DEPARTMENT OF POLITICAL SCIENCE

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A quantitative analysis of the link between the Eurozone crisis and declining worker productivity in the Greek economy

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Abstract

The purpose of this thesis is to investigate the causes of Greece's worker productivity decline in the aftermath of the euro crisis. Through the employment of three groups of time-series regressions, the empirical analysis of the thesis demonstrates that: 1) there exists an unambiguous correlation between the unfolding of the euro crisis and Greece's declining worker productivity – a correlation which is entirely disconnected from the progression of the country's competitiveness; 2) the progression of the crisis is intimately correlated with Greece's recent surge in human capital emigration; and 3) this outflow of human capital-rich workers may explain a large portion of Greece's worker productivity decline since 2008. These findings are of utmost significance for the discussion on the optimality of the Eurozone as a currency area, as they suggest that crisis-induced migration is inherently asymmetric in the sense that it disproportionately "selects" the highly educated. Thus, presuming that the common currency in combination with Greece's relatively low level of economic development is largely to blame for the severity of the Greek crisis, the EMU appears to be indirectly hampering the productivity development of its economically weakest member state.

Key words: *Greece; euro crisis; worker productivity; human capital transfers; optimum currency area theory; worker flexibility*

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Models, tables and diagrams

1. Introduction

The question whether Europe constitutes an optimum currency area has long be a subject of heated debate among academics and policymakers. Some are sceptical of the Eurozone's prospects, and argue that the macroeconomic asymmetries between the constituent countries[1], in combination with low labour flexibility[2] and a lack of transfer mechanisms, makes it impossible for a common monetary policy to work. Others regard these asymmetries as a self-correcting problem, envisaging that the countries' economies will converge automatically over time. In the wake of the euro crisis, it grew increasingly clear that neither asymmetry nor labour flexibility are endogenous to monetary integration. The countries' real exchange rates had diverged, effectively compromising competitiveness in the Southern parts of the currency area (de Grauwe, 2012). Moreover, the ensuing mass-unemployment was not offset by any proportional increase in migration among idle workers, as unemployment rates have remained at high levels even after the crisis (OECD, 2019d). Furthermore, the absence of transfer mechanisms between Eurozone countries, and the constraining mandate given to the European Central Bank (ECB) in the treaties, allowed interest rates on sovereign loans to spiral out of control in the debt-ridden PIGS countries[3], thus increasing the imminence of default. As such, the exogenous nature of symmetry and flexibility, and the absence of transfer mechanisms to compensate for imbalances, appear to have played a major role in the financial disaster that the Eurozone has endured throughout much of the past decade.

More recent theorising on optimum currency areas (OCA) suggests that symmetry is irrelevant to whether a currency area may be considered optimal. Adherents of this perspective allege that regions within a currency area can never become perfectly symmetrical, and that such a situation would not be desirable anyway, as asymmetries may

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[1] The concept of macroeconomic asymmetries concerns everything from differences in economic structure (e.g. sector sizes, degree of state involvement) to disparities in macroeconomic indicators (e.g. inflation, natural rate of unemployment, output cycles).

[2] In conventional OCA theory, flexibility encompasses not only labour, but wages as well. However, since the common monetary policy removes the option of adjusting wages by way of currency devaluation, any wage flexibility would have to be carried out through either inflation (in other countries) or wage deflation. Since inflation has been virtually non-existent, or even negative in many countries throughout much of the crisis (Eurostat, 2019c), and since wage deflation is a painful, slow and aggravating process (Krugman, 2012: 168–170), the wage flexibility criterion is not applicable to the Eurozone.

[3] PIGS is an acronym for Portugal, Italy, Greece and Spain.

work as a hedging mechanism provided the area is adequately integrated in terms of monetary and fiscal policy (Schelkle, 2013). In addition, labour flexibility is thought of as hopelessly inadequate, in the sense that it can never relocate enough workers to balance for asymmetric crises (ibid.). As such, adherents of this variation allege that integration and transfer mechanisms constitute the sole determinant of whether a currency area is optimal (ibid.).

The crisis exposed flaws in the Eurozone architecture – flaws which are very much in line with the predictions of conventional OCA theory, regardless of whether asymmetry is impossible and/or labour flexibility inadequate. Yet even though conventional OCA theory predicted divergence in real exchange rates, competitiveness and interest rates on sovereign debt, that does not explain why the ensuing crisis was followed by a sharp decline in Greece's *worker productivity*[4]*;* since 2008, the country's average worker productivity has fallen by around 10% (OECD, 2019a). A contributing factor to this dynamic could be that there exist disparities in worker mobility *within* national populations (Cenci, 2015; Dustmann & Frattini, 2014; Labriandis, 2014); a possibility which is disregarded by the flexibility criterion as operationalised in the three OCA variations.

In short, much of the discussion on OCA theory assumes that flexibility is either a convergence-inducing, or a convergence-neutral phenomenon; that is, a phenomenon which offers at worst *no* value in bracing the EMU for future crises, and which in any case does not induce divergence. This is a rather shallow analysis of the nature of flexibility, as it assumes that there are no internal disparities in migration opportunities *within* national populations, which evidence suggests that there are (Dustmann & Frattini, 2014; Labriandis, 2014). In effect, this is a denial of the *asymmetric nature of flexibility*, and thus of the adverse effects that asymmetric migration patterns might have for the Eurozone (ibid.). The inadequate attention paid to the implications of asymmetric flexibility for productivity growth, especially in times of crises, constitutes a significant research gap which mandates further exploration: Are there adverse aspects to flexibility which are not visualised through the OCA criteria, and if so, could these aspects explain Greece's worker productivity decline since the onset of the crisis?

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[4] Worker productivity is defined as *real GDP per hour worked* (OECD, 2019a).

1.1. Aims & research question

The aim of this study is to fill the research gap outlined above by investigating the reasons for the progression of Greece's worker productivity in the aftermath of the euro crisis. In short, while existing research accounts for the dynamics which induce divergence of real exchange rates, competitiveness and interest rates on sovereign bonds, this does *not* explain why Greek workers have grown *less* productive on average since 2008 (OECD, 2019a). The inability of existing research to account for this peculiarity is problematic, as Greece's productivity decline could imply that *structural divergence is intrinsic to the Eurozone's current architecture*. Considering that the lion's share of existing research ascribes much of the recent financial disaster to the Eurozone's internal asymmetries and institutional inadequacies (see section 2), Greece's worker productivity decline constitutes an important research topic.

