpha_L e_0)]$; so when k is close to one (i.e. effort in foreign country produces a quality level similar to that at home) it is optimal to offshore the production; while if the foreign country has an organization of labour and/or a technological level such that effort produces a lower quality level than at home (so k decreases), the strategy of staying at home using immigrants is allowed to be optimal for the firm[16]. If the firm wants to reach the quality level q_2 it would be optimal to produce at home using immigrants if $(w_r^h - w_r^f) < \frac{1}{2}[(1-k)(\alpha_H e_1 + \alpha_L e_0) - \Delta + \phi]$. Again the lower the k parameter the lower the probability that the firm finds it optimal to offshore the production abroad.

Finally if the firm wants to reach the highest quality level q_3 it would be optimal to produce it at home if $(w_r^h - w_r^f) < \frac{1}{2}[(1-k)(\alpha_H e_1 + \alpha_L e_1) + \phi]$. Notice that with respect to the simple case in which effort produces the same quality level in both countries, here the conditions of optimality for every quality level for the home strategy are increased by a positive term $(\frac{1}{2}(1-k)(\alpha_H e_1 + \alpha_L e_0))$, that increases the circumstances under which it is optimal to produce at home using immigrants[17]. Intuitively, wide technological differences between home and foreign countries discourage the home employer to delocalize the production abroad.

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[15] Remember that q_1 is dominated both at home and abroad.

[16] This conclusion was not possible under the assumption that the two countries have the same technology and the same organization of labor.

[17] Moreover, even if the firm producing abroad would be free to save the local agent cost (ϕ) and behaving under asymmetric information, there is still place for the strategy of using immigrants at home. In particular the conditions under which it is optimal to produce abroad (without paying the local agent) are:

[a] $(w_r^{h,m} - w_r^f) < \frac{1}{2}[(1-k)(\alpha_H e_1 + \alpha_L e_0)]$ for quality level q_2

[b] $(w_r^{h,m} - w_r^f) < \frac{1}{2}[(1-k)(\alpha_H e_1 + \alpha_L e_1)]$ for quality level q_3

4.5 Many workers with a continuum of types

The results so far rely on the assumption of only two workers, one for each type, in production. Now we relax this assumption allowing for many workers ($n = 0, .., N$) in a continuum of skill levels. Each worker still provides a certain level of effor ($e_j = 1, 2$). The distribution of workers in the continuum of types follows a Pareto distribution[18] with density function $f(\alpha) = \gamma \frac{\alpha_m^\gamma}{\alpha^{\gamma+1}}$, support $\alpha \in [\alpha_m; \infty]$[19], and where α_m is the lowest type of the distribution. The distribution of skills in the firm reflects the overall distribution of skill in the country.

The employer chooses the quality level he wants to reach (q^*) and consequently the scheme of incentives to give to workers (in other words he defines α_j as the last type of worker receiving the incentive); so the firm will provide incentive to workers type from α_m to α_j and the higher α_j the higher the quality of the output. The quality level of the output is now a continuous variable defined as follows:

$$[4.26] \ q(\alpha_j) = e_1 n \int_{\alpha_m}^{\alpha_j} \alpha f(\alpha) d\alpha + e_0 n \int_{\alpha_j}^{\infty} \alpha f(\alpha) d\alpha$$

Before going into defining the profits functions, we need to set up the new participation and incentive constraints. The (IC) constraints will assure us that each worker who receives the incentive will exert a high effort, while the (IR) constraint reflects the fact that agent of type α has the option of rejecting the contract and having w_u but he prefers to take the contract, and this has to be valid for each type $\alpha \in [\alpha_m; \infty]$:

$[4.27]$ (IR) $w(q(\alpha_j, e)) - e_j \geq w_u \quad \forall \alpha \in [\alpha_m; \infty]$

$[4.28]$ (IC) $w(q(\alpha_j, e)) - e_j \geq w(q^-(\alpha_j, e)) - e_{k \neq j} \quad \forall \alpha \leq \alpha_j \in [\alpha_m; \infty]$

The IR constraint has to be binding because otherwise the employer may reduce the wage and increase profits without losing the worker. The IC constraint assures that the incentive

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[18]The Pareto distribution is quite convenient to our purpose because it has a support positively defined (it would not be intuitive to have negative productivity types) and because it allows us to have a high share of low productive workers and a low share of high productive workers and it fits well the real world. Moreover by changing the γ parameter between home and abroad, and assuming $\gamma^{home} < \gamma^{abroad}$ we can replicate the actual situation in which a poor country (abroad) has an higher share of low productive workers than a rich country (home).

[19]Results don't change allowing for a truncated support (i.e $\alpha \in [\alpha_m; 1]$); it simply implies to divide the density function by the term $1 - \alpha_m^\gamma$

scheme is respected by workers, in other words, the utility by each worker if he respects the incentive scheme $(w(q(\alpha_j, e)) - e_j)$ is greater than the utility in the case of shirking behaviour $(w(q^-(\alpha, e)) - e_{k \neq j})$. The problem here is that for a huge number of workers in production, the shirking behaviour of a single worker has no effect on the overall quality, so it can be the case that shirking behaviour cannot be detected and punished by the employer by giving $w(q^-(\alpha, e))$. Thus our model only works perfectly in cases of a small number of workers. Using the model in the case of large firms (great number of workers) requires the additional assumption that each worker that receives the incentive will exert the high effort for sure[20]. In order to make the model more realistic we assume a training cost $T(\alpha_j)$[21] for immigrants (if used in production) increasing with the quality level and so essentially increasing in α_j (i.e. this is the cost for language skills); moreover we assume the cost of information ϕ increases with the quality level $(\phi(\alpha_j))$[22].

Under this set up the unit profit function when the firm keeps production at home using natives (perfect information) and immigrants (asymmetric information) are respectively:

$$[4.29] \; \pi_i^{h,n} = e_1 n \int_{\alpha_m}^{\alpha_j} \alpha f(\alpha) d\alpha + e_0 n \int_{\alpha_j}^{\infty} \alpha f(\alpha) d\alpha - w_r^{h,n} n \int_{\alpha_m}^{\infty} f(\alpha) d\alpha - \Delta n \int_{\alpha_m}^{\alpha_j} f(\alpha) d\alpha^{23}$$

$$[4.30] \; \pi_i^{h,m} = e_1 n \int_{\alpha_m}^{\alpha_j} \alpha f(\alpha) d\alpha + e_0 n \int_{\alpha_j}^{\infty} \alpha f(\alpha) d\alpha - (w_r^{h,m} + \Delta) n \int_{\alpha_m}^{\infty} f(\alpha) d\alpha - T(\alpha_j)$$

if the firm decides to offshore the production abroad, it will pay a local agent to reveal worker's type, so the firm will pay ad hoc wages and the unit profit function has the following form:

$$[4.31] \; \pi_i^{f} = e_1 n \int_{\alpha_m}^{\alpha_j} \alpha f(\alpha) d\alpha + e_0 n \int_{\alpha_j}^{\infty} \alpha f(\alpha) d\alpha - w_r^{f} n \int_{\alpha_m}^{\infty} f(\alpha) d\alpha - \Delta n \int_{\alpha_m}^{\alpha_j} f(\alpha) d\alpha - \phi(\alpha_j).$$

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[20] Alternatively we may think a large firm that splits the production in many stages, in which a small number of employees work.

[21] The training cost function $T(\alpha_j)$ is assumed to be monotonically increasing and concave in α_j (i.e. $\dot{T}(\alpha_j) > 0$ and $\ddot{T}(\alpha_j) < 0$), and $T(\alpha_m) = 0$

[22] The cost of information $\phi(\alpha_j)$ is assumed to be monotonically increasing and concave in α_j (i.e. $\dot{\phi}(\alpha_j) > 0$ and $\ddot{\phi}(\alpha_j) < 0$), and $\phi(\alpha_m) = 0$.

[23] Notice that $\int_{\alpha_m}^{\alpha_j} f(\alpha) d\alpha$ is simply the share of workers that receive the incentive.

Notice that the profit function in the case of production with immigrants workers includes the cost of incentives, this is because we are considering the case in which the firm wants to realize a quality level higher that the minimum. If the firm would produce the minimum level of quality, it does not need to provide incentives, there is no reason for paying the local agent, and no reason for meet the cost of training. Thus we may conclude again that, if the firm wants to produce the lowest quality level, it would be optimal to produce abroad.

Since once α_j is fixed (quality is fixed) the revenue side of equations [4.29]-[4.31] does not make a difference between the alternative strategies, we can analyse the cost side (c_i) in order to conclude about the optimal choice for the firm:

[4.32] $c_i^{h,n} = w_r^{h,n} n \int_{\alpha_m}^{\infty} f(\alpha)d\alpha + \Delta n \int_{\alpha_m}^{\alpha_j} f(\alpha)d\alpha$

[4.33] $c_i^{h,m} = (w_r^{h,m} + \Delta)n \int_{\alpha_m}^{\infty} f(\alpha)d\alpha + T(\alpha_j)$

[4.34] $c_i^{f} = w_r^{f} n \int_{\alpha_m}^{\infty} f(\alpha)d\alpha + \Delta n \int_{\alpha_m}^{\alpha_j} f(\alpha)d\alpha + \phi(\alpha_j).$

But the share of workers who receive incentives under a Pareto distribution has the following form:

[4.35] $\int_{\alpha_m}^{\alpha_j} f(\alpha)d\alpha = 1 - \left(\frac{\alpha_m}{\alpha_j}\right)^{\gamma}$

thus the cost functions in [4.32] - [4.34] can be written as:

[4.36] $c_i^{h,n} = w_r^{h,n} n + \Delta n - \Delta n \left(\frac{\alpha_m}{\alpha_j}\right)^{\gamma_h}$
[4.37] $c_i^{h,m} = (w_r^{h,m} + \Delta)n + T(\alpha_j)$
[4.38] $c_i^{f} = w_r^{f} n + \Delta n - \Delta n \left(\frac{\alpha_m}{\alpha_j}\right)^{\gamma_f} + \phi(\alpha_j).$

Figure 4.2 shows the cost functions in [4.36] - [4.38] that are monotonically increasing (and concave) in α_j (i.e in the quality level). As in paragraph 4.4 we assume that:

[4.39] $w_r^{h,n} - w_r^{h,m} > \Delta.$

It assures that $c^{h,n}(\alpha = \alpha_m) > c^{h,m}(\alpha = \alpha_m) > c^{f}(\alpha = \alpha_m)$ thus for low quality output level, it is optimal to produce abroad. We also assume that:

[4.40] $\frac{\delta c_i^f}{\delta \alpha_j} > \frac{\delta c_i^{h,m}}{\delta \alpha_j} > \frac{\delta c_i^{h,n}}{\delta \alpha_j}$,

so that as α_j increases (i.e and the quality level increases), the difficulty (cost) of producing abroad rises faster than producing using both natives and immigrants; moreover the difficulty in producing using immigrants rises faster than producing using natives. The assumptions [4.39]-[4.40] guarantee that $c^f(\alpha = \infty) > c^{h,m}(\alpha = \infty) > c^{h,n}(\alpha = \infty)$ thus for high quality output level, it is optimal to produce at home using native workers. Given assumptions [4.39]-[4.40] only two scenarios may emerge, the case in which the strategy of using immigrants at home is not dominated (figure 4.2(a)) or the case in which it is dominated (figure 4.2(b)); it depends both on the reservation wage $(w_r^{h,n}, w_r^{h,m}, w_r^f)$ and on the speed at which cost functions in [4.36]-[4.38] increase with α_j.

When the strategy of using immigrants is not dominated (figure 4.2(a)) it will be optimal to produce low quality goods (from quality α_m to α_{OM}) abroad, to produce intermediate quality goods (from quality α_{OM} to α_{MI}) at home using immigrants and high quality goods (from quality α_{MI} to ∞) at home using natives.

Scenario in figure 4.2(b) represents the case in which the strategy of using immigrants is dominated; it occurs (for example) when the reservation wage for immigrants at home and natives are very similar[24], so also intuitively there is no place for the strategy of using immigrants being optimal: when immigrants at home and natives have similar reservation wage, the employer has not convenience of paying the training cost for immigrants, and natives will be used also for intermediate quality levels of output. Empirical results in Ottaviano, Peri and Wright (2010) suggest that there are some tasks covered by natives, others covered by immigrants and others offshored; so it seems that there is place for immigrants in domestic production. For this reason we focus on the case in which immigrants-using-strategy is not dominated. Finally we can conclude that the extension of the baseline model to a continuum of types doesn't change the main conclusion:

Proposition 2 *under asymmetric information about immigrants, the higher the quality level of the output that the firm wants to reach, the greater the range of circumstances under which it is*

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[24]The same thing happens if the reservation wage abroad is very low with respect the reservation wage of immigrants at home. Alternatively the strategy of using immigrants is dominated if the cost function of the strategy of using immigrants at home is very steep.

optimal for the firm to continue producing at home. In particular, for intermediate quality level of output, the firm may prefer to produce at home by using immigrant workers in production.

4.5.1   Implications for the brain drain process

The span of quality levels (described by α_m - α_{OM} in figure 4.2) for which it is optimal to offshore the production, depends also on the γ_f parameter of the Pareto distribution of skills abroad: the higher γ_f is the lower the availability of skilled workers is in the poor country. Since the brain drain process implies a reduction in the availability of high skilled workers in the poor country, we can conclude that (everything else being constant) brain drain, by increasing γ_f, reduces the stretch of quality for which it is optimal to produce abroad (figure 4.3). From equation [4.38] we know that an increase in γ_f, due to the brain drain process, makes the cost function of producing abroad steeper in the early quality levels[25] (from dashed to continuous line of offshoring cost function in figure 4.3). This reduces the circumstances for which it is optimal to produce abroad (from α_m - α_{OM} to α_m - α'_{OM} in figure 4.3), and increases the cases for which it would be optimal to produce at home by using foreign born workers.

So the brain drain process, reducing the number of high skilled workers in poor countries, reduces also the span of quality levels that it is worthwhile to produce abroad, stimulating domestic firms to produce at home using immigrants workers.

4.6   Conclusion

The increasing globalization and international factor movement are making more and more easy both to offshore the production in countries where labour cost is low, and to hire immigrants maintaining the plant in the home country. To our knowledge only two recent contributions tried to develop a model combining offshoring and migrants hiring (Ottaviano, Peri and Wright 2010; Barba Navaretti, Bertola and Sembenelli 2008). The model we present in this paper contributes to the literature considering the fact that employers don't have perfect information

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[25]When α_j approaches to infinity the cost of producing abroad does not depend of the γ_f parameter

Figure 4-2: Cost functions for each alternative in the skills range
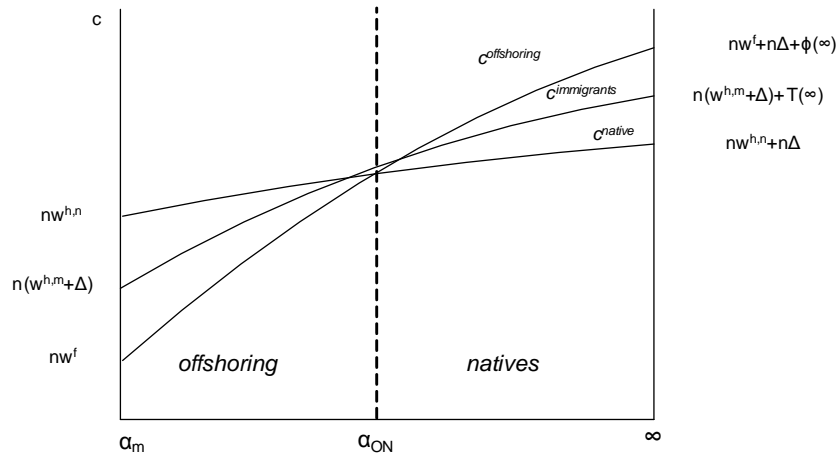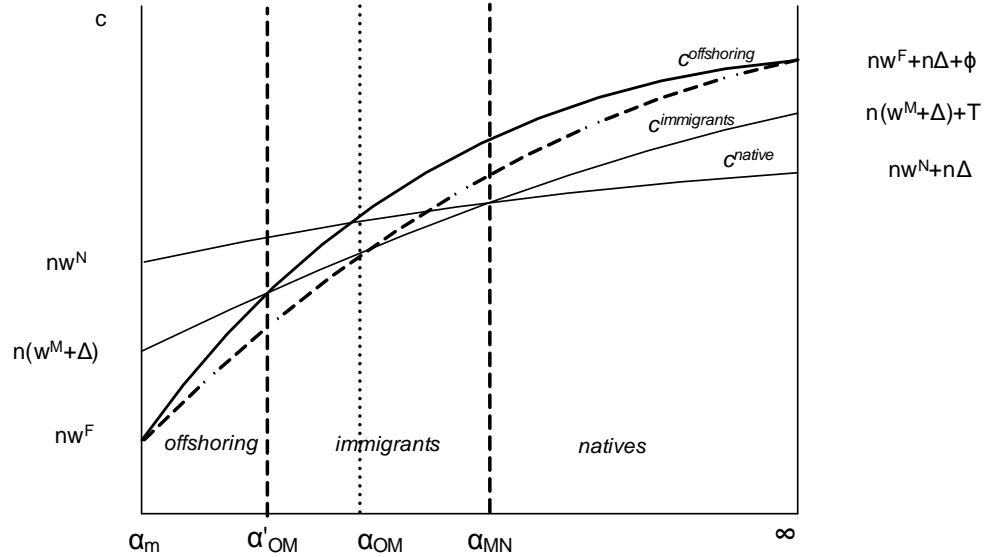
(a)
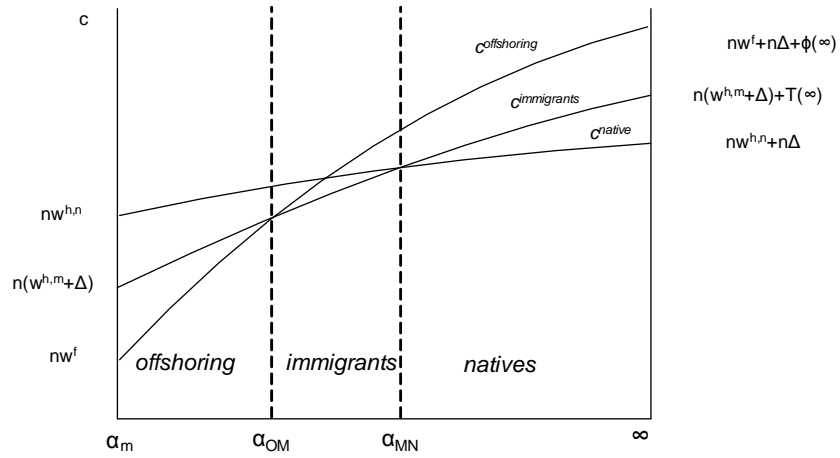
(b)

Figure 4-3: Change in the cost function of producing abroad after the brain drain process out of the poor country

about the ability of immigrants when they are used in production. Coherently with Ottaviano, Peri and Wright (2010) we find a kind of substitutability between the three alternatives that firms may take (offshoring, immigrants or natives in home production). From the baseline model, where only two skill levels are assumed in production, we conclude that the higher the quality level that the firm wants to reach, the larger the circumstances under which it is optimal for the firm to continue producing at home. Allowing for a continuum of worker types in production, we find that for low quality goods it would be optimal for a firm to offshore the production abroad. For high quality level it will be optimal to produce at home using native workers; but it may be the case that for intermediate quality levels, hiring foreign born workers at home is the best choice. Finally we find that brain drain process, by reducing the number of high skilled workers in the poor country, shrinks the span of quality levels for which it is optimal to produce abroad, increasing the cases for which it would be optimal to produce at home using immigrants workers.

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4.7 Appendix

4.7.1 A1: Why the incentive compatibility constraint avoids opportunistic behaviour

Before starting the production, the employer decides how many workers to incentivate according to the desired quality level, so he sets a contract (in the form of take it or leave it) to the workers. At the end of the period the employer pays workers according to the observed quality level, in particular he will pay $w(q_i)$ if the observed quality level is equal to the planned one (i.e no shirking behaviour), otherwise he will pay a punishing wage $w(q_i^-)$ if one of the two workers does not exert effort, or $w(q_i^{--})$ if both workers avoid the effort. This is credible because the employer observes the quality level at the end of the period and he can recognize how one or both workers behaved. This may be represented with the Prisoner's Dilemma game as follows:

	high effort	*low effort*
high effort	$w(q_i) - e_1; w(q_i) - e_1$	$w(q_i^-) - e_1; w(q_i^-) - e_0$
low effort	$w(q_i^-) - e_0; w(q_i^-) - e_1$	$w(q_i^{--}) - e_0; w(q_i^{--}) - e_0$

given the payoff scheme each worker will not engage an opportunistic behaviour if $w(q_i) - e_1 \geq w(q_i^-) - e_0 \geq w(q_i^{--}) - e_0$ which is our incentive compatibility constraint. From the payoff scheme it is easy to derive the incentive as $\Delta = e_1 - e_0$.

4.7.2 A2: Extension: employer does not know the realization of workers type in production

In paragraph 4.3 we assumed that employer knows the realization of workers' types distribution (we assumed always both one skilled and one unskilled worker in production). This may appear restrictive, but removing this assumption does not change the conclusion of the model. If the employer does not know the realization of types in production, he has an expected skill level in production $\bar{\alpha}$[26]. So the quality levels in production change as follows (we use $\tilde{q}$ to distinguish with respect quality levels under perfect information about the realization of types) :

---

[26]If we assume uniform distribution of types $\bar{\alpha} = \frac{\alpha_H + \alpha_L}{2}$.

$$\tilde{q}_o = 2\bar{\alpha}e_0$$

$$[4.50] \; \tilde{q}_i = \begin{array}{l} \tilde{q}_1 = \bar{\alpha}e_1 + \alpha_H e_0 \\ \tilde{q}_2 = \bar{\alpha}e_1 + \alpha_L e_0 \end{array}$$

$$\tilde{q}_3 = 2\bar{\alpha}e_1$$

With the new quality levels, we may derive the new profits functions when firm decides to stay producing at home using immigrants[27]:

$$[4.51] \; \pi^{h,m}(\tilde{q}_0) = 2\bar{\alpha}e_0 - 2w_r^{h,m}$$

$$[4.52] \; \pi^{h,m}(\tilde{q}_1) = \bar{\alpha}e_1 + \alpha_H e_0 - 2w_r^{h,m} - 2\Delta$$

$$[4.53] \; \pi^{h,m}(\tilde{q}_2) = \bar{\alpha}e_1 + \alpha_L e_0 - 2w_r^{h,m} - 2\Delta$$

$$[4.54] \; \pi^{h,m}(\tilde{q}_3) = 2\bar{\alpha}e_1 - 2w_r^{h,m} - 2\Delta$$

again the solutions $\tilde{q}_1$ and $\tilde{q}_2$ are dominated by $\tilde{q}_3$. At the same way we derive the profits functions when the firms delocalizes the production abroad:

$$[4.55] \; \pi^f(\tilde{q}_0) = 2\bar{\alpha}e_0 - 2w_r^f$$

$$[4.56] \; \pi^f(\tilde{q}_1) = \bar{\alpha}e_1 + \alpha_H e_0 - 2w_r^f - \Delta - \phi$$

$$[4.57] \; \pi^f(\tilde{q}_2) = \bar{\alpha}e_1 + \alpha_L e_0 - 2w_r^f - \Delta - \phi$$

$$[4.58] \; \pi^f(\tilde{q}_3) = 2\bar{\alpha}e_1 - 2w_r^f - 2\Delta$$

Comparing the strategy to go abroad with the strategy to stay at home on the base of the former profits functions, we may conclude that it will be optimal to produce the highest quality level ($\tilde{q}_3$) at home if $\left(w_r^h - w_r^f\right) < \phi/2$; it will be optimal to produce $\tilde{q}_2$ at home if $\left(w_r^h - w_r^f\right) < (\phi - \Delta)/2$; finally it will be never optimal to produce $\tilde{q}_0$ at home[28]. In the end we obtain the same results as in section 4.4 where employer knows the realization of types in production.

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[27] As in paragraphs 4.3 and 4.4 using native workers in the two workers model is dominated by immigrants using choice.

[28] Remember that the strategy $\tilde{q}_1$ is dominated both at home and abroad strategy.