THE RATE OF SUBSTITUTION BETWEEN DIFFERENT WORKERS' CHARACTERISTICS:
A NESTED CES ANALYSIS

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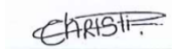
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Abstract

This empirical analysis examines the causal relationship between native and immigrant workers in the Maltese islands based on the individual's highest level of education and working experience. A pooled time series of the Maltese labour market is utilized through microdata which was obtained from the National Statistics Office and spans a time period between 2014 and 2020. Three empirical results are obtained, as estimates of the substitutability between (a) native and immigrant workers, (b) broad and narrow experience groups and (c) broad education groups are estimated through the Skill-Cell Model, which is derived from the nested CES production function.

The conclusions that this study derives suggests that the null hypothesis can be rejected, thus implying that the elasticity of substitution between native and immigrant workers is imperfect. The same results are obtained when analysing the rate of substitution between broad and narrow experience groups and between broad education groups. These results are in line with the existing literature. The most important conclusion reached from this study is that there does not exist a perfect substitutability between native and immigrant workers. Therefore, the results obtained from this study have important policy implications, as the study concludes that the Maltese islands can welcome a number of immigrants without having any significant impact on the native wages. Even though it is found that a 1% increase in immigrants is likely to decrease the average weighted weekly wages by approximately 3.31%, it is noted that such a decrease is not significantly large. Finally, it is also suggested that the Maltese labour market should mainly attract immigrants with a high level of experience, as these will have a significantly small impact on the native wages while meeting the demand for the required labour in the Maltese labour market.

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CHAPTER 1: INTRODUCTION

1.1. BACKGROUND AND CONTEXT

The issue of immigration has been a highly debated topic in Europe for a number of years (Holicza et al. 2018) and this has created further debates in Malta in the recent months with the preliminary publications of the Population Census 2022. Throughout the past decade, the total population in the country has increased by 25%, with one-fifth of the total population being of a foreign nationality. This reflects a 469% increase in foreign nationals on the islands from 2011 to 2021 (NSO 2022), of which approximately 25.9% formed part of the Maltese labour market as at 2020 (Ministry for Finance and Employment 2021).

Malta currently has the second highest rate of non-Maltese which form part of the local labour market in the EU, after Luxemburg. Malta also has the highest rate of non-EU nationals forming part of the Maltese labour market in the EU, the non-EU workers making up 14% of the total labour force (Ministry of Finance and Employment 2021). With a significantly high percentage of foreign nationals in Malta, the Faculty of Social Wellbeing in the University of Malta carried out a *General Opinion Survey* on the Maltese population in the recent months and found that most of the respondents consider immigrants to be a burden to the country. Nevertheless, it was also noticeable that the majority of the participants who have a particularly high level of income disagreed with this statement and stated that immigrants bring more benefits to the Maltese economy rather than costs (Azzopardi et al. 2021).

Native workers across different countries generally fear an increasing labour market competition, with the fear being that this may lead to lower wages (Azzopardi et al. 2021). However, these results are expected to be seen in circumstances where native workers and immigrants are perfect substitutes in the host economy (Manacorda et al. 2012). In a case where they are not perfect substitutes, it may be the case that an increase in immigrants leads to higher wages and increasingly better employment effects (De New et al. 1994). Furthermore, in some cases, foreign workers can be complements to the local labour market (Ma 2020). Nevertheless, the issue of immigrants and the local labour market has been subject to a number of debates between economists and policy makers (Gerfin et al. 2010) and the question on what type of immigrants are most beneficial to the local labour market as well as what type of immigration policy should be imposed has been given a lot of attention.

The evidence that exists on the impact that immigration has on the Maltese labour market is scarce and given the size and location of the Maltese islands, the evidence found in other countries are naturally different from the expected causal relationship that immigrant and native wages are presumed to have in Malta. The causal relationship is likely to depend on the type of immigrants that Malta is welcoming, subject to their set of skills, such as their level of education or working experience. Therefore, each type of worker is expected to have a different impact on the Maltese local wages. This empirical research aims to provide a resolution to this gap in the literature through a nested constant elasticity of substitution (CES) production function. It is found that there exists an imperfect rate of substitution between immigrants and natives in all levels of the nested CES, such that Malta can welcome a number of immigrants with any skill set without having any significant impact on the local wages.

1.2. RESEARCH QUESTION, HYPOTHESIS AND OBJECTIVES

Through the arguments put forward in Section 1.1., an empirical econometric analysis will be performed, and the results obtained will contribute to answering the research question of this dissertation; *To determine what types of immigrants are likely to have a positive or a negative impact on the local wages subject to their differing skills in the Maltese labour market, based on their nationality, level of education and working experience.* The evaluation of the research question aims to obtain the following objectives. The first objective is to assess whether the elasticities of substitution between natives and immigrants based on their respective skills is perfect or imperfect. The second objective that this study aims to reach is to determine which type of immigrants should mostly be attracted into the Maltese labour market with the aim of benefitting the Maltese native worker. Based on the results obtained in previous empirical studies, the research hypothesis being tested throughout this dissertation is as follows:

H_0: *There is no evidence that immigrant and native workers are imperfect substitutes in labour.*

H_1: *There is evidence that immigrant and native workers are imperfect substitutes in labour.*

1.3. SIGNIFICANCE AND CONTRIBUTION OF THE STUDY

A number of local studies have assessed the relationship between immigration and the rental market (Bonett 2020), crime (Camilleri 2015 and Camilleri 2018), as well as the causal impact of immigrants on the Maltese economy from a macro (Galea 2019) and a social-spatial (Tabone 2019) point of view. Furthermore, Spiteri (2020) has also directly assessed the impact that third

country nationals have on the Maltese wages. However, to the author's best knowledge, there has not been a study which attempts to estimate the elasticity of substitution and which analyses the impact that different skilled immigrants have on the local wages. As such, this empirical analysis aims to fill this gap in the literature while contributing to the recent demand for an improvement in the productivity of the Maltese labour market.

1.4. STRUCTURE OF THE STUDY

With a better understanding of the subject matter and aim of the research, the remainder of the dissertation is structured as follows: Chapter 2 provides a detailed theoretical framework and an assessment of similar previous studies. Chapter 3 then highlights what dataset is accessed to carry out the empirical analysis, together with a set of descriptive statistics. In Chapter 4, the methodology is explained, together with an overview of the results obtained and some methodological limitations. An in-depth discussion and interpretation of the results is then provided in Chapter 5, which will also discuss whether the study's hypothesis is rejected or otherwise, whereas Chapter 6 draws the main conclusions obtained from the study, together with some policy recommendations. At the end of the dissertation, an Appendix section is also included, where additional information is provided for a more thorough understanding of the arguments put forward in the empirical analysis.

CHAPTER 2: LITERATURE REVIEW

The following literature review shall provide a better understanding of the literature that this dissertation will follow to answer the research question introduced in Section 1.2. Section 2.1. explains the different types of models that previous literature utilized in order to derive the desired relationship. As the preferred model is highlighted, Section 2.2. then provides a detailed explanation of the theoretical framework. Subsequently, Section 2.3 analyses the results of prior findings while Section 2.4 explains how the arguments put forward in previous sub-sections may be impacted if a long-term approach is taken.

2.1. THE DIFFERENT MODELS PREVIOUSLY USED

The causal impact that an influx of immigrants has on native workers became of interest in the 1980s in the United States, and later gained momentum within European economies (Pischke et al. 1997). A couple of different models were developed and utilized by various researchers to observe the relationship between immigrants and native wages and the results obtained varied across models (Dustmann et al. 2013) and across countries (Angrist et al. 2003). Indeed, Havranek et al. (2020) found that the elasticity of substitution in developed countries is larger than that in less developed countries.

2.1.1. The Spatial Correlation Model

Earlier studies such as Card (1990), Altonji et al. (1991), Pischke et al. (1997), Carrasco et al. (2008), Dustmann et al. (2013) and Gu et al. (2016) have utilised the Spatial Correlation Model to assess the impact that an influx of immigrants has on the native workers' wages and on their respective employment outcome[1] in the host country. Through this model, empirical evidence is found on a regional level (Gu et al. 2016). Such a model has several disadvantages and therefore, the results concluded by studies using such model tend to vary (Dustmann et al. 2013).

Several studies found that immigrants have a small and insignificant impact on the local wages across cities or states (Friedberg et al. 1995, Card 2001, Card et al. 2007). Other spatial correlation empirical evidence found a positive relationship between the share of immigration in the host country's labour market and (a) the native workers' average wages and (b) the level

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[1] The Legal Information Institute at Cornell Law School, New York defines 'employment outcome' as the ability of an individual to enter and to retain his employment, be in full-time or part-time in an integrated labour market (LII 2016).

of employment (Card 1990, Altonji et al. 1991, Pischke et al. 1997, Borjas 2001, Dustmann et al. 2013). Previous studies also noted that even after adjusting the data for region size, spill overs of human capital and the likelihood that immigrants cluster in strong local economies, the positive relationship still persists (Card 1990, Gu et al. 2016). Dustmann et al. (2013) interpreted this positive relationship on the basis that an influx of immigrants increases the aggregate supply, thereby creating a surplus within the economy. However, Borjas (2001) provides an alternative explanation, this being that immigration *greased the wheels* of the labour market. In other words, when immigrants are faced with a decision regarding where to move and start working, they are likely to choose regions which hold better economic opportunities and relatively higher wages (Borjas 2001). Indeed, the author found that in high-wage states, the ratio of new immigrants to natives and the ratio of new immigrants to immigrants who have already settled is significantly high (Borjas 2001). Contrastingly, Pischke et al. (1997), Borjas (2005) and Dustmann et al. (2013) concluded that when natives notice a significant influx of immigrants, they tend to move their labour and capital resources to another region, and this phenomenon continues on until the returns are equalised across all regions. Nevertheless Pischke et al. (1997) argued that some counties in Germany attract both immigrants and native workers and little evidence was found that native workers had become redundant through an influx of immigrant workers (Pischke et al. 1997).

One major limitation of the Spatial Correlation Model is that when immigrants are clustered in high-wage states, a positive spurious correlation is likely to arise between immigrant and native wages which could ultimately result in a positive relationship between immigrant and native wages (Pischke et al. 1997, Borjas 2005). Contrastingly, in his difference-in-differences analysis on Mariel Flow[2], Card (1990) found that a sudden increase of immigrants into the Miami labour market had no effects on any of the natives' wage rate. Nevertheless, the author explained that these results could have been obtained because Miami had a long-run programme on receiving large quantities of these immigrants.

2.1.2. The Textbook Model
The Textbook Model refers to the classic supply and demand framework (Carrasco et al. 2008). Regardless of any relationship found in the literature, the Textbook Model predicts that there should be a negative or downwards sloping demand curve, meaning that if there is an influx of

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[2] The Mariel Flow study refers to the significantly large mass migration of 125,000 Cubans into the US (1980) in search of political asylum.

immigrants into a host economy, then this should have a negative impact on the wages of competing factors (Borjas 2003, Bonin 2005, Carrasco et al. 2008). Ottaviano et al. (2012) argued that the impact that immigrants have on the native wages should depend on whether their characteristics are similar or otherwise, whereby a negative relationship should be present if immigrants and natives have similar characteristics and vice versa if their characteristics differ (Ottaviano et al. 2012). More specifically, Bonin (2005) noted that in any basic labour market model, if native and foreign workers are complements to one another, an influx of immigrants should positively impact the wages and negatively impact the level of unemployment. Similarly, if the two types of workers are substitutes, then an inflow of immigrants should have a negative impact on the wages of native workers (Bonin 2005).