Notwithstanding that there exist a wide array of factors which affect worker productivity rates, the determinant at issue in this study is *human capital.* Human capital is paramount in determining the total productivity of factors in any economy, and is also the only of the neoclassical growth determinants (see Todaro & Smith, 2015: 137–140)[5] which is likely to have declined as a result of the crisis. Indeed, evidence suggests that none of the other neoclassical determinants – the ratio of physical capital per worker, the optimal capital intensity, the institutional quality or general technological advancement – declined amid the financial meltdown (Bank of Norway, 2013; Briegel, 2015). It is possible, however, that the deterioration of macroeconomic conditions brought by the crisis induced a decline in Greek worker productivity because it intensified the outflow of qualified workers from Greece. Thus, in the words of OCA theory, the subject at issue in this study is to what extent the euro crisis induced *indirect transfers in the form of human capital* from Greece, and to what extent such a development may explain Greece's declining worker productivity since 2008. The research question reads as follows:

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[5] The neoclassical growth equation (or the Solow growth model) is often expressed as $Y^* = \bar{A}k^{\propto}L^{1-\propto}$, where $\bar{A}$ is total factor productivity (technology, institutions and human capital), $k^{\propto}$ denotes the rate at which physical capital generates productivity growth (presuming accumulated net investment=capital) and Y^* is the equilibrium output (Todaro & Smith, 2015: 137–140). Note that this equation conventionally refers to long-run output. It may however be used as a reference point for investigations relating to short-run output fluctuations as well.

Did the euro crisis initiate an intensification of the outflow of human capital from Greece, and if so, to what extent can this outflow account for the country's declining worker productivity since 2008?

2. Overview of existing theoretical contributions & empirical research

In the following sections, existing research on OCA theory and Eurozone convergence/divergence is discussed at length. The discussion starts off by outlining three variations of OCA theory, and then proceeds to closely examine empirical evidence on the accuracy of these variations. Thereafter, attention is directed toward the flexibility criterion, particularly whether asymmetric flexibility appears likely to impact productivity rates. Finally, focus is shifted to the possibility that these asymmetries could be "triggered" by asymmetric shocks.

2.1. The evolution of optimum currency area theory

In September 1961, Robert A. Mundell published the article "A Theory of Optimum Currency Areas" in American Economic Review. As the title suggests, the article presents a theory on what criteria an area needs to fulfil to be able to form a well-functioning currency union. Essentially, Mundell's argument can be boiled down to two main criteria: *symmetry* and *flexibility*. Different regions within the area should have similar economic structure and synchronized business cycles, and to compensate for asymmetries, the flexibility, especially for labour power, needs to be high within the area (McKinnon, 1963; Mundell, 1961). In short, the rationale for the flexibility criterion is that a high rate of labour mobility allows for any surplus labour to be smoothly allocated to the parts of the currency area where it is most needed (Mundell, 1961). As such, flexibility may function as a substitute for symmetry in times of crises, at least in theory, as workers who lose their jobs may simply relocate to areas where demand for labour is higher. This supposed relationship between symmetry and flexibility can be illustrated as follows:
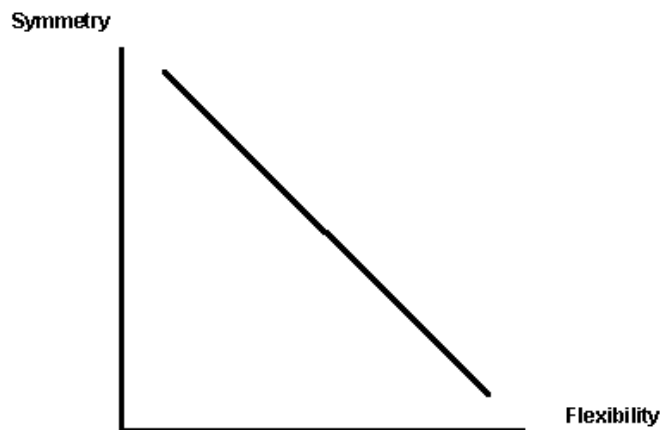
Model 2.1.1. (de Grauwe, 2006).

A few years after Mundell's paper had been published, the theory was elaborated by Peter Kenen (1969), who added a third criterion: asymmetries within a currency area cannot be eradicated by high flexibility alone – *transfer mechanisms and integration* are also required to counter the effects of asymmetric shocks. Essentially, Kenen's concept encompasses various forms of risk integration, such as fiscal transfers and institutional risk-sharing. One concrete example of how risk integration enhances the stability of a currency area is to do with what the Belgian economist Paul de Grauwe (2012) refers to as the *fragility hypothesis.* Countries in a currency union are inherently vulnerable to investors' "animal spirits"[6], as any sovereign debt they take on is bound to be denominated in a currency which they do not autonomously control. What this means is that they cannot resort to printing money if their debt situation deteriorates, thus implying that there is a real risk of default. Moreover, this risk is arguably a self-fulfilling prophecy, as investors' worries are bound to translate into higher interest rates, thus increasing the risk that countries' credit situations derail (ibid.). If a currency union's constituent countries would either integrate their sovereign debts, or give the central bank the role of lender of last resort, this situation could presumably be avoided, as it would effectively

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[6] The concept of "animal spirits" was coined by John Maynard Keynes (2018: 161–162), and concerns consumers' propensity to allow emotions and instincts to guide their economic behaviour.

neutralise the risk of default[7]. Against this background, the supposed relationship between symmetry and institutionalised transfer mechanisms can be illustrated as follows:
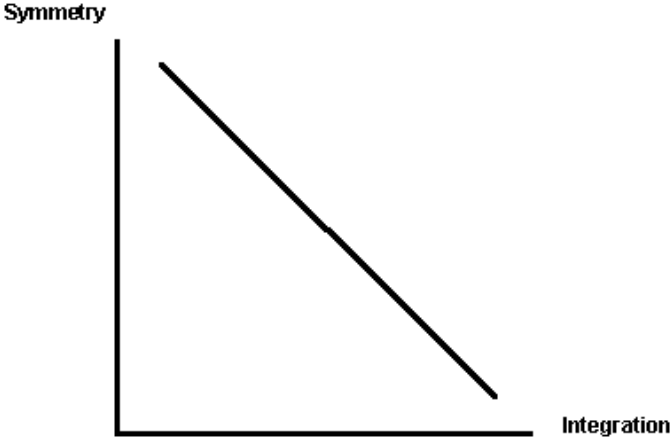
Model 2.1.2. (de Grauwe, 2006).

The view that flexibility and transfer mechanisms are required for a currency union to be optimal is disputed by adherents of so-called *endogenous optimum currency area theory*. Proponents of this perspective, notably Frankel and Rose (1998), claim that asymmetries are not a problem, since the area's constituent parts are bound to start converging as soon as a common currency is introduced; that is, the OCA criteria are alleged to be *endogenous to monetary integration*. Among other things, adopting a common currency is assumed to inevitably induce an increase in trade and capital flows between the currency union's constituent countries, and thereby spur economic growth, increase governments' tax bases, and ultimately result in overall stronger public finances (ibid.). Additionally, a common currency is alleged to greatly facilitate transnational business, as the absence of exchange rate fluctuations reduces uncertainty (Fingleton et al., 2015; Wagner, 2014). As such, countries need not be symmetrical nor flexible for a currency union to be economically beneficial, as market dynamics will gradually induce macroeconomic convergence and labour flexibility

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[7] The proposal of collateralised sovereign debt is politically complicated, as it would imply that the consequences of excessive public spending by one country affects the entirety of the currency union equally. Hence, such debt integration must likely be accompanied by some form of budgetary integration (de Grauwe, 2012).

automatically. This idea may be illustrated as follows:
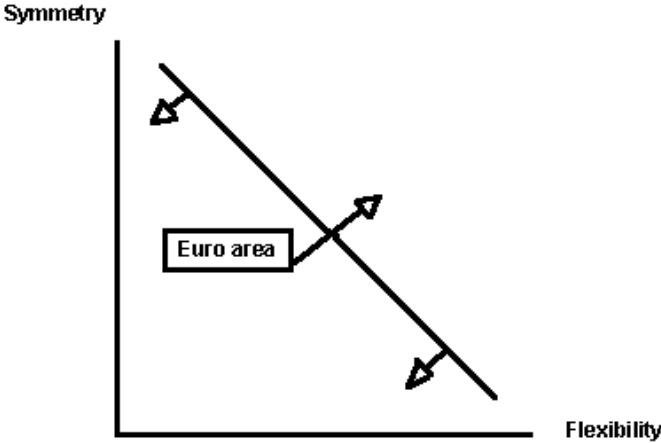
Model 2.1.3. (de Grauwe, 2006).

More recent theorising suggests that the first two criteria, symmetry and flexibility, contribute little to the body of knowledge on optimum currency areas. Firstly, perfect symmetry is alleged to be unachievable (Schelkle, 2013); an assumption which is backed up by the continued diversity of regions in the United States[8] (Arpaia et al., 2016). The difference between the Eurozone and the US, these researchers argue, is not to do with symmetry, but with transfers and integration. Indeed, provided a currency area practices interregional fiscal transfers and has an integrated central bank system with a far-reaching mandate (like the Federal Reserve), asymmetries may even work as a hedge against risk, as they prevent all parts of the currency area from receding simultaneously (de Grauwe, 2012; Schelkle, 2013). Secondly, flexibility is alleged to be inadequate, as non-economic factors such as language barriers and cultural frictions make it highly unlikely that workers would migrate on a scale sufficiently large to offset such high unemployment rates as those observed over the course of the euro crisis (Ghoshray et al., 2016; Schelkle, 2013). As such, transfer mechanisms and

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[8] In 2013, approximately 30% of the US population lived and worked in a state other than the one in which they were born. While this figure is significantly higher than for the EU (5%), it is not sufficient to offset the effects of a severe asymmetric shock (Arpaia et al., 2016; Schelkle, 2013).

integration is alleged to constitute the single most important parameter in analysing currency areas, including the EMU.

Since the EMU is an unparalleled monetary experiment, most empirical evidence on the veracity of the OCA variations relate to the Eurozone crisis. The events of the crisis hold valuable lessons for monetary economics, and staunchly indicate that the OCA criteria are in fact very much *exogenous* to monetary integration. Regardless of the alleged impossibility of symmetry and inadequacy of flexibility, this suggests that the concern of conventional OCA theorists is well-founded.

2.2. The events of the euro crisis in relation to OCA theory

Applied to the euro system, conventional OCA theory (Kenen, 1969; MacKinnon, 1963; Mundell, 1961) proposes that the architecture of the EMU is bound to instigate divergence in terms of competitiveness and thereby induce immense current account imbalances and crisis vulnerabilities. According to this line of argument, employing a common nominal interest rate for a set of countries with disparate rates of inflation implies an array of problems.

Firstly, since the ECB's interest rates[9] must regard the inflation rates of all constituent economies, they are certain to be too high for countries with relatively low inflation (such as Germany), and too low for countries with relatively high inflation (such as Greece). In accordance with the Fisher equation $R = i - \pi$, this means that the real interest rate R (the nominal rate i subtracted by inflation π) will fall below zero in the countries with the highest inflation (de Grauwe, 2006). Since this is bound to induce a sharp fall in the price of credit, aggregate demand will become artificially high, and the creation of bubbles will become more likely (Krugman, 2012: 177–184).

Secondly, the combination of free capital movement and the opportunity of lending money at comparatively high rates in countries with high inflation will lead lenders to flock to these countries, thus further driving down the real cost of borrowing (ibid.). Thirdly, as the access to cheap credit stimulates aggregate demand, inflation will eventually accelerate, thus

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[9] The ECB operates three different key interest rates; the deposit facility, which determines the rate which banks are paid on their overnight deposits in the Eurosystem; the marginal lending facility, which determines the rate at which banks may borrow from the Eurosystem; and the main refinancing operations interest rate, which sets out the rate at which the ECB provides liquidity (ECB, 2019).

damaging the concerned economies' competitiveness and undermining domestic production, ultimately making the countries increasingly reliant on foreign credit (ibid.). This leads the currency union to become extremely vulnerable to economic shocks, as a fall in asset prices in one of the indebted countries may easily lead borrowers' repayment prospects to deteriorate, thus inflicting huge losses on the banks and threatening the very stability of the corresponding countries' financial systems. These predictions are a rather accurate account of how the Eurozone economies' internal asymmetries paved the way for a devastating asymmetric crisis once the housing bubble burst in the United States in 2007-08.

2.2.1. The symmetry criterion

Pre-crisis data suggest that the real exchange rate of Eurozone economies (based on inflation-adjusted unit labour cost[10]) diverged consistently after the common currency had been introduced. Indexed to 1998-levels, the real exchange rate of Germany had fallen by around 10% by 2005, whereas the real exchange rate of Greece had appreciated by 15% (de Grauwe, 2006). As one would expect, this led to deteriorating current account balances, and eventually made the continued welfare of Greece reliant on foreign credit (Schelkle, 2013). Additionally, the access to cheap credit led to vast increases in household debt. Indeed, between 2000–2006, Greece's household debt-to-GDP ratio rose by 400%, from 10 to 50% of GDP (Trading Economics, 2019a). What is more, since most of this debt was denominated in a currency which the country's central bank lacked autonomous control over (the euro), it was unable to relieve the situation by printing money and buying the debt up. This led household debt-to-GDP to rise even after the crisis broke out, as GDP fell while debt was only slowly payed down (ibid.). These increases in household debt correspond well with the progression of housing prices in Greece between 2000–2018, which rose by as much as 200%, and proceeded to crash below pre-euro levels as the crisis unfolded (CEIC, 2018; Trading Economics, 2019b). While this data only presents a fraction of what happened to the Eurozone over the course of the crisis, it offers an accurate picture of how the Eurozone's asymmetries polarised imbalances throughout the currency area, and how baneful these imbalances turned out to be when the crisis hit (for a discussion on the role of sovereign debt, see section 2.2.3.).

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[10] Unit labour cost concerns the cost per unit produced. A high unit labour cost implies higher market prices, and vice versa (de Grauwe, 2006).

2.2.2. The flexibility criterion

As macroeconomic conditions deteriorated in Greece after 2008, unemployment rates soared, especially among young adults. Indeed, in 2013–14, unemployment stood at around 60% among young adults, and 30% in total (Ghoshray et al., 2016). What is more, much like Schelkle (2013) asserts, labour flexibility appears to have been inadequate throughout Europe, as a mere 5% of the EU population lived and worked outside their country of birth in 2013, despite the astonishingly high unemployment rates[11] (Ghoshray et al., 2016). In previous research, insufficient educational attainment, cultural barriers and insufficient language skills have been identified as possible explanations for the seeming inability (or unwillingness) of workers to leave their countries of birth to seek employment abroad (Gill, 2005; Stiglitz, 2016: 134–135). As such, contrary to the assertions of endogenous OCA theorists (such as Frankel & Rose, 1998), labour flexibility, much like symmetry, appears to be *exogenous* to monetary integration.

2.2.3. The "transfer mechanisms and integration" criterion

In 2009, it was revealed that the Greek government had consistently been manipulating its balance sheets, and that there was a big hole in the country's budget (largely induced by the imbalances described above). At the same time, the country suffered from a deep recession, and GDP was rapidly declining (Eurostat, 2019a). Amid this development, investors' confidence in Greece's capability to finance its commitments plunged, and the interest rates on its sovereign bonds skyrocketed, all the while the country's financial system was crumbling (Krugman, 2012: 195–207). Eventually, Greece lost access to international financial markets, and was forced to ask the "Troika" (the IMF, ECB and European Commission) for emergency loans (Copelovitch et al., 2016). In exchange for receiving these loans, Greece agreed to adopt harsh austerity measures with the intention of restoring investor confidence and bringing interest rates back down. However, the effect was the opposite. The combination of deep recession and severe fiscal austerity degenerated into disaster, as it caused aggregate demand to fall, unemployment to rise and the country's tax base to sharply diminish (Shambaugh, 2012). Conventional OCA theory would suggest that this development was inevitable without adequate integration and transfer mechanisms (de Grauwe, 2006; Kenen, 1969; Mundell, 1961). Essentially, the risk of default played a large role in driving up

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[11] It is worth mentioning that the poor macroeconomic conditions in other EU countries could serve as an explanation for the dismal labour flexibility.

interest rates, and in accordance with the fragility hypothesis (see section 2.1.), this would not have happened had there existed a lender of last resort, or a commitment from other Eurozone states to guarantee the creditworthiness of the Greek government. Similarly, had it not been for these institutional inadequacies, Greece would not have lost access to financial markets, and would thus have been able to employ fiscal expansion to jump-start the economy[12]. As such, evidence indicates that flaws in the edifice of the euro system – the ECB's confining mandate and the absence of fiscal integration – is what enabled the Greek economy to descend into free-fall.

2.2.4. Does the common currency induce economic divergence?

In relation to the empirical findings presented above, it seems rather clear that the common currency has not induced convergence among its constituent economies, thus suggesting that the idea that the OCA criteria are endogenous is misguided. On the contrary, it appears the countries' economies have actually diverged in terms of several macroeconomic indicators since the euro was launched, some examples being competitiveness, current account (im)balances and sovereign debt spreads. As such, regardless of whether symmetry is impossible and flexibility inadequate, conventional OCA theory seems to contain valuable insights about the dynamics of the Eurozone.

Nevertheless, there is at least one aspect of the crisis which conventional OCA theory cannot account for: *the progression of worker productivity rates*. While worker productivity rates have grown at a sluggish pace in most EU countries since the crisis broke out, Greece's productivity has actually *declined* significantly since 2008. This is an extraordinary development; while the symmetry criterion predicts divergence on competitiveness, it does not explain why Greece's worker productivity has fallen in the aftermath of the crisis.

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[12] Fiscal jump-starts were employed to varying extents by several countries, the United States among them (Krugman, 2012: 116).

Diagram 2.2.4.
PIGS countries: real GDP per hour worked (index: 2010=100)
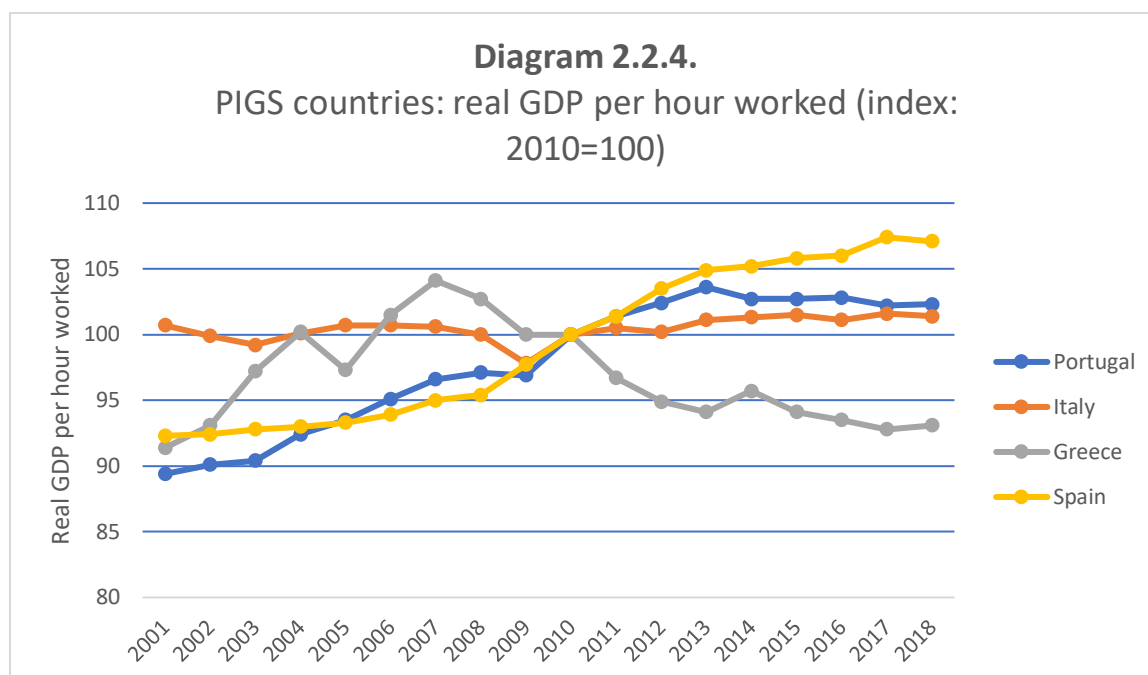
Source: OECD (2019a).

Diagram 2.2.4. displays the progression of worker productivity in the PIGS countries since 2001. The four countries were all devastated by the crisis, however, Greece is the only country which has seen a consistent worker productivity decline since 2008, and indeed, the only country with a current worker productivity rate below 2010-levels. These figures indicate that something is amiss in the case of Greece.

2.3. Why Greece's worker productivity decline?

In order to discern what has happened to Greece's worker productivity since the euro crisis, one must first consider what drives productivity growth. The neoclassical growth model, a widely-used reference point in economic growth research, proposes that real GDP per capita growth (i.e. productivity growth) is best described as a complex feedback-relationship between institutional quality, capital investment rates, technological sophistication and human capital resources[13] (Todaro & Smith, 2015: 137–140). In short, an economy's worker productivity is expected to grow if institutions are solid, consumers well-educated and investments rates sufficiently high to allow physical capital to become more plentiful and more efficient.

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[13] The neoclassical growth model also includes labour force size (Todaro & Smith, 2015: 138). However, since this study concerns worker productivity rates, labour force size is not discussed.

Upon a closer look at these determinants, one may rule out the prospect that Greece's worker productivity decline is to do with physical capital (e.g. machinery, vehicles etc.), technological sophistication or institutional quality, simply because empirical findings suggest that it is implausible that Greece's institutions and/or physical capital stock somehow grew worse as a result of the crisis. Indeed, evidence suggest that the regression coefficient for the relationship between GDP change and institutional development[14] in the period 2010–2013 is near 0, and not even statistically significant (Briegel, 2015). Similarly, the capital intensity of Greece actually increased by 1,3% between 2008–2012, thus ruling out that the declining worker productivity stems from physical capital deterioration (Bank of Norway, 2013).

Human capital, however, is a mobile productivity factor which has a direct impact on the average worker productivity of any economy. In short, a doctor produces a service which is highly valued, which means that doctors usually contribute more to GDP than, say, factory workers[15] (Fingleton et al., 2015). As such, a net outflow of high-productivity workers should have a negative effect on average worker productivity. Interestingly, however, neither of the three OCA variations included in this study investigate the possibility that the flexibility criterion could be inherently asymmetric; that is, that workers' mobility could differ depending on variables such as educational attainment (Cenci, 2015; Gill, 2005).

Considering the large body of research on the *brain drain* phenomenon, it appears that labour flexibility is indeed asymmetric (ibid.). For example, Labriandis (2014) finds that a disproportionate share of those who have left Greece to work elsewhere within the EU in recent years are tertiary educated, and that their primary destinations have been London and Brussels. This is corroborated by Dustmann and Frattini (2014), who conclude that the average age of migrants from EU15 countries to the United Kingdom between 2007–2011 was 27, and that 62% of them held university degrees. As such, it appears quite evident that worker mobility within the EU single market is to some extent characterised by asymmetric flexibility, and that a person's flexibility is indeed determined by factors such as educational

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[14] For a detailed account of what institutional quality/development entails, see Briegel (2015).

[15] The contribution to GDP of higher productivity workers is both direct and indirect in nature. The direct impact accords with the dynamic described above, while the indirect impact is that the doctor's higher salary stimulates aggregate demand by way of higher spending, investment etc.

attainment[16]. However, it remains unclear how asymmetric flexibility responded to the euro crisis, particularly whether the euro crisis constitutes a *structural break* which intensified the human capital outflow from Greece, and whether this explains the puzzling progression of Greece's worker productivity since 2008.

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[16] Eurostat data (2018) suggests that there is an exceedingly strong correlation between education and language abilities; the more educated a person is, the better their language skills. As such, language abilities are taken to be intrinsic to educational attainment.

3. Theoretical framework

The theoretical framework of this study draws upon the neoclassical account of economic growth (see Todaro & Smith, 2015: 137–140), which alleges that the productivity of an economy is determined by human capital, physical capital, technological sophistication and institutional quality. The fact that the subject at issue in this study is worker productivity *decline* rather than *growth* simplifies the task of discerning which determinant ought to be responsible for Greece's predicament. In short, previous studies find no evidence that the euro crisis brought about a deterioration of physical capital or institutions (Bank of Norway, 2013; Briegel, 2015), thus leaving human capital as the sole remaining determinant. What is more, since human capital is inherently mobile, it is plausible that the progression of Greece's worker productivity in recent years stems from an intensified outflow of qualified workers.

However, if human capital outflows constitute the causal mechanism that has depressed Greece's productivity over the past decade, emigration from the country must have consistently been asymmetric in nature, as a symmetric outflow of workers would have had no impact on average worker productivity[17]. As Labriandis (2014), Cenci (2015) and Dustmann and Frattini (2014) demonstrate, intra-EU labour migration appears to adversely select the educated, thus implying, contrary to the assumptions of the three OCA variations discussed in the previous chapter, that labour flexibility could be a *shock exacerbating phenomenon.* As such, the theoretical relationship between the euro crisis (the independent variable) and Greece's worker productivity decline (the dependent variable) is mediated by human capital transfers (the mediating variable), which occur due to asymmetries in flexibility within the Greek population. This hypothetical relationship may be illustrated as follows:

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[17] In short, if a country has 100 workers who produce a value of 10, 100 workers who produce a value of 5 and 100 workers who produce a value of 3, and then goes on to lose 10 workers of each kind, the mean productivity of the labour force remains unchanged.
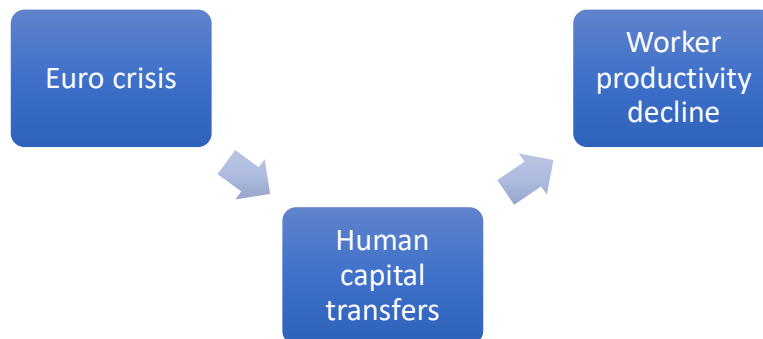
There is one major issue with this causal model. The fact that most countries have some degree of employment protection means that employers often cannot lay off workers as they would like. This means that as the business cycle turns sour, firms' labour intensity would be expected to remain close to the level which was optimal before the crisis, but which is too high after the crisis has struck. As such, it would be natural for recessions to be accompanied by declines in worker productivity. This would suggest that there is an implicit bias between the independent variable (the euro crisis) and the dependent variable (worker productivity). Fortunately for the academic value of this thesis, however, this arguably does not apply to post-crisis Greece.

In exchange for the bail out loans, the Greek government pledged to impose harsh austerity measures on every aspect of the Greek economy – from welfare spending to labour market regulation (Fingleton et al., 2015). As such, employment protection was effectively removed as the crisis unfolded, and employers were therefore allowed to lay off workers at will (Kennedy, 2018). Obviously, this variable is potentially distortionary, and must therefore be controlled for. Theoretically, this control may be described as follows.

When employers decide how many workers to hire, they do not consider worker productivity, but the closely related (but not identical) concept of *competitiveness*. Essentially, the difference is that whereas worker productivity measures production value per unit of *time,* competitiveness evaluates worker productivity with respect to *cost.* Employers ought to be

unconcerned with the pace at which workers produce, as they could simply employ more workers provided the *cost per unit produced* is not too high. Thus, it is competitiveness, not worker productivity, which is tied to real GDP decline. Naturally, this means that one may control for this implicit bias by separating worker productivity from worker cost by employing *unit labour cost* as a second independent variable in the regressions; if unit labour cost went down after 2008, then that means labour intensity in the Greek economy actually grew *more* optimal as a result of the crisis. If this is the case, the bias has effectively been controlled for (see chapter 4 for a detailed account of this).

Finally, it should be noted that the causal relationship can only be applied to worker productivity *decline*, and that it therefore cannot be employed to establish productivity *divergence*. Essentially, worker productivity growth can stem from any of the neoclassical growth determinants, whereas a decline in worker productivity, for the reasons mentioned above, could not plausibly result from any determinant other than human capital. Moreover, it should be noted that this is a macro-oriented theoretical framework which is not intended to empirically investigate the incentives behind people's migration, simply because the available data is not up for that task. Such an investigation would require bespoke survey data, and is therefore left as a subject for future studies. Instead, the euro crisis is assumed to strengthen citizens' incentives to migrate by way of deteriorations in public services, life opportunities and general social order.

3.1. Hypotheses

The theoretical model outlined above illustrates how the crisis may have initiated a consistent worker productivity decline in Greece by way of intensifying the outflow of human capital from the country. In accordance with the model, the study's hypotheses and null-hypotheses read as follows:

H1: The euro crisis caused Greece's average worker productivity to decline.
H01: There is no significant correlation between the euro crisis and the decline of Greece's average worker productivity.

H2: The decline did not stem from a decrease in competitiveness.

H02: The evidence is not sufficient to rule out that the decline stemmed from a decrease in competitiveness.

H3: The worker productivity decline was to a significant extent mediated by an intensified outflow of tertiary educated workers from Greece to other EU countries.

H03: The worker productivity decline does not appear to have been mediated by an intensified outflow of tertiary educated workers from Greece to other EU countries.

As such, the expected findings of the study are that there is a strong correlation between the onset of the Eurozone crisis and worker productivity decline in Greece, and that this productivity decline stems from human capital transfers rather than deteriorations in unit labour cost.

4. Methods & data

This section outlines the study's research design by presenting and discussing data, methods of analysis, measurements and methodological limitations.

4.1. Method of analysis

The empirical analysis of this study consists of three separate groups of *time-series regressions*: One which investigates the correlation between the independent variable and the dependent variable (regression group A); one which investigates the correlation between the independent variable and the mediating variable (regression group B); and one which investigates the correlation between the mediating variable and the dependent variable (regression group C). In addition to the core variables of the study, the control variable *unit labour cost* (see section 4.3.4.) is included in regression group A to control for the possibility of an implicit bias between the independent variable and dependent variable.

Furthermore, this research design only isolates the effect of human capital on worker productivity in years when the latter *declined*. Thus, the years in which worker productivity increased are likely to be less accurately measured than those in which worker productivity declined. To remedy this problem, all groups include separate regressions for 1995–2018 (the entire time-period), 1995–2008 (pre-crisis, when worker productivity generally increased) and 2008–2018 (post-crisis, when worker productivity generally declined). If there are observable differences in the results of the regressions on 1995–2008 and 2008–2018, one may suspect that the results of the former are confounded by biases which are not eradicable with the current research design, and that the crisis constitutes a structural break which redefined the relationship between the included variables.

Moreover, regression groups B and C include models with time-lags, the aim being to aggregate the effects of multiple years and investigate whether this impacts the regression results (rationales for lagged regression models are provided in sections 4.2. and 4.3.2.). In order to facilitate the employment of these lags, all regressions regard *levels of* rather than *changes in* variable values. All regressions are performed using the statistics programme Stata 15.

4.2. Data

The data set used in this study consists of bits and pieces from various well-known databases, namely Eurostat and the OECD. Eurostat, the statistics body of the European Union, compiles and processes data on behalf of EU member states on a wide range of variables, including *real GDP*, which is the operationalisation of this study's independent variable. Similarly, the OECD collects data on all matters relating to its member states' economies, and the organisation's database thus includes statistics on Greece's real GDP per hour worked and unit labour cost (the operationalisations of the dependent variable and control variable). All data in Eurostat's/OECD's databases has been compiled using standard macroeconomic accounting methods (Baldacci et al., 2016; OECD, n.d.). Details regarding these methods are outside the scope of this thesis; however, it is worth stressing that the data has been compiled in an uncontroversial fashion which ensures high reliability. The data for all three variables is updated with new figures every quarter.

The data for human capital transfers (tertiary educated Greeks residing in other EU countries) comes from the EU LFS; a household survey which consists of a range of labour-related questions, and which is carried out by Eurostat on a quarterly basis[18] (meaning that the annual data is updated with new statistics every quarter). *Inter alia*, respondents are asked to indicate their level of educational attainment, the country in which they reside, and the country of which they are citizens (Eurostat, 2019b). The respondents of interest in this study are Greek citizens who are tertiary educated (levels 5–8 on the ISCED scale[19]), and who reside in another EU country. The sample size for Greece is rather large; between 30 000 and 40 000 households (approximately 75% response rate), which make up about 1% of the country's total population. Moreover, the sample reflects that many attributes are unlikely to be normally distributed among the Greek population by accounting for disparities relating to age (between 15–65), sex, socioeconomic status and whether the respondent lives in a rural or urban area (Eurostat, 2015). All respondents participate in the survey for six quarters in a row, and are thereafter replaced. As such, one sixth of the sample is replaced every quarter (ibid.).

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[18] The national surveys which make up the EU LFS are carried out by national governments. The national governments also prepare the sample and questionnaire; however, the data is processes by Eurostat. The countries included in the survey are the EU28, the EFTA states and several candidate countries.

[19] The ISCED scale is maintained by UNESCO, and the acronym stands for International Standard Classification of Education. The nine classifications on the 2011-scale are: early childhood education (0); primary (1); lower secondary (2); upper secondary (3); post-secondary but non-tertiary (4); short-cycle tertiary (5); bachelor (6); master (7); doctoral (8).

Annual data is used for all variables, meaning that the observations (1995–2018) are rather few. Quarterly or biannual data could have been used instead. However, there is a significant risk that such short intervals could compromise the regressions, as it is doubtful that tertiary educated workers respond to changes in real GDP quickly enough for quarterly or biannual data to capture the causal model that this study seeks to test (this is also one rationale for the employment of time-lags). As such, annual data is the best available option, notwithstanding that too few observations could be problematic with respect to statistical significance. Finally, all variables except human capital transfers have been *indexed to 2010-levels* to facilitate the interpretation of the regression coefficients.

4.2.1. Omitted data

By Eurostat's own account, the EU LFS observation for 1998 is of poor reliability (Eurostat, 2019d), and it has therefore been omitted in its entirety.

4.3. Operationalisations and univariate statistics

This subchapter describes how the variables have been operationalised, and presents univariate data on each variable. Conveniently, all the operationalised variables are on an interval scale, and are therefore easily employable in regression analyses.

4.3.1. Independent variable – the euro crisis (real GDP)

Drawing on the conventional definition of a recession as a situation in which GDP declines two quarters in a row, the independent variable – the euro crisis – is operationalised as *real GDP*. Since there exists a rather unambiguous definition of which criteria an economic downturn must fulfil to be considered a recession, this operationalisation is rather uncomplicated with respect to validity. In terms of univariate statistics, real GDP in Greece between 1995–2018 progressed as illustrated in the diagram below. The essential point to note here is the enormous decline after 2008[20].

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[20] The measure used to compute real GDP here is called chain-weighting. Essentially, chain-weighted GDP does not only account for price changes based on a static Consumer Price Index (CPI); it also accounts for any changes in consumer choice/spending which price changes may induce (see Jones, 2018: 32–33).

Diagram 4.3.1.
Greece real GDP (Index 2010=100)
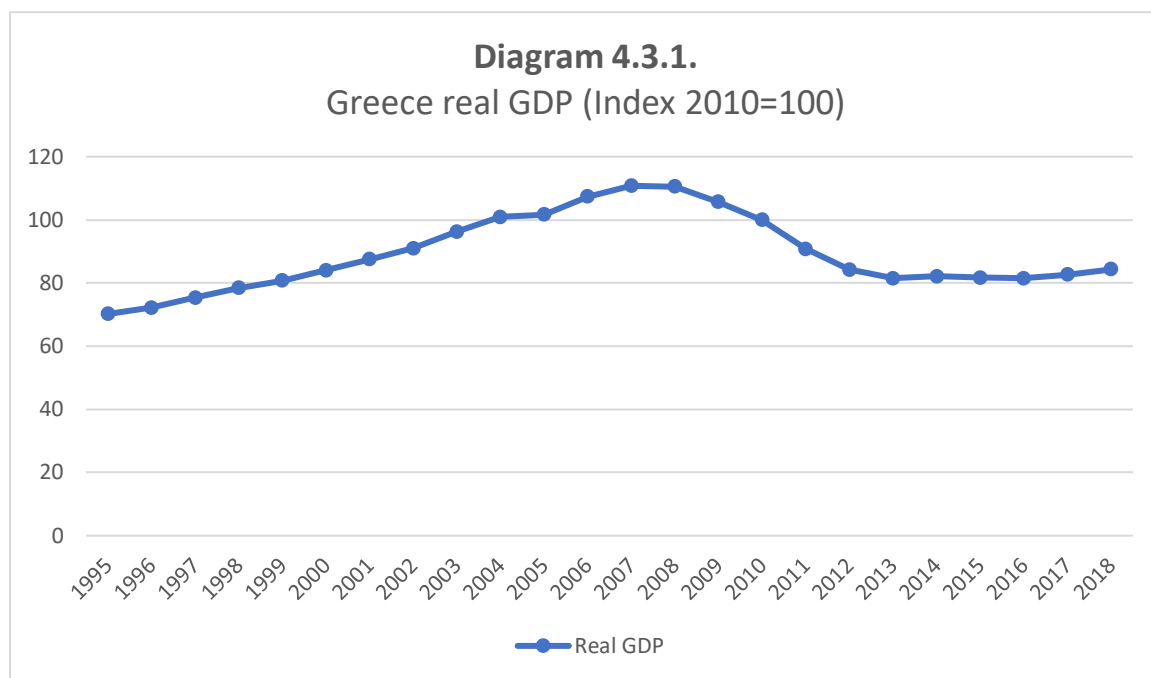
Source: Eurostat (2019a).

With respect to reliability, there is at least one problem, namely that the timeframe within which emigrants' respond to real GDP decline might differ. To resolve this issue, regression group B is run with time-intervals of two, three and four years, in addition to the "plain" models with 1-year intervals.

4.3.2. Dependent variable – worker productivity (average real GDP per hour worked)

Worker productivity is operationalised as *average real GDP per hour worked*; that is, the mean real value generated by one hour of labour throughout the Greek economy. This is a bias-prone variable, as worker productivity is affected by many economic inputs, notably physical capital, institutional quality and human capital. As discussed in chapter 2, the variables of institutional quality and physical capital may be ruled out by reference to existing empirical research, thus leaving human capital as the sole remaining main determinant. In terms of validity, there exists one major problem with this operationalisation, namely that it might be inherently connected to real GDP. This problem is resolved through the employment of unit labour cost as a control variable (see section 4.3.4. for a closer account). Univariate data for real GDP per hour worked looks as follows.

Diagram 4.3.2.
Greece GDP per hour worked (Index: 2010=100)
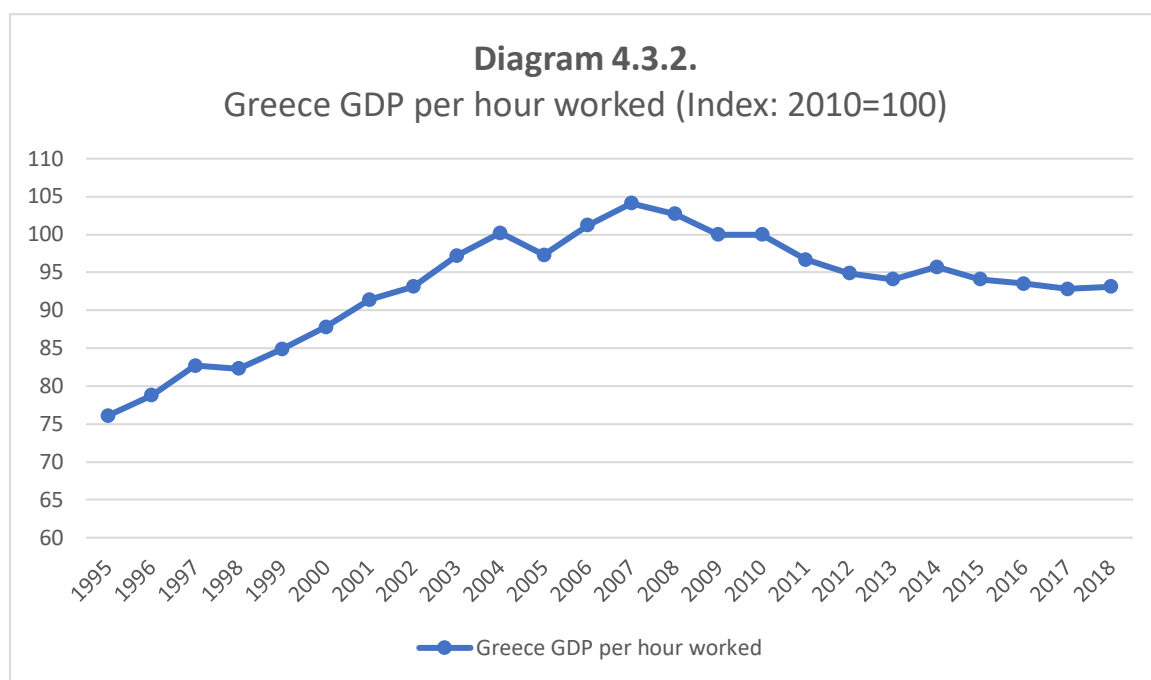
Source: OECD (2019a).

It should be noted that this operationalisation is subject to at least two limitations: 1) that tertiary educated migrants who were unemployed when they emigrated are not included in the data; and 2) that it does not regard that real GDP per hour worked varies greatly between different professions, ranks etc. The first limitation ought to be of marginal significance, as unemployment rates among tertiary educated workers have consistently been much lower than among the population at large (Cenci, 2015). With respect to the second limitation, however, the situation is more precarious. Essentially, the market values of different goods and services produced by tertiary educated workers vary markedly; a fact which puts into question the validity of designating all tertiary educated workers as "highly (and equally) productive". While it is indisputable that education is a watershed parameter when it comes to real GDP per hour worked[21], the vast disparities within the group (ISCED 2011 5–8) could distort the regressions if emigration is not consistently proportional across the economy. For example, the outflow of tertiary educated workers in year B might be greater in total than the outflow in year A. However, if year A sees a disproportionately large outflow of workers in, say, the financial industry, the decline in real GDP per hour worked could be greater in year A than in year B, regardless of year B's greater emigration volumes. To control for this potential

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[21] Educational attainment is frequently used by researchers as an operationalisation of worker productivity (ex. Cenci, 2015; Labriandis, 2014; Dustmann & Frattini, 2014).

bias, regression group C is run with time-lags of two, three and four years in addition to the "ordinary" 0-lag (i.e. 1-year interval) regressions[22], the rationale being that emigration is less likely to be skewed over the course of several years compared to over the course of just one.

4.3.3. Mediating variable – human capital transfers (Greek tertiary educated citizens residing in other EU countries)

The mediating variable – human capital transfers – is operationalised as *Greek tertiary educated citizens residing in other EU countries*. This operationalisation is less straight forward than the ones for the independent and dependent variables. However, the operationalisation has one crucial benefit, namely that it is equitable with *cumulative net migration* and not just *emigration*, and therefore circumvents the otherwise problematic issue of *return migration*. Univariate data for this variable is presented in the diagram below.

Diagram 4.3.3.
Tertiary educated Greek expats (thousands)
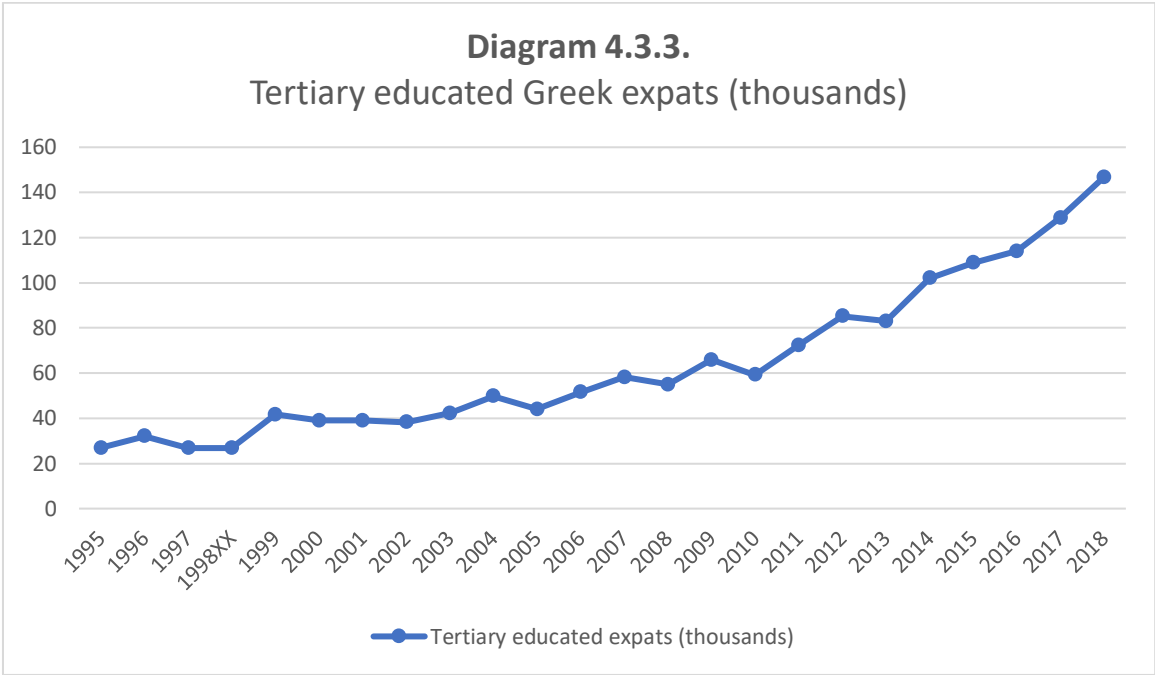
Source: Eurostat (2019d).

In accordance with the findings of Labriandis (2014) and Dustmann and Frattini (2014), these numbers suggest that the euro crisis clearly initiated an increase in the outflow of tertiary educated workers from Greece to