Nevertheless, in their European-wide panel study, Angrist et al. (2003) disagreed with previous studies as they found that there only exists a negative relationship between immigrants and the host economy's labour market in cases where the country has rigid institutions or else where the competition on the market is tight. This study therefore suggested that in reality, such a relationship is more subtle than the relationship assumed by the Textbook Model (Angrist et al. 2003). Friedberg et al. (1995) argued that the relationship depends also on whether the host country is an open or a closed economy. In the case of a closed economy, the relationship between natives and immigrants is similar to that of the Textbook Model. Furthermore, if the immigrants are willing to work for a lower wage than natives, then this would ultimately result in a more elastic labour supply. Different results however, are argued in the case of an open economy, where the Heckscher-Ohlin model suggests that if the factor endowments are not too different across the home and the host country of an individual and both countries have the same technologies, then an influx of immigrants would not have any significant impact on the wages (Friedberg et al. 1995).

2.1.3. The Skill-Cell Model

It would be naïve if in such a study concerning natives and immigrants, natives are assumed to be homogenous, as in reality they differ in a number of ways (Haus-Reve et al. 2021). Therefore, several studies (Borjas 2003, Gerfin et al. 2010, Manacorda et al. 2012, Ottaviano et al. 2012, Haas et al. 2013, D'Amuri et al. 2014, Boubtane et al. 2016 and Havranek et al. 2020) have developed and utilized an alternative model to derive the causal relationship that exists between natives and immigrants. Indeed, a multiple level of nested CES was introduced

to analyse the relationship across predetermined narrow skill groups. The Skill-Cell Model overcomes one of the problems of endogeneity and increases the degree of heterogeneity within the model. This is because, even if the model assesses individuals with equivalent levels of education and working experience, their nationality will still create a wedge between them in the host country's labour market (Ottaviano et al. 2012). This would therefore create diversity among the average wages of these differing skill-cells.

The literature discussed two reasons to explain why the average wages within each skill-cell differ between native and immigrant workers. This may firstly be a result of cultural differences between natives and immigrants. This can be either in favour of the immigrant, such as culture-specific skills, or else against the immigrants in the host economy. The most common disadvantage that immigrants face is the limited knowledge of the language or the culture of the host country (Chiswick et al. 1985, Peri et al. 2009, Haas et al. 2013). Given the comparative advantage that native workers hold in their home country, immigrant workers generally choose to work in different occupations relative to their native counterparts (Ottaviano et al. 2012, Ministry of Finance and Employment 2021). Peri et al. (2006) indeed found that new immigrants prefer to work in those sectors where there is already a relatively high rate of foreign-born workers. If these jobs that immigrants take happen to fall within a specific low-skill group (Haas et al. 2013), then this would encourage native workers to take on more complex and high skilled jobs, thereby securing their average wages from immigration competition (D'Amuri et al. 2014). Naturally, there are a number of other factors which may have an impact on this relationship, thus creating an omitted variable bias within the model. These issues were empirically controlled for through the fixed effects (Gu et al. 2016).

2.2. THEORETICAL FRAMEWORK

In this subsection, the theoretical framework which constitutes the empirical analysis of the research question presented in Section 1.2. will be discussed. This analysis will be made following Borjas (2003), Ottaviano et al. (2008), D'Amuri et al. (2010) and Gerfin et al. (2010). Ottaviano et al. (2008) and Kaiser et al. (2010), who base their analysis on the assumption that natives and immigrants with differing education and experience levels are imperfect substitutes. Furthermore, in their analysis, they build their model on the general equilibrium framework, where the factor prices of capital and of labour are equivalent to their respective marginal products (Ottaviano et al. 2008, Gerfin et al. 2010). Through such an approach, the

production function will cater for both the direct and the cross-skill effects that immigrants can have on the local wages (Ottaviano et al. 2008).

2.2.1. The Production Function

The analysis starts from the standard neoclassical framework, where firms employ both labour and physical capital with the aim of producing a homogenous good to be sold in a perfectly competitive market at the going market price with the aim of maximizing their profit. This can be defined through the augmented Cobb-Douglas production function as in Borjas (2003), Ottaviano and Peri (2008), D'Amuri et al. (2010) and Gerfin et al. (2010) with the assumption of constant returns to scale:

$$Y_t = A_t L_t^\alpha K_t^{1-\alpha}$$

Equation 1: Cobb Douglas Production Function

Y_t refers to the total output, A_t represents the total factor productivity and K_t represent the physical capital stock. The main coefficient of interest for this dissertation is L_t which represents the labour supply. As presented in Equation 1, L_t holds the nested CES aggregates which incorporates all the different skills and characteristics of the employees (D'Amuri et al. 2010). In their study for the German labour market, D'Amuri et al. (2010) do not only take into consideration these CES aggregates between native and immigrant workers, but also between the old and new immigrants themselves.

2.2.2. The Nested CES Structure

The nested CES structure becomes useful to segregate the different characteristics of workers, as introduced originally by Ottaviano et al. (2008). The baseline is characteristic 0, which contains all the workers with the different characteristics. The total workers are then split into groups subject to characteristic 1 ($i_1 = 1, \dots, M_1$). Each of these groups are then further split into another set of groups subject to characteristic 2 ($i_2 = 1, \dots, M_2$) (Ottaviano et al. 2008). This partition then keeps on going based on how many characteristics one wishes to include in the analysis. The authors illustrate this phenomenon through Figure 1, which illustrates how one group with a set of characteristics i_{n+1} is nested in the partitioned group i_n such that the nth characteristic can be used to "index the nesting level along the depicted partitioning structure" (Ottaviano et al. 2008 P. 159).

Figure 1: Nested-CES scheme, Source, Ottaviano et al. (2008)
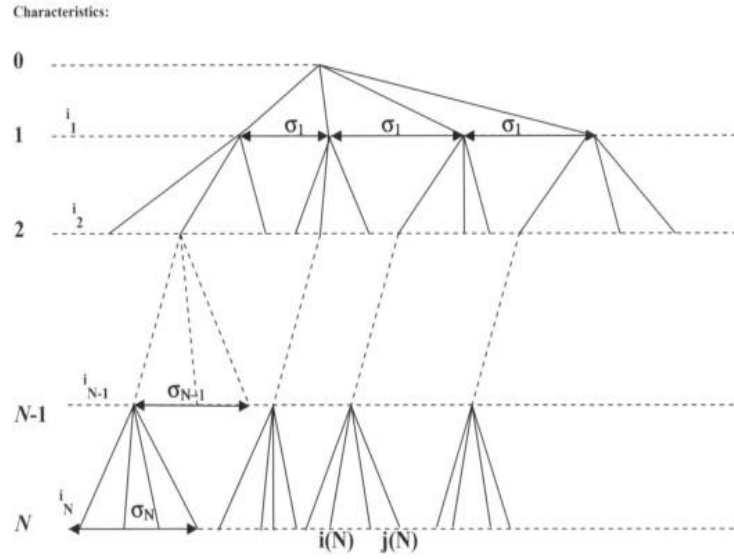
A number of studies (Card et al. 2001, Borjas 2003, Ottaviano et al. 2008, D'Amuri et al. 2010 Gerfin et al. 2010, D'Amuri et al. 2014) utilize this general nested CES scheme based on the assumption that this model can describe the cross-effects in the labour market (Borjas 2013) to obtain the elasticities of substitution between immigrant and native workers (characteristic 1) based on their working experience (characteristic 2) and their highest level of education obtained (characteristic 3). As previously mentioned, these different levels of skills are represented by L_t, which has a nested CES structure. D'Amuri et al. (2010) and Gerfin et al. (2010) illustrate this feature through Equation 2, which disaggregates the aggregate labour as follows:

$$L_t = [\theta_{Ht} L_{Ht}^{\varepsilon HL} + \theta_{Lt} L_{Lt}^{\varepsilon HL}]^{1/\varepsilon_{HL}}$$

Equation 2: Nested-CES structure in labour aggregate

From the above disaggregation, L_{Ht} and L_{Lt} represent the total labour input with a high level and a low level of education respectively. Similarly, θ_{Ht} and θ_{Lt} represent the productivity parameters of the workers. This in turn captures the relative efficiency of labour throughout the firm's production process. D'Amuri et al. (2010) and Gerfin et al. (2010) constraint these productivity parameters to add up to one to capture any productivity shocks which may be common amongst the different type of labour ($\theta_{Hkjt}+\theta_{Mkjt}=1$). From Equations 1 and 2, the productivity terms (θ) and the total factor productivity A_t are variables which solely depend on technology, and thus are independent from any influx of immigrant workers (D'Amuri et al. 2010).

2.3. THE ISSUE OF SUBSTITUTABILITY

Having a look at the different literature which has utilized the Skill-Cell Model, it is noted that different results have been obtained. The reason for these different results found in the literature may depend on two factors. First of all, the level of development of the country may play a part as the elasticities of substitution are systematically larger for more advanced economies (Havranek et al. 2020). Secondly, the inflow of immigrants is generally not equally distributed across each education-experience group and therefore the impact of immigrants on natives in each group is likely to differ (Gerfin et al. 2010). Nevertheless, given the sensitivity of the construction of the data into skill-cells, the structure of the nested CES itself, such as how many education groups are taken or how the experience groups are being defined may also drive a wedge in the results obtained (Gerfin et al. 2010).

As a general rule, most studies have utilized the inverse elasticity of substitution ($1/\sigma$) to derive and ultimately estimate the desired elasticity σ (Haas et al. 2013). The higher the elasticity of substitution is, the smaller would be the immigrant's decrease in income in the host country (Chiswick et al. 1985). If σ results to be exactly one, then this would represent the Cobb-Douglas case. If on the other hand σ is smaller than one or greater than one, then this would imply that immigrant and native workers are gross complements and gross substitutes respectively, *ceteris paribus* (León-Ledesma et al. 2010). Some previous literature had assumed perfect substitutability between native and immigrant workers (Manacorda et al. 2006, Peri et al. 2006), implying that the inverse elasticity of substitution coefficient is equivalent to zero (Manacorda et al. 2012). Furthermore, through their analysis of similar literature, Haas et al. (2013) assessed that the majority of the literature had conditioned the degree of substitutability to a value of 10, whereby any value of σ above or below this threshold would be considered to be perfect or imperfect respectively. In turn, this threshold will also be taken in Chapters 4 and 5 of this study.

2.3.1. The Rate of Substitution Between Natives and Immigrants

In their national panel data analysis for the US, Borjas (2003) found a negative relationship between immigrant and native workers, such that a 10% increase in immigrants in the labour force would result in a 4% decrease in the native workers' average wage. The author explained that the extent of the impact that immigrants could have on the native wages depends on the specific education-experience groups that one takes into consideration (Borjas 2003). This may

be the reason why Bonin (2005) found that a 10% increase in immigrants in the German labour market led to a less than one percent reduction in native wages. Indeed, Gerfin et al. (2010) found that in the short run, there exists a negative relationship between immigrant inflow and native wages specifically in high skill groups.

In the British study of Manacorda et al. (2012) found that the inverse elasticity of substitution between natives and immigrants is around 0.128. These results are approximately three times lower than the results obtained in the American studies carried out by Peri et al. (2006), Card (2009) and Ottaviano et al. (2012), where an inverse elasticity of substitution of around 0.05 was found between native and immigrant workers between 1990 and 2006. Taking a European context, the German studies D'Amuri et al. (2010) and Haas et al. (2013) obtained very similar inverse elasticities of substitution between natives and immigrants, where the results obtained ranged from -0.03 to -0.062. While these suggest a perfect rate of substitution, earlier studies for the same German labour market found an imperfect substitutability between native and immigrants (Brücker et al. 2011). A Swiss study on the other hand obtained contrasting results ranged from -0.05 to -0.19 (Gerfin et al. 2010). These results, other than Brücker et al. (2011) and Manacorda et al. (2012) contrast the conclusions drawn by two highly cited studies, namely Friedberg et al. (1995) and Smith et al. (1997) who agree and conclude that the impact of immigrants on the wages of competing workers is small. Nevertheless, even though Haas et al. (2013) found a perfect relationship, the authors argued that the results were not too far from imperfect substitutes.

2.3.1.1. New vs old immigrants
By only taking into consideration relatively new immigrants, a lower rate of substitution would be expected (Ottaviano et al. 2012). The reason for this is that these '*new*' waves of immigrants are likely to be the most differing in terms of skills and abilities when compared to native workers and to previously settled immigrants (Ottaviano et al. 2012). Gerfin et al. (2010) agreed and empirically found that an inflow of immigrants into the host economy's labour market would have a greater negative impact on previously settled immigrant wages rather than on native wages, even if both types of workers hold similar characteristics and are found within the same education-experience skill-cell (Gerfin et al. 2010). Nevertheless, with every new generation of immigrants in the host country, the immigrants' relationship with natives will become more and more elastic. This is because second generation immigrants for instance will

be exposed to more country-specific skills than their parents did when they first moved to a new country (Chiswick et al. 1977, Ottaviano et al. 2012, Manacorda et al. 2012).

2.3.2. The Rate of Substitution Across Experience Groups

The majority of similar empirical research has taken the level of experience of a particular individual as the second level of the nested CES, and indeed experience plays an important role in determining the effect that immigration is likely to have on native workers' employment opportunities (Bonin 2005). Taking into consideration a US Skill-Cell Model, Welch (1979) and Ottaviano et al. (2012) found that if immigrants and natives had a similar level of experience, the degree of substitutability will be higher (and the immigrant impact on native wages will be more severe) than when the two types of workers' experience levels are distant. Indeed, the latter found that the inverse elasticity of substitution among broad and narrow experience groups is of -0.17 and -0.28 respectively (Ottaviano et al. 2012).

Similar results were obtained by another Borjas (2003) which concluded that if immigrant and native workers hold a similar level of experience, then they will be closer substitutes than if their level of experience differs. For instance, the author found that the inverse elasticity of substitution between immigrants and natives with the same level of education (college graduates) and the same level of experience (less than 10 years of experience) is highest (0.76) when compared to other similar experience groups (Borjas 2003). On the other hand, Card et al. (2001) empirically found that the degree of substitutability across different experience groups is less than perfect. Katz et al. (1992), Borjas (2003) and Brücker et al. (2008) agreed with the conclusions drawn out by Card et al. (2001) as they concluded that their respective elasticities of substitution were 0.33, 0.28 and between 0.033 and 0.067. Contrastingly, Geis et al. (2008) failed to reject the null hypothesis that the elasticity of substitution across experience groups is imperfect.

2.3.3. The Rate of Substitution Across Education Groups

The majority of the previous studies have also disaggregated workers by the highest level of education achieved (being low or high educational attainments). Gerfin et al. (2010) argued that workers within the same education group are closer substitutes than workers across broad education groups. In their empirical analysis through a Skill-Cell Model, Ottaviano et al. (2008)'s results agreed with this hypothesis.

Looking into previous European studies, in Britain it was found that the inverse elasticity of substitution among workers varies from -0.069 for workers with secondary education or lower to -0.176 for workers with a university degree or higher, where the degree of substitution among workers with the same level of education was around -0.203 (Manacorda et al. 2012). However, in the German labour market, neither Bonin (2005) nor Haas et al. (2013) find any significant distinctions between the impacts on wages from workers with low and high levels of education. Indeed, both German studies found a significantly low relationship of around -0.009 (Bonin 2005) and -0.0095 (Haas et al. 2013). Therefore, it can be argued that the elasticity of substitution between low-educated immigrant and native workers was negatively stable in Germany. In contrast, other US studies (Borjas 2003, Borjas et al. 2007) found the elasticity of substitution to be infinite. This implied that an inflow of immigrants within the same education cell would have greater impacts on already previously settled immigrants' wages, which suffered a decline of 6.7% (Borjas 2003) rather than on natives' wages (Borjas 2003, Borjas et al. 2007, Ottaviano et al. 2012, Manacorda et al. 2012).

2.4. PHYSICAL CAPITAL ADJUSTMENT

In a perfect equilibrium competitive labour market, it is assumed that all individuals are being paid their marginal product as labour compensation (Gerfin et al. 2010). However, it would be somewhat naïve to analyse the relationship in the short-term while assuming a fixed capital stock (Peri et al. 2006). This approach was taken by Borjas (2003), where the author ignored the idea that physical capital stock in reality may not be fixed. Given that immigration is not caused in aggregate batches at any specific time period (Peri et al. 2006), recent studies, such as Peri et al. (2006), Brücker et al. (2008) and Gerfin et al. (2010) have also taken into consideration the long-run effects besides the general analysis of the short run.

Based on the general growth models (Ramsey 1928, Solow 1956), later studies such as Peri et al. (2006), Brücker et al. (2008) and Gerfin et al. (2010) show that in the long term, capital stock should adjust following a balanced growth path such that a constant return to scale is analysed (Peri et al. 2006, Ottaviano et al. 2008). In their German analysis, Brücker et al. (2008) found that in the short run, an inflow of immigrants led to a decrease in wages by 0.4% whereas in the long term, this rate remained stable due to capital adjustments. This is generally expected as the adjustments to physical capital in the long-term are generally gradual (Peri et al. 2006). These results were in line with those found by Peri et al. (2006), where no negative relationship

between the capital-output ratio and the changes in the supply of labour was found in the long run. These arguments also follow Kaldor (1961)'s stylized facts, which argued that as time goes by, the capital-to-output ratio remained constant and therefore changes in capital stock adjusted relative to the inflow of immigrants which impacts the supply of labour in any given country.

2.5. CONCLUSIONS

In conclusion, there is vast literature on the subject both in the US and in Europe. This said, very limited literature on the subject can be found locally. Indeed, this study aims to fill this gap in the literature for the Maltese islands. Nevertheless, it is noted that from here onwards, the study will only focus on the short-term causal relationships, whereas a long-term analysis is suggested to be performed by future studies. As also discussed through the theoretical framework in Section 2.2., the chosen model for such an analysis is the Skill-Cell Model through the nested CES production function. Even though this model has some methodological limitations, this approach was chosen over the Spatial Correlation Model as it would be difficult to carry out a regional study in the Maltese islands given its small size and the facility to travel across the islands.

CHAPTER 3: DATA COLLECTION AND ANALYSIS

Now having a clearer understanding of the existing literature concerning this dissertation's research question, this chapter will provide an analysis of the micro data which will be utilized. Section 3.1. explains what data has been collected and from which sources. Section 3.2. gives a brief overview of the number and the type of observations within each skill-cell, and Section 3.3. then provides some descriptive statistics as it examines any trends or irregularities that are observed within the raw data. By the end of this chapter, a better understanding of what data the methodology in the next chapter will be working with should be obtained.

3.1. DATA COLLECTION AND DATA SOURCES

Prior to the collection and analysis of the data, the aim of the study is revisited. A key tool in evaluating the research question through a nested CES analysis is to construct three levels of nested cells which correspond to a native or an immigrant worker's level of education and working experience. This model directly captures the correlation between the different skill-cells through the cells' respective elasticities of substitution (Gerfin et al. 2010), which revolves around the study's research question.

3.1.1. Data Sources

For the formation of the empirical analysis through the model previously discussed, all the necessary data with regards to the model's dependent and independent variables were obtained from the Labour Force Survey (LFS) complied by the National Statistics Office (NSO)[3]. The micro-data was obtained through a direct request, subject to a confidentiality agreement. The average index and rate of change between 2014 and 2020 was also obtained from the Eurostat Database to adjust the salaries by the HICP index. The NSO was also used to obtain data on the aggregate number of individuals who were employed in the Maltese labour market during the period in question, for the sole reason of data validation as will be assessed in section 3.2. To ensure that the confidentiality of all the survey participants is protected, certain unique socio-economic combinations in the dataset were excluded from the study for ethical reasons.

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[3] No ethical issues are expected to emerge during the process of data collation. The required clearance was obtained from the relevant faculty's Research Ethics Committee through a unique form ID: FEMA-2022-00218

The study focuses on annual data spanning from 2014 up till 2020. This time period was chosen after communication with the NSO, who suggested that the level of immigrants and the labour market in general was relatively stable prior to 2014, with little to no significant variation from one year to the other. Indeed, Malta started to face extraordinarily high levels of immigration from 2013 and had become the country with the highest rate of immigration in the EU in 2019 (Debono 2021). Furthermore, the dataset was requested up until 2020 to eliminate any irregular behaviour in the labour market that may have been caused through the Covid-19 pandemic. The study takes a sample of all men and women (native or otherwise) working in the Maltese labour market from the age of 25 to 64 years. The data includes persons who work for a private or a public employer, thereby excluding those individuals who are self-employed, unemployed, retired or early retirees.

3.2 DATA ANALYSIS

The magnitude of the dataset remained relatively constant throughout the years, spreading from 6,540 observations in 2014 to 6,012 observations in 2020. The total number of observations captured in the LFS was compared to the total number of individuals which formed part of the Maltese labour force across the years (NSO 2021) and it was found that the number of observations in the study represent around 3.13% of the total labour force in Malta (Table 1).

Table 1: Representation of the LFS in the Maltese Labour Market (2014-2020)

Year	Total Number of Employed Individuals in Malta[4]	Number of observations in the LFS[5]	LFS Representation of all workers in Malta
2014	174,520	6,540	3.75%
2015	182,135	6,607	3.63%
2016	192,512	6,654	3.46%
2017	203,738	6,470	3.18%
2018	215,955	6,127	2.84%
2019	228,606	5,683	2.49%
2020	228,981	5,955	2.60%
Total Average	**201,226**	**6,291**	**3.13%**

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[4] Source: NSO (2021), *Regional Labour Supply by Place of Residence and Work*: 2018-2020
[5] Source: National Statistics Office, Labour Force Survey

3.2.1. Skill-Cell Construction

The research question is concentrated on what impact immigrants have on the native wages. As such, the dataset includes these two nationality groups, immigrants and natives, where the native group of workers include all those who are residents of Malta. The aim is also to assess how the impact on native wages differs with the immigrants' level of education and working experience. Indeed, the dataset is disaggregated into three education groups based on the International Standard Classification of Education (ISCED) set out by the United Nations (NSO 2014); secondary schooling or less (ISCED 0 to 2), post-secondary education or equivalent (ISCED 3 to 4) and tertiary level of education or higher (ISCED 5 to 8). The most important criterion in this group is the highest level of education that the individual obtained during the time of data collection. The sample number of individuals in these skill-cells is illustrated in Table 2.

Table 2: Sample population by level of education

	Maltese workers		Foreign workers	
Low level of education (ISCED 0 to 2)	18,624 persons	44.32%	636 persons	31.63%
Medium level of education (ISCED 3 to 4)	13,887 persons	33.04%	547 persons	27.20%
High level of education (ISCED 5 to 8)	9.514 persons	22.64%	828 persons	41.17%
	42,025 persons	**100%**	**2,011 persons**	**100%**

The impact that immigrants have on native wages will also be assessed through a second characteristic, that is by the level of experience that each worker has. The variable available in this regard was the number of years that individuals had been working in their current job at the time that the survey was carried out, which is used as a proxy for the number of years that the workers have been part of the working population, be it in Malta or otherwise. Three groups were formed in this regard: those with an experience level of six years or lower, between seven and twelve years of experience, and those with an experience level of thirteen years or more within the same company as at the time of the survey. These experience groups were chosen to ensure that there are enough observations within each skill-group, especially with regards to foreign workers.

Given the significant increase in the total flow of immigrants throughout the past decade, it was expected *a priori* that the majority of the foreign workers were likely to have fewer years

in experience than Maltese workers. Table 3 portrays this idea, where more than half of the total foreign observations have less than six years of experience. Indeed, Table 3 supports the theory provided by Borg (2019) who noted that the majority of the foreign workers arrived in Malta in the recent years, and that most generally left the islands after two years.

Table 3: Sample population by the number of years in job

	Maltese workers		Foreign workers	
6 years of experience or less	15,935 persons	37.92%	1,318 persons	65.54%
Between 7 and 12 years of experience	8,378 persons	19.94%	417 persons	20.74%
Between 13 of experience or more	17,712 persons	42.15%	276 persons	13.72%
	42,025 persons	**100%**	**2,011 persons**	**100%**

3.3. DESCRIPTIVE STATISTICS

In the following section, some descriptive statistics of the variables previously mentioned will be provided. This section will point out a number of apparent trends that are observed from the raw data. The main objective of this subsection is to ensure that there is a variation within the main variables of interest, which will thus make it possible to assess the relevant elasticities of substitution.

3.3.1. Changes in The Native and Immigrant Labour Supply by Education

Unlike previous studies which have been carried out in Malta, this empirical analysis aims to assess the impact of immigrants on native wages based on their level of education and working experience. This approach is necessary because, as illustrated in Table 4, the number of immigrants that Malta has received throughout the years of interest have not been equivalent across each education group. For instance, since the largest increase of immigrant contribution into the Maltese labour market was among the highly educated skill-cell, then as per the Textbook Model, it is expected that there would be a greater outwards shift in the labour supply of highly educated workers and this would therefore have a greater negative impact on the wages of the competing factors with the same skill, *ceteris paribus* (Borjas 2003, Bonin 2005, Carrasco et al. 2008).

Table 4: Relative change in the number of hours worked by education group in each native-education cell, 2014 to 2020

	Percentage change due to natives	Percentage change due to foreigners	Total percentage change in hours worked for each group
Low education	-7.53%	5.69%	-1.85%
Medium education	4.00%	4.97%	8.97%
High education	3.30%	20.35%	23.65%
Total	**-0.23%**	**31.01%**	**30.78%**

This suggests that a composite effect is present. When observing similar trends, Gerfin et al. (2010) had arrived at two possible rationales behind this. Firstly, they argued that this could either be the result of an aggregate increase in the Maltese labour supply (30.78% increase) throughout the period in question, or else because there was a decrease in the low-education group by 1.85%. This trend was expected *a priori*, as throughout the years, the general education level among the Maltese residents has improved, coupled with an increased female participation as a result of a number of policy initiatives. In fact, the percentage of early leavers from education and training in Malta decreased from 18.8% in 2011 to 11% in 2021 (Eurostat 2022a), even though it still remains above the EU target. More detail about this can be accessed in Appendix 1.

3.3.2. Changes in the Average Real Wages and Hours Worked by Nationality and Education

Table 5 presents the percentage change in the average real annual salary and the share of hours worked relative to the nationality and education group from 2014 to 2020. As expected *a priori*, the average annual wages within each education group for both native and foreign workers was lower in 2014. Nevertheless, it is also interesting to note that the average wages of native workers grew faster than foreign workers. Further information with regards to the increase in wages of native and foreign workers by education group over the reference period is elucidated in Appendix 2. It is noted that the annual salaries taken into consideration were adjusted for the average index and rate of change.

Table 5: Average Annual Salaries and Share of Hours Worked for Native Workers[6]

Natives					
	Average Real Annual Salaries			Share of Hours Worked	
	2014	**2020**		**2014**	**2020**
Low education	€13,344.57	€14,173.72	**Low education**	46.73%	39.38%
Medium education	€16,745.48	€18,518.35	**Medium education**	31.16%	35.07%
High education	€24,088.55	€29,439.25	**High education**	22.11%	25.55%
Average	**€18,183.40**	**€20,897.57**	**Total**	**100.00%**	**100.00%**

Table 6: Average Annual Salaries and Share of Hours Worked for Foreign Workers[6]

Immigrants					
	Average Real Annual Salaries			Share of Hours Worked	
	2014	**2020**		**2014**	**2020**
Low education	€13,294.05	€13,724.35	**Low education**	35.68%	26.26%
Medium education	€17,487.16	€18,279.92	**Medium education**	25.84%	26.51%
High education	€23,903.61	€26,418.95	**High education**	38.49%	47.23%
Average	**€18,228.28**	**€19,474.41**	**Total**	**100.00%**	**100.00%**

From these observations in Tables 5 and 6, Table 7 is derived, where one can assess how the relative size of each education group has changed with respect to the workers' contributions into the Maltese labour market, i.e. their usual weekly hours worked. An interesting observation from Table 7 is that the average wage in all native and immigrant education groups has increased from 2014 to 2020, with the average wages amongst natives increasing more than twice the increase among immigrants' wages. Similarly, for both natives and immigrants, even though the share of hours worked by low-educated workers have decreased, it is observed that their average wages have still increased. The reason for such an increase in wages despite the decrease in contribution could be due to a labour shortage among the low educated groups. Nevertheless, the share of hours worked among the other types of higher educated workers have increased. Similar results were obtained by Gerfin et al. (2010). The greatest increase in wages and hours worked by immigrants are observed among the highly educated group. The

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[6] In the calculation of the annual average salaries, the wage observations in each education group were trimmed on both ends by one percentile in order to cater for the outliers, as displayed by the box plot in Appendix 3. Given the nature of the study all outliers will be kept when the results are run in Chapter 4 as these may hold significant information about the population at large.

textbook model would ones again suggest a negative impact on the native wages within the same education group, however, Table 7 observes that throughout the same period, the native workers within the high education group also increased. The average wage increase of natives (22.29%) was double the increase in wages of immigrant workers (10.52%), whereas the percentage change in the hours of contribution of native workers was almost half of that of immigrants'.

Table 7: Change in Annual Salaries and Share of Hours Worked by each Education Group

	Native		Immigrants	
	Change in average weekly wages	Percentage-point change in the share of hours worked	Change in average weekly wages	Percentage-point change in the share of hours worked
Low education	6.27%	-7.35%	3.24%	-9.29%
Medium education	11.23%	3.91%	4.53%	0.32%
High education	22.29%	3.44%	10.52%	8.97%
Total	**14.93%**		**6.84%**	

3.3.3. Variation Within the Education and Experience Groups

With the aim of the research analysis being to assess the rate of substitution between immigrant and native workers, the nature of the study requires that the supply of immigrants in the Maltese labour market is well scattered across the different education and experience groups. Such an analysis can be assessed through the below plots, where the supply shock of immigrants (as calculated in Equation 3) with a high, medium and low level of education in 2014, 2017 and 2020 are plotted against the workers' years of experience in their current job. The below three figures show that there is great dispersion in the immigrant supply shock over the years as the shocks vary between the different education groups. Another important aspect gathered from the below graphs is that the immigrant supply shock within the different education groups is not exactly the same across the different experience groups. Nevertheless, a trend is observed, as the majority of all type of immigrants had six years or less of experience within the Maltese labour market as of 2014. This was nonetheless expected *a priori* as the majority of the immigrants within the islands have arrived only in the recent years. Whereas this may be a limitation of the study, this is something which is true in the population labour market and therefore the results are still expected to be a true representation of the population.

$$m_{bgt} = \frac{F_{bgt}}{N_{bgt} + F_{bgt}}$$

Equation 3: Immigrant Supply Shock

Figure 2: Variation within the low education group
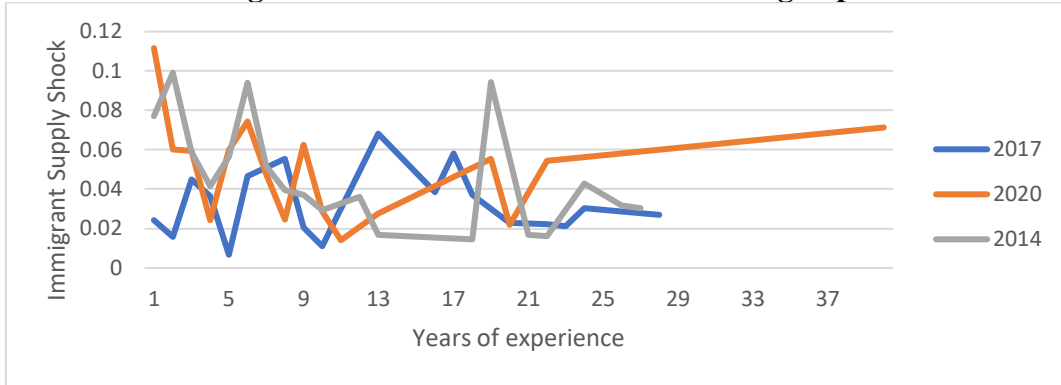
Figure 3: Variation within the medium education group
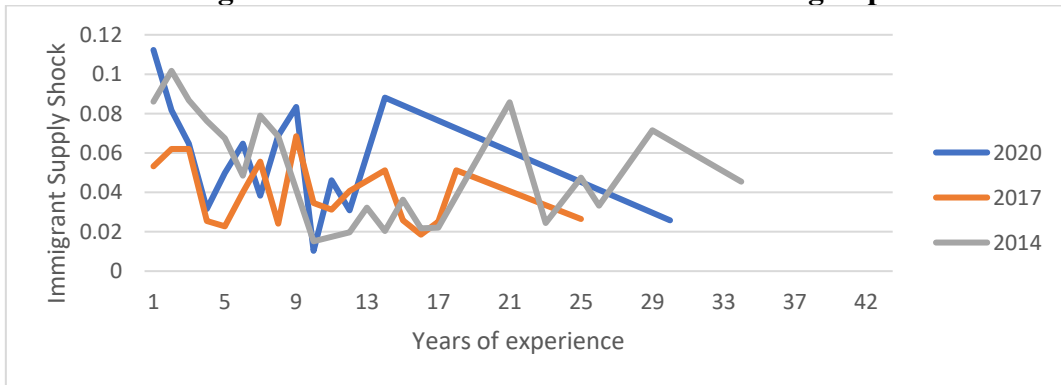
Figure 4: Variation within the high education group
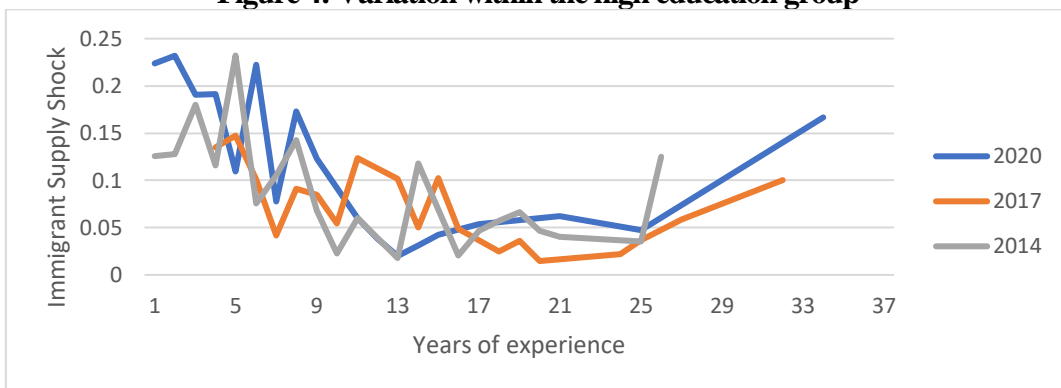
3.5. CONCLUSIONS

The discussions in this section cannot be used to make any conclusions on what the causal impact of immigration on native wages is in a given country, even if the relationship between

these two variables results in discernible correlations. Indeed, there may be a number of other factors which may impact this causal relationship, as will be discussed in the next chapter. In order to isolate the impact that immigration may have on the local wages, a structural model will be developed which will then be used to determine the elasticities of substitution between the different skill groups through an aggregate CES production function.

CHAPTER 4: METHODOLOGY

This chapter presents the methodology used to empirically assess and evaluate the theoretical framework which was brought forward in Chapter 2. In essence, the following chapter is structured as follows: Section 4.1. provides a detailed explanation of the model, explaining how the skill-cells are constructed and how some methodological issues have been overcome. Section 4.2. then explains the process and presents the results for each level of the nested CES, which will be discussed in Chapter 5. Finally, Section 4.3. notes the methodological limitations of this empirical analysis.

4.1. THE EMPIRICAL MODEL

As previously discussed, the research question for this empirical research will be obtained through a nested CES analysis. The study will focus on three levels of nested CES. First, the elasticity of substitution between natives *(n=N)* and immigrants *(n=F)* will be estimated. Then, this estimation will be utilized to move to the second level of the nested CES, where an estimate for the elasticity of substitution between experience groups *(g)* will be obtained. Finally, the third level of nested CES will be reached and the elasticity of substitution between broad education groups *(b)* will be estimated. From here onwards, skill-cell *(g,b)* at time period *t* represents the group of individuals with *g* level of experience and *b* level of education at a given time *t*. Taking into consideration the three education groups and the three experience groups previously discussed, in total, nine skill-cells for immigrants and nine skill-cells for natives are formed per year. The constructed skill-cells are as shown in Appendix 4.

It was expected *a priori* that the sample provided would include far less observations relating to foreign workers than it would have relating to native workers, especially when the sample is constructed into different cells. Indeed, when the cells were constructed by year as shown in Appendix 5, five out of nine of the constructed skill-cells for foreign workers consisted of 10 observations or less, with the weakest skill-cell containing only 4 observations *(n=F, b=2, g=3, t=2020)*. Nevertheless, such a small number of observations may not provide a reliable representation of the average annual salaries and the average hours worked. Therefore, to overcome this issue, the data was pooled together by two years, except for 2014 (2014, 2015/2016, 2017/2018, 2019/2020). These pools were chosen such that the weakest cell in the construction never consists of less than 10 observations. The number of observations per

pooled year for each skill-cell are as in Appendix 6. Therefore, the LFS sample between 2014 and 2020 was translated into 4 waves and 72 observations which are available for the estimation of the elasticity of substitution.

4.2. MODEL DESCRIPTION AND EMPIRICAL FINDINGS

In this subsection, the results from three levels of the nested CES will be provided, together with a detailed description of how the sample was assembled. The discussion will be separated into the three nested CES structures and the limitations or problems that arise in each level will be highlighted and an explanation of how they are alleviated will be provided. Since this empirical study is the first of its kind for the Maltese islands, a number of attempts were made to estimate the elasticity of substitution and all statistically significant results will be presented and at the end of each subsection, the preferred elasticity of substitution will be chosen. These results will then be discussed in dept in Chapter 5.

4.2.1. Elasticity of Substitution Between Nationality Groups

As previously discussed, the sample from the LFS was split into eighteen skill-cells, based on each individual worker's level of education, working experience and nationality. Given that the LFS consists of microdata, the average salaries earned and average hours worked by each skill-cell *(b,g)* were estimated for the seven individual years (from 2014 to 20202) and for the four pooled waves. Whereas some studies such as Manacorda et al. (2012) and Ottaviano et al. (2012) utilized the usual weekly hours worked by each individual to represent the total labour supply, Gerfin et al. (2010) argue that an issue of endogeneity may arise with this approach, as the total hours worked are likely to be correlated with the salaries earned. Therefore, as also chosen by Brücker et al. (2008), employment *(E)* is instead utilized as a proxy of labour supply to alleviate this issue. The variable employment represents an annual weighing factor that each individual *n* has in the sample (ω_i), as provided by the NSO. As such, the employment was calculated as in Equation 4 and the average of such was also estimated for each skill group:

$$E = \sum_{i=1}^{N} \omega_i$$

Equation 4: Employment as a function of the individual annual weights

The raw dataset from the LFS consisted of annual salaries and weekly hours worked. Therefore, the variable for annual salaries was first adjusted for inflation and then divided by 52 weeks to translate the variable to weekly salaries. Through this calculation, it is being assumed that all

individuals in the dataset were employed throughout the entire year, and this in itself is a limitation of this model. Nevertheless, as an attempt to alleviate this problem as much as possible, the annual weighing factor (ω_i) which was provided by the NSO was also used to calculate the weekly salaries based on each individual's representativeness in the sample, as follows:

$$\overline{w} = \frac{\sum_{i=1}^{N} w_i * \omega_i * H_i}{\sum_{i=1}^{N} \omega_i * H_i}$$

Equation 5: Hours-weighted weekly average wage

$\overline{w}$ is the hours-weighted weekly average wage in each labour supply cell and H_i is the usual weekly hours worked by each individual. This estimation for the hours-weighted weekly average wage gives more weight and less weight respectively to those who work the most and the least hours in the sample. To some extent, this diminishes the impact of the previous limitation discussed.

Once all of these adjustments have been made to the sample, the following regression is run to obtain an estimate for the elasticity of substitution (σ_I) between the two nationality groups. If $\sigma_I \neq 1$, then this would imply that immigrants and native workers are not perfect substitutes, thereby implying that a change in the foreign labour supply would impact the native-immigrant wage differential. Indeed, this variable is put as the dependent variable. The model includes also a common time trend (d_t) which captures all of the time-invariant factors within the model, together with nine education-experience specific dummy variables (d_{bg}) and an experience-specific time trend (d_{gt}). These were included in the model to control for any unobserved factors. For instance, whereas the latter caters for the fact that the quality of the workers in each experience group is likely to have changed over time, the former absorbs any systematic differences that may be present between one skill-cell and the other. The main independent variable is the log ratio of immigrant-native supply, represented by the E as in equation 1. This variable was included in the model as in Borjas (2003) to capture the impact that an increase in immigrants would have on the native labour market outcome.

$$\ln\left(\frac{w_{Fbgt}}{w_{Dbgt}}\right) = d_{bg} + d_t + d_{gt} - \frac{1}{\sigma_I}\ln\left(\frac{E_{Fbgt}}{E_{Dbgt}}\right) + u_{bgt}$$

Equation 6: Estimation of the elasticity of substitution between nationality groups

Table 8: The inverse elasticity of substitution $-\left(\frac{1}{\sigma_I}\right)$ **and the elasticity of substitution** σ_I **between natives and immigrants**

	Coefficient $-\left(\frac{1}{\sigma_I}\right)$	Number of observations	Elasticity of substitution (σ_I)
1. Regression with 4-year cells			
a. **Baseline**	-0.0043155* (0.0022309) [-1.93]	72	231.722859
b. **Regression analytically weighed by employment**	-0.3020821 (0.3181939)	72	N/A
i. **Clustering S.E. by Experience fixed effects only**	-0.3020821** (0.1405232) [-2.15]	72	3.31035834
2. Regression with 7-year cells			
a. **Baseline**	-0.1719597** (0.0827093) [-2.08]	126	5.81531603
b. **Regression analytically weighed by employment**	-0.3382621 (0.2990687)	126	N/A
i. **Clustering S.E. by Experience fixed effects only**	-0.3382621** (0.1367084) [-2.47]	126	2.95628745

Note: This table reports a number of estimates for the inverse elasticity of substitution between immigrants and natives $\left(-\frac{1}{\sigma_I}\right)$, with each row corresponding to a separate OLS model. The baseline model represents a simple OLS estimate without weights, fixed effects or clusters. In all the other models, the standard errors are shown in the parenthesis and are heteroscedasticity-robust and clustered around nine education-experience-specific groups. The t-values are presented in square brackets, significance levels: *** t < 1%, ** t < 5%, * t < 10%[7]. Source, LFS.

Given that the individuals' level of education is not expected to vary significantly across their lifetime, the education specific fixed effects will not be included in the model. The natural logarithms of each respective ratios are taken into consideration so as to create a specification which can be given a value. Furthermore, the subscripts *Fbgt* and *Dbgt* allow the foreign and domestic labour force respectively to vary by education *(b)*, experience *(g)* and time *(t)*. For the purpose of this dissertation's research question, it is noted that this dissertation will focus only on the short run elasticities. In all of the models that will be provided hereunder, a simple

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[7] For all of the above results, a two-tailed test was run. For the results with 72 observations, the critical values are *** t< 2.6469, **t<1.9939, * t<1.6666 for 1%, 5% and 10% significance level. For results with 126 observations, the critical values are *** t< 2.6157, **t<1.9791, * t<1.6571 for 1%, 5% and 10% significance level.

OLS analysis will be utilized, where the standard errors are clustered around the education-experience skill-cells to cater for any possible serial correlation and/or analytically weighted by E. Analytical weights are utilized as this method divides the square of the variance of each skill-cell by the weight that each i observation holds within the skill-cell (σ^2/E_i), thereby taking into consideration the differential precision across each observation.

It is evident that the results obtained from seven years (-0.33826 with standard errors of 0.1367) and from four pooled waves (-30208 with a standard error of 0.1405) are not significantly different from one another. Given that the results obtained in this subsection will be utilized to estimate the elasticity of substitution in the next subsection, the constant was included to ensure that the residuals remain with a zero mean. A number of other estimates besides those illustrated in Table 8 were ran, by taking the hours worked as a proxy of labour supply instead of employment or else, weighing the data by usual hours worked or by taking the occupation of the individuals as a proxy of experience level. However, none of these instances were statistically significant, and thus were not included.

From the above estimates, it is gathered that the estimated coefficients (excluding the baseline estimates) lie in a narrow range between -0.338 and -0.302, thus implying that the elasticity of substitution lies between 2.96 and 3.31 respectively with standard errors between 0.13 to 0.29. From these estimates, it shall be concluded that the preferred elasticity of substitution between native and immigrant workers is 3.31. Therefore, in theory, it is said that a 1% increase in immigrants into the Maltese labour market in general would result in a 3.31 percent decrease in the weekly (weighted) wages. This therefore implies that the elasticity of substitution between natives and immigrants is imperfect. In the next subsection, the same results will also be assessed for an infinite value of elasticity of substitution as well as a zero elasticity of substitution to reflect the perfect and imperfect cases of elasticity of substitution respectively.

4.2.2. Elasticity of Substitution Between Broad and Narrow Experience Groups

This section will estimate the elasticity of substitution between broad and narrow experience groups. First, the model carried out by Gerfin et al. (2010) is considered. With a clear estimate of the elasticity of substitution between the different nationality groups (σ_I), the analysis moves to the second level of nested CES, where an estimate of the elasticity of substitution between broad experience groups will be obtained. Following the set of equations which were presented

by Gerfin et al. (2010), the estimate for elasticity in section 4.2.1. is used to obtain an estimate for the native and foreign workers' respective productivities ($\hat{\theta}_{Fbgt}$ and $\hat{\theta}_{Nbgt}$). The summation of the education-experience specific time trends, the experience fixed effects and the common time trend from Equation 3 in the previous section can be estimated as follows, where $\hat{u}_{bgt}$ represents the residuals from the above regression.

$$\hat{D}_{bgt} = \hat{d}_{bg} + \hat{d}_t + \hat{d}_{bt} = \frac{1}{\sigma_I}\left(\frac{E_{Fbgt}}{E_{Dbgt}}\right) - ln\left(\frac{w_{Fbgt}}{w_{Dbgt}}\right) - \hat{u}_{bgt}$$

Equation 7: Summation of fixed effects

As in Gerfin et al. (2010), the summation of the levels of productivity are constrained to be equal to one in each individual education-experience specific skill-cell. Therefore, the productivity levels for native and foreign workers are estimated as follows:

$$\hat{\theta}_{Fbgt} = \frac{exp\,(\hat{D}_{bgt})}{1 + exp\,(\hat{D}_{bgt})}$$

Equation 8: Immigrant Productivity Level

$$\hat{\theta}_{Nbgt} = \frac{1}{1 + exp\,(\hat{D}_{bgt})}$$

Equation 9: Native Productivity Level

In the estimation of the elasticity of substitution between broad experience groups, Gerfin et al. (2010) define the supply variable as the summation of the product of the productivity and the supply factor for each nationality type, subject to the elasticity of substitution σ_I. In this analysis, the labour variable is being represented by employment (E) and $\hat{\varepsilon}_I = (\hat{\sigma}_I - 1)/\hat{\sigma}_I$.

$$\hat{E}_{bgt} = \left[\hat{\theta}_{Fbgt}\hat{E}^{\hat{\varepsilon}_I}{}_{Fbgt} + \hat{\theta}_{Mbgt}\hat{E}^{\hat{\varepsilon}_I}{}_{Mbgt}\right]^{1/\hat{\varepsilon}_I}$$

Equation 10: Labour supply variable subject to σ_I

Finally, the Swiss study also estimates the log-ratio of the average weekly wage in a specific skill-cell (b,g) and time period t as follows (Gerfin et al. 2010):

$$\ln(\overline{w_{bgt}}) = \frac{\overline{w}_{Fbgt}E_{Fbgt} + \overline{w}_{Mbgt}E_{Mbgt}}{E_{Fbgt} + E_{Mbgt}}$$

Equation 11: Log-ratio of average weighted weekly wage

Through the above estimations, the second level of nested CES can be performed to obtain an estimate for the elasticity of substitution among experience groups σ_X. This estimation includes a common time trend (d_t), an education-specific time trend (d_{bt}) and an education-experience specific time trend (d_{bg}) to capture all of the differences that may be present in the productivity of the different group of workers. Similar to before, the estimations are analytically weighed[8] to employment and the standard errors are clustered to the education-experience groups to allow for serial correlation within each group. Finally, the random error u_{bgt} captures any disturbances which may be present in each skill-cell at any time period t. With the method of estimation being OLS, the estimation results are presented in Table 9.

$$ln(\overline{w_{bgt}}) = d_t + d_{bt} + d_{bg} - \frac{1}{\sigma_X} ln\,(\hat{E}_{bgt}) + u_{bgt}$$

Equation 12: Estimation of the elasticity of substitution between broad experience groups

Table 9: The inverse elasticity of substitution -($1/\sigma_X$) and for the elasticity of substitution (σ_X) between experience groups

	Coefficient $(-1/\sigma_X)$	Number of observations	Elasticity of substitution σ_X
Estimation for σ_I = 3.31	-0.8173985*** (0.2573559) [-3.18]	72	1.22339349
Estimation for σ_I = 0	-0.8251559** (0.3261308) [-2.53]	72	1.2118922
Estimation for σ_I = ∞[9]	-0.8535509*** (0.2809896) [-3.04]	72	1.17157629

Note: This table reports a number of estimates for the inverse elasticity of substitution between experience groups, with each row corresponding to a separate OLS model. The standard errors are shown in the parenthesis and are heteroscedasticity-robust and clustered around the education-experience-specific groups. The t-values are shown in the square brackets, significance levels: *** t < 1%, ** t < 5%, * t < 10%[10]. Source, LFS.

From the above estimates, it is found that the results for the elasticity of substitution between experience groups also falls within a tight range from -0.853 to -0.817 and standard errors between 0.257 and 0.326. Even though the results obtained for σ_I = 3.31 and σ_I = ∞ are similar, they are not equivalent. Therefore, with this assessment, enough evidence is provided to reject the null hypothesis, thereby concluding that the elasticity of substitution between broad

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[8] Analytical weights were chosen over frequency weights as Borjas et al. (2008) proofs that they are more effective.

[9] As a value of infinity, the value 9.99999E+307 was inputted.

[10] For all of the above results, a two-tailed test was run. For the results with 72 observations, the critical values are *** t< 2.6469, **t<1.9939, * t<1.6666 for 1%, 5% and 10% significance level.

experience groups is not perfect. As an extension to other studies, the elasticity of substitution between broad experience groups was also tested against a scenario where the elasticity of substitution is zero. Such a case would imply that immigrant and native workers do not substitute to each other at all and that an increase in immigrant workers do not have any impact on the natives' wages. It was found that the elasticity of substitution ($\sigma_I = 3.31$) is closer to the results obtained for $\sigma_I = 0$. This thus implies that immigrants and natives across broad experience groups are far substitutes to one another. Nevertheless, when compared to estimates obtained by other countries, the results overall seem to be rather small. This shall be discussed in more depth in Chapter 5.

Next, the elasticity of substitution between narrow experience groups will be assessed, as was done by Bonin (2005). The results obtained in Table 10 are in line with the *a priori* expectations. With the dependent variable being the immigrant-native wage differential, the results obtained show that it would be more difficult to substitute one immigrant with one native if the native has been a lot of experience within the same company, whereas it would be easier to substitute one immigrant for one native if the native does not have much experience within the given company.

Table 10: Elasticity of substitution between experience groups

	Coefficient $(-1/\sigma_X)$	Number of observations	Elasticity of substitution σ_X
Within low experience groups σ_{LX}	-0.289581* (0.158731)	24	3.45326523
Within medium experience groups σ_{MX}	-0.6186795* (0.381777)	24	1.61634578
Within high experience groups σ_{HX}	-1.369162*** (0.1464502)	24	0.73037376

*Note: This table reports a number of estimates for the inverse elasticity of substitution between individual experience groups, with each row corresponding to a separate OLS model. The standard errors are shown in the parenthesis and are heteroscedasticity-robust and clustered around the education-experience-specific groups. Significance levels: *** t < 1%, ** t < 5%, * t < 10%. Source, LFS.*

4.2.3. Elasticity of Substitution Between Education Groups

In many other similar studies (Katz et al. 1992, Card et al. 2001, Borjas 2003, Peri et al. 2006, Borjas et al. 2007, Ottaviano et al. 2008 and Gerfin et al. 2010), the main issue from all of the three levels of nested CES was in the estimation of the elasticity of substitution between education groups. The reason why this has raised a lot of questions in the literature is because when taking into consideration only education groups, a lot of degrees of freedom are lost, and

therefore it becomes problematic to obtain significant results, especially given that this study only covers a seven-year period. From the different methodologies available with regards to this elasticity, the approach taken by Katz et al. (1992) is the most cited, and therefore this theoretical model will be utilized. Similar to this study, and others following it such as Borjas (2003), Borjas et al. (2007) and Ottaviano et al. (2008), it is assumed that d_t has a linear time trend in order to try to alleviate the issue of degrees of freedom. As such, the following regression is run, where the OLS regression is analytically weighed by employment.

$$\ln\left(\frac{w_{Ht}}{w_{Lt}}\right) = d_t - \frac{1}{\sigma_{HL}}\ln\left(\frac{E_{Ht}}{E_{Lt}}\right) + u_t$$

Equation 13: Elasticity of substitution between High and Low education groups

The results obtained from this regression are generally not assessed in other literature. This is because as per the categorization of the education group which were discussed in Chapter 3, group *H* above represents individuals with a university degree or higher whereas group *L* represents those individuals who hold a secondary education of lower. These groupings are different then the groups specified by other studies. For instance, Katz et al. (1992), Card et al. (2001), Ottaviano et al. (2008) and Manacorda et al. (2012) classify individuals with a high school degree or lower into the *L* group. When this relationship was tested for this dissertation, no significant relationship was observed, possibly due to significantly low number of observations. Therefore, the original education groups constructed in section 3.2.1. will be kept, and the elasticity of substation between high and low education groups as presented by Katz et al. (1992) will be extended to also assess the elasticity of substitution between high and medium education groups, as presented in Equation 14.

$$\ln\left(\frac{w_{Ht}}{w_{Mt}}\right) = d_t - \frac{1}{\sigma_{HM}}\ln\left(\frac{E_{Ht}}{E_{Mt}}\right) + u_t$$

Equation 14: Elasticity of substitution between high and medium education groups

The *a priori* expectations are that the elasticity of substitution between high and low education groups would be lower than that between high and medium education groups as it is expected that it would be easier to substitute workers with somewhat similar levels of education than it would be to substitute workers with very different levels of education. The results in Table 11 are in line with these expectations, as it is found that the elasticity of substitution between different education groups lies in a tight range between 0.2587 and 0.2666, with standard errors never larger than 0.17 and very different from zero. Surprisingly, the elasticities obtained lie in between 3.75 and 3.86, which are significantly higher than the results obtained by other studies. This may be the case as a different definition of the education groups were taken into

consideration, as else because of the significantly small number of observations available. This shall be discussed in more detail in Chapter 5. The above model was also run to test the causal relationship between medium and low education groups, however no statistical significance was found.

Table 11: Estimates for inverse elasticity of substitution and for the elasticity of substitution between broad education groups

	Coefficient	Number of observations[11]	Elasticity of substitution
High/Low education group	-0.2662144** (0.1112974) [-2.39]	14	3.7563708
High/Medium education group	-0.2587198* (0.1705848) [-1.52]	14	3.86518542

*Note: Each regression is run individually. All three regressions are run with seven years in observation and employment as the supply variable. All results are analytically weighed by employment, but no clusters are included. The number of observations were obtained from the new construction of the variables into the three education groups. The t-values are shown in the square brackets, significance levels: *** t < 1%, ** t < 5%, * t < 10% [12] Source, LFS.*

4.3. METHODOLOGICAL LIMITATIONS

4.3.1. The Endogeneity Problem

One of the most important limitations in the study revolves about the issue of endogeneity. This issue can arise from two areas. Firstly, endogeneity may lead to a bias in the simulation of the impact of immigrants on native wages. This issue is generally present since an influx of immigrants is generally assumed to be unexpected, or as a shock into the Maltese labour market. This assumption is made because immigrants are at large conditioned by a push factor, meaning that the drive out of their home country is independent of the demand for labour in the host country (Gerfin et al. 2010), such as in cases where migrants arrive at the host country with the aim of seeking refuge (Dumont et al. 2016). However, this assumption may not be entirely correct. Indeed, in most cases individuals are attracted to the host country for economic reasons such as the lack of skilled or unskilled workers in the host country. This is most likely to be the case in the Maltese islands, where employers seek foreign workers because they cannot find workers from the local labour supply. These are referred to as pull factors and are considered to be an endogenous factor as the immigrants will not be replacing or having an

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[11] Given the small sample size, these results shall be interpreted with caution due to their limited reliability.

[12] For all of the above results, a two-tailed test was run. For the results with 14 observations, the critical values are *** t< 3.0123, **t<2.1604, * t<1.7709 for 1%, 5% and 10% significance level.

impact on the wages of the natives or of the long-term immigrants. Therefore, if an influx of immigrants is assumed to be purely exogenous, the impact that immigrants are likely to have on the native wages is likely to be biased.

Secondly, endogeneity may disrupt the estimation of the respective elasticities of substitution. As in a number of other similar studies (Borjas 2003, Brücker et al. 2008, Gerfin et al. 2010) the usual hours worked per worker are used to reflect the labour supply, which in turn is related to the annual salaries that the workers receive in the regression model. The issue of endogeneity in this case arises because these two variables may be simultaneously determined (Gerfin et al. 2010). In turn, the elasticities of substitutions may have an upwards bias and thus there would be a larger spill-over effect from the nationality cell to the other skill-cells.

4.3.2. Observational Limitations

The data obtained does not contain the date of entry of the immigrants into the Maltese islands and therefore it becomes difficult to make a distinction between first generation and second-generation immigrants. This dissertation does not make such a distinction, and this may lead to variations in the results obtained (Bonin 2005). This issue could be overcome if data on the individuals' job experiences both in Malta and abroad was available, however this was not the case as the experience of individuals utilized in the methodology only reflects the number of years that an individual has been working in the job during the time that the survey took place. Therefore, not only does this variable fail to reflect any experience gained abroad, but it also does not reflect whether the individual has changed their company in the recent years within the Maltese labour market itself. This may underestimate both natives' and immigrants' experience levels as well as the estimated elasticities.

For the purpose of comparing the sample dataset with the population at large, the analysis in Table 12 has been carried out. According to a Central Bank of Malta (CBM) report, in 2018, the median hourly wages for workers with a high level of education was 40% higher than those individuals with a medium level of education, whereas the median hourly wages for workers with a high level of education was 65% higher than those with a low level of education (Gauci 2021). With careful attention given to the definitions of what incorporates a high, a medium and a low level of education, these findings from the CBM were compared to the median wages in the sample during the year 2018 and somewhat different results were obtained. The analysis

from the dataset shows that those workers with a high level of education earn 67.62% and 53.29% higher wages than those with a medium and a low level of education respectively. There are two possible explanations for such a gap in the median wage: either the workers in the sample with a medium and those with a low level of education are earning more and less than the population labour market which was considered by the CBM or else the workers with a high level of education are earning less than and more than the median population with a medium and a low level of education respectively. This in itself is a limitation of the sample data as it may overstate or understate the elasticity of substitution concerning medium and low education groups respectively.

Table 12: Comparison of the average wages of each education group to previous literature, 2018

	Analysis from the CB study			Analysis from Sample dataset	
	Median level	**Low level**		**Median level**	**Low level**
High level	40%	65%	High level	67.62%	53.29%

CHAPTER 5: DISCUSSION AND RECOMMENDATIONS FOR FURTHER STUDIES

The impact that immigrants have on the native wages has become quite topical among EU countries, including Malta as there have been ongoing discussions about the need to improve the productivity within the Maltese labour force. Indeed, the results obtained in this study will serve as a contribution in assessing which type of immigrants are more likely to negatively or positively impact the wages within the local community. This study has aimed to observe this causal relationship through the elasticities of substitution between different workers based on their nationality, education and level of experience. Several past studies carried out in other European and American countries have assessed this relationship through a nested CES analysis, and this study is the first attempt in Malta to assess this causal relationship in such a way. Based on the results summarized in Chapter 4 and the discussions put forward in this chapter, the null hypothesis of the study will be rejected, thereby implying an imperfect elasticity of substitution between native and immigrant workers.

5.1. COMPARISON TO SIMILAR STUDIES

Analysing first the elasticity of substitution between immigrants and natives, the results obtained build on the existing evidence of Peri et al. (2006), Manacorda et al. (2006), Ottaviano et al. (2008), Brücker et al. (2008), Felbermayr et al. (2010), Card (2009), D'Amuri et al. (2010), Manacorda et al. (2012) and Ottaviano et al. (2012) that the elasticity of substitution between native and immigrant workers is imperfect. Nevertheless, Borjas et al. (2008) argued that if enough caution is taken in the model with regards to heterogeneity and the construction of the skill-cells, then there would not be enough evidence to reject the null hypothesis, thereby concluding that the elasticity of substitution between nationalities may indeed be perfect. This was expected because heterogenous variables generally have a lower elasticity of substitution than homogenous ones (Felbermayr et al. 2010). This thus explains why the basic model in Table 12 resulted in significantly high elasticities, and this is also why it is important to carefully construct the observations into separate skill-cells. However, it is evident that the elasticities obtained in this dissertation are lower than those obtained by all these studies, as shall be observed shortly. This was expected *a priori* as, according to Havranek et al. (2020), the elasticity of substitution in more developed countries should be relatively higher than in less developed ones. This can be observed by comparing the elasticity of substitution between nationalities in the Maltese labour market (3.31) with those in the UK by Manacorda et al.

(2006) and Manacroda et al. (2012), with the elasticities of substitution between native and immigrant workers in the UK ranging from 5 to 10 respectively and those obtained in Germany by D'Amuri et al. (2010), Brücker et al. (2011) and Haas et al. (2013) with the rates of substitutions standing at 33.33, 16.12 and 7.01 respectively.

The elasticity of substitution between different skill groups is very sensitive to the variable definitions within each skill group. Indeed, Welch (1979), with five-year experience groups and four education groups obtained an elasticity of substitution between broad experience groups between 4.6 and 12. On the other hand, Katz et al. (1992) constructed five-year experience groups and two education groups and obtained an elasticity of substitution of 3. Similarly, taking into consideration the labour supply of the baby boomers, Card (2001) obtained an elasticity between 4.2 and 9.3. In this dissertation, a different set of education and experience groups were considered due to the lack of observations within each skill group, as discussed in Chapter 3. As also expected *a priori*, the results obtained for the Maltese islands are smaller than those in other larger and relatively more developed countries (Havranek et al. 2020). The argument put forward by Borjas et al. (2008) with regards to heterogeneity can also be applied when making a comparison of elasticities between broad and narrow experience groups. Since in narrow experience groups a lower level of heterogeneity is expected, the results are expected to be higher than those obtained between broad experience groups. This was indeed the case as obtained in Table 10, and the results are also in line with Welch (1979) and Card et al. (2001) as they found that the elasticity of substitution between different experience groups is indeed less than one i.e., imperfect. However, the German study by Bonin (2005) did not find any significant relationship between such skill groups.

At first glance, contrary to the other two levels of nested CES, the results obtained for the elasticities of substitution between education groups for this dissertation are larger than those obtained by other studies. However, the results obtained for this elasticity of substitution are highly sensitive to the definitions of the variables and on the model ran, and therefore the elasticities can only be compared to those studies which have utilized the same model as that described in section 4.2.3. However, since the definitions of the education groups were taken to be different from other studies, such comparison may not be done. Nevertheless, it can be stated that an imperfect elasticity of substitution between broad education groups was still obtained, and therefore the results are in line with Welch (1979), Katz et al. (1992), Card et al.

(2001) and Ottaviano et al. (2008). On the contrary, neither Bonin (2005) nor Haas et al. (2013) found a significant impact on wages between workers with a low and a high level of education.

5.2. INTERPRETATION OF THE RESULTS

In line with similar findings obtained by all of the previous literature analysed thus far, all but one of the results obtained suggest that there exists a negative relationship between immigrant and native workers in the Maltese labour market, and this relationship holds even between immigrants and natives in broad and narrow experience groups and between high/low and high/medium education groups. Such results suggest that an influx of immigrants will generally decrease the wages in the host economy. If the study was to assume that the elasticity of substitution between native and immigrant workers is perfect as in Manacorda et al. (2006) for the UK and in Peri et al. (2006) for the US, then it would be expected that the wage gap in each skill-cell is constant. However, this is evidently not the case in this study, as the estimates for $1/\sigma_I$, $1/\sigma_x$, $1/\sigma_{HL}$ and $1/\sigma_{HM}$ are indeed less than 1.

5.2.1. Nationality Groups

According to Borjas (2013), if the elasticity of substitution is found to be imperfect, then the group which experienced the greatest increase in supply will always experience a decline in their respective wages. As per the sample data from the LFS, over the years between 2014 and 2020, the total supply of native workers decreased by 8.91% while the total supply of immigrant workers increased by 6.31%. Therefore, with an imperfect elasticity of substitution of 3.31 and a standard error of 0.14, the results suggest that a 1% rise in immigrants in the Maltese labour market would result in a 3% decrease in the native weighted weekly wages. However, other findings with similar results suggest that with a new influx of immigrants, the negative impact on wages is more likely to be on the wages of previously settled immigrants within the same skill groups rather than on the wages of native workers (Card 2001, Ottaviano et al. 2008, Gerfin et al. 2010, Borjas et al. 2011 and Manacorda et al. 2012), especially since the results suggest an imperfect elasticity of substitution (Card 2009). At the time of the data collection, information on when the immigrants entered the Maltese labour market was not available. However, Card (2009) suggests that if such information were available, the elasticity of substitution between native and immigrant workers is expected to be smaller. In the recent months, the Maltese *National Employment Policy* (Ministry of Finance and Employment 2021) argued that immigrants generally choose to work in sectors which differ from those of natives,

even if they hold the same level of experience and/or education. This statement is in line with Peri et al. (2006) and Peri et al. (2009), which suggest that this may be another reason as to why the impact that immigrants have on local wages is small and imperfect.

Another reason as to why the impact that immigration has on local wages is minimal may be due to the type of immigrants that are entering the Maltese labour market. As concluded by Borg (2019) for the case of the Maltese islands, generally, those immigrants who have a low level of education tend to remain in the country in the long term, whereas immigrants who have a higher level of education generally stay on average for two years, as they then move to another country is search or better wages and opportunities (Borg 2019). Therefore, the low and imperfect results are therefore in line with the conclusions drawn by Haas et al. (2013), where it is stated that an imperfect substitution is expected where there are low and persistent wages. These results shall therefore be considered in the construction of immigration policies in the Maltese islands.

5.2.2. Experience Groups

With the argument of heterogeneity in mind (Borjas et al. 2008), it was expected *a priori* that the elasticity of substitution between broad experience groups would be lower than that between narrow skill-cells, as was indeed the case. Furthermore, while it was anticipated *a priori* that the elasticity of substitution between broad experience groups would be imperfect, an unexpected finding was that a very low elasticity was obtained for $\sigma_I = 3.31$, with the results being closer to $\sigma_I = 0$ than to $\sigma_I = \infty$. These results contradict the findings of Gerfin et al. (2010), as this dissertation suggests a high degree of imperfect substitution, to a rate of almost having no relation to one another. The reason for this may depend on the definition of the variable utilized for the experience group. It may be that if an individual has been working within the same sector for 10 years but has only recently changed their employer, then this worker would be included within the low skilled experience group. This could also be present amongst the immigrant population, where the majority of the immigrants have entered the Maltese labour market in the recent years and since no data is available on their experience abroad, they would be included within the low experience cells.

This study went beyond previous literature as the elasticity of substitution was also estimated for individual experience groups. With the explanatory variable for experience being represented by the number of years that an individual has been working within the same

company as of the time of the survey, the results obtained are in line with the *a priori* expectations. Indeed, if there is a 1% increase in immigrants, it would be more possible that these replace workers who have been working within the same company for only a few years rather than replacing those who have been working within the same company for a longer period of time. As a matter of fact, while the elasticity of substitution is imperfect across all experience groups, such that $\sigma_{LX} > \sigma_{MX} > \sigma_{HX}$. Therefore, a greater negative impact (3.45%) on the local weighted weekly wages is expected across those with a low level of experience. Similar findings were also obtained by Brücker et al. (2011).

One result which stands out from all the rest is the elasticity of substitution between immigrants and natives with a high level of experience (0.73). This is the only elasticity in this dissertation which resulted to be less than one, thus implying a highly inelastic degree of substitution between highly skilled immigrants and natives. In other words, if there is a high influx of highly experienced immigrants, this will not have any significant impact the wages of highly skilled natives. With the experience variable being reflected by the number of years in the current job, it is noted that the elasticity of substitution is comparing individuals based on their experience within one company, rather than based on their experience as a whole. Nevertheless, based on the nature of the model and on the structure of Equation 12, similar results are expected to be obtained had the individuals' lifetime experience been included. These results are in line with those concluded by Card (2009). Such a result may have cropped up because, in the Maltese islands, certain type of immigrant workers with high education and/or high skills are generally in demand and sought after in the Maltese labour market. Therefore, even though such immigrants are likely to have some impact, the majority are attracted into the Maltese labour market due to a shortage in the local labour supply. Ma (2020) also reported similar results, however, the author argued that for some occupations, a complementary relationship is found between highly skilled immigrants and natives.

5.2.3. Education Groups
The results obtained from Table 11 are in line with the *a priori* expectations, in that $\sigma_{HL} < \sigma_{HM}$. Nevertheless, the small distinction between the two elasticities of education was unexpected, as it was anticipated that σ_{HM} would be significantly higher than σ_{HL}. Such a small distinction in the two elasticities of substitution between broad education groups is likely to have arisen because of the small size of the Maltese labour market, coupled with its heightened demand for labour due to the relatively high economic growth. This could also explain why, unlike the

other elasticities obtained, the results in this section are significantly higher than those obtained by other studies. Nevertheless, such an analysis should be made with caution due to the different models utilized to arrive at the elasticities. Given that from 2014 until 2020 Malta was nearly in full employment, with the unemployment rate ranging between 3.4% and 6% (Eurostat 2022b), highly educated individuals may still be finding it hard to find employment within the industries in which they specialize. As a result, a lot of highly educated individuals would often search for employment in other sectors and thus be substitutes to medium and low educated individuals. This scenario is generally mostly observed amongst foreigners. Indeed, from the sample dataset from the LFS, only 9.27% of all native individuals with a high level of education were working in low skilled jobs, as opposed to the 24.08% of the foreign highly educated nationals working in low skilled jobs.

5.3. RECOMMENDATIONS FOR FURTHER STUDIES

To the author's best knowledge, this study is the first attempt to assess the causal relationship between immigrants and workers based on their differing skills in the Maltese labour market. The findings from this study present the following opportunities for further research:

(i)   A future study may take into consideration workers' age-differences, draw up a distinction between old and new immigrants, and assess the relationship that exists between the immigrants' own demographics.

(ii) Further research is also recommended to establish how the earnings of immigrants in the host country can be compared to the workers within the same skill group at the immigrants' home country, in order to assess the economic assimilation that these immigrants have on the Maltese labour market.

(iii) Furthermore, a follow-up research can utilize the elasticities of substitution that are presented through this empirical research to assess and estimate the wage effects that immigrants have on the Maltese labour market. As an extension of the present study, this would be valuable to local migration policy makers in assessing how well the Maltese labour market absorbs immigration, with the aim of potentially protecting the local worker from excess competition.

CHAPTER 6: CONCLUSIONS AND POLICY RECOMMENDATIONS

This empirical research serves as a contribution to the various literature which have come to surface regarding the impact that immigrants have on the Maltese labour market. This area of study was chosen as throughout the past two decades and particularly in the last 10 years as has also been found through the Census on the Maltese population (2011-2021), Malta has welcomed a significant number of immigrants into its labour force, and with this significant increase, a number of debates have been raised on the issue. Based on the results obtained in the study, there is enough evidence to reject the null hypothesis of the research question, thus implying that there is an imperfect elasticity of substitution between immigrant and native workers in the Maltese islands across all skill groups. This suggests that Malta can welcome a number of immigrants without having any significant impact on the average wages or on the level of employment of the native workers. Indeed, it has been found that the average elasticity of substitution between natives and immigrants with different measures of skill falls in the range of 0.73 and 3.85. Emphasis is also made once again that the results obtained reflect only short-run elasticities.

6.1. POLICY RECCOMENDATIONS

The discussion put forward in this study only deals with part of the whole picture which deals with how the Maltese economy should react to the significant influx of immigrants that it has been receiving. As such, with regards to policy recommendations regarding immigration, a more detailed analysis is required, one which assesses the potential benefits that immigrants could have on the Maltese economy, as well as gaining a better understanding of how the Maltese labour market is being affected by the foreign labour supply. Nevertheless, this study could serve as a contribution in this puzzle, particularly in light of the recent demand for a more improved labour market by analysing which type of workers are most efficient and are likely to positively impact the Maltese labour market, thereby increasing the productivity.

In the analysis on what impact immigrants have on the Maltese labour market, Spiteri (2020) concluded that this impact depends on the various characteristics of the immigrant, and that policy makers should attract those immigrants who improve the wages in the Maltese economy. As such, this dissertation has aimed to assess which immigrant characteristics are likely to have the greatest and the lowest impact on the native wages. As such, an imperfect elasticity of

substitution was obtained for all immigrant-native skill groups, thus suggesting that if Malta welcomes significantly high quantities of immigrants, then these will in turn decrease the local wages. Similar but slightly lower/higher results were obtained when the same relationship was observed while taking into consideration the level of experience/education of individuals. Nevertheless, this dissertation concludes that those immigrants with a high level of experience are the ones which have the lowest impact on the local wages. Therefore, this dissertation has filled in the gap in the literature as it is recommended that policy makers establish policies which attract highly skilled immigrants so as to retain the strength of the native wages while meeting the demand for labour in the Maltese labour market.

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APPENDICES

The sample dataset from the LFS suggests that there has been a general decrease in the hours contributed to work by those who hold a low level of education, and an increase in contributary hours by those with a high level of education (illustrated in Table 6 of the main text). Even though this is supported by the data from the Eurostat (2022a), Malta still remains above the EU target for 2030 with regards to early school levers as illustrated in the below figure. It is noted that the arguments put forward in the main text relate solely to the analysis made based on the data from the LFS.
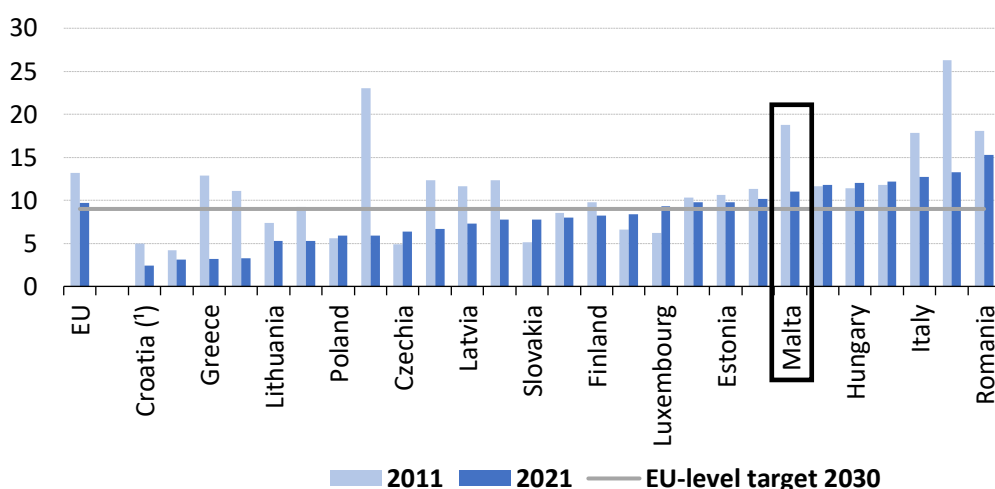
Source: Eurostat. (2022a). Early leavers from education and training. Eurostat. Retrieved 6th August 2022

Appendix 2: Analysis of the wage increased by education group (2014-2020)

From the sample dataset, it was analysed that over the years, the greatest increase in wages was among those with a high level of education, whereas the smallest increases were among those with a low level of education. In aggregate, the Native workers' wages increased by more than the immigrants' in every education group, as illustrated below.

	Native	**Immigrant**	**Difference in percentage points**
Low education	6.27%	3.24%	3.04%
Medium education	11.23%	4.53%	6.70%
High education	22.29%	10.52%	11.76%
Total increase/ difference	**14.93%**	**6.84%**	**8.09**%

Source: Author's computation

Appendix 3: Outlier analysis

The below box plot shows that there are some outliers in the dataset when it is digested into the education and nationality groups. From the below figure, it is evident that foreign workers' wages are more clustered together than natives' wages.
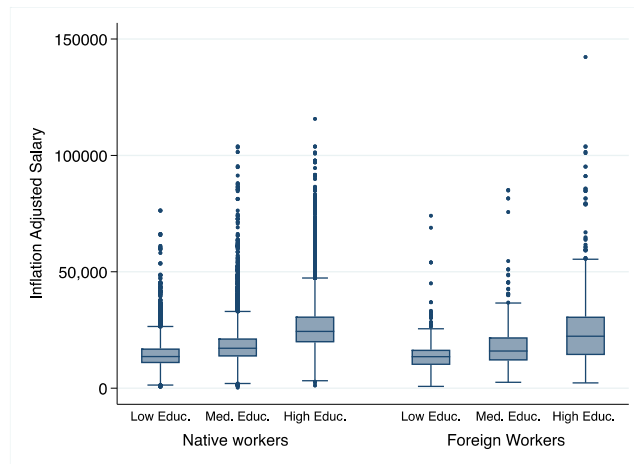
Source: Author's computation

Appendix 4: Construction of skill-cells by education and experience group

	Natives				Immigrants		
Skill-Cell	Mean wage	Mean hours	No. of Observations	Skill-Cell	Mean wage	Mean hours	No. of Observations
b = 1, g = 1	13026.63	39.31372	7,552	b = 1, g = 1	13636.56	40.35379	434
b = 2, g = 1	16866.73	39.55776	5,427	b = 2, g = 1	17304.1	39.98194	359
b = 3, g = 1	27215.43	40.41457	2,956	b = 3, g = 1	23189.31	41.06892	525
b = 1, g = 2	14343.24	40.48787	3,515	b = 1, g = 2	14631.31	40.02107	109
b = 2, g = 2	17892.37	40.36758	2,684	b = 2, g = 2	19439.08	42.67128	112
b = 3, g = 2	26801.51	39.32913	2,179	b = 3, g = 2	30750.93	44.54277	196
b = 1, g = 3	15583.66	41.22067	7,557	b = 1, g = 3	18595.88	44.01535	93
b = 2, g = 3	20398.84	40.40433	5,776	b = 2, g = 3	20468.94	41.05025	76
b = 3, g = 3	27616.66	39.74283	4,379	b = 3, g = 3	27826.61	40.18996	107

Source: Author's computation from the LFS sample data

Appendix 5: Number of observations of immigrants in the sample, by skill-cell

	b₁_g₁	b₁_g₂	b₁_g₃	b₂_g₁	b₂_g₂	b₂_g₃	b₃_g₁	b₃_g₂	b₃_g₃	Minimum observations
2014	87	19	17	57	13	17	74	26	25	13
2015	67	24	13	46	23	17	71	28	17	13
2016	53	18	17	50	23	12	40	33	10	10
2017	32	9	15	42	19	8	50	25	11	8
2018	47	10	10	50	6	11	71	28	15	6
2019	82	16	12	51	10	7	108	27	18	7
2020	66	13	9	63	18	4	111	29	11	4

Source: Author's computation from the LFS sample data

Appendix 6: Number of observations of immigrants in the sample, by skill-cell and pool years

	$b_1\_g_1$	$b_1\_g_2$	$b_1\_g_3$	$b_2\_g_1$	$b_2\_g_2$	$b_2\_g_3$	$b_3\_g_1$	$b_3\_g_2$	$b_3\_g_3$	Minimum observations
2014	87	19	17	57	13	17	74	26	25	13
2015/ 2016	120	42	30	96	46	29	111	61	27	27
2017/ 2018	79	19	25	92	25	19	121	53	26	19
2019/ 2020	148	29	21	114	28	11	219	56	29	11

Source: Author's computation from the LFS sample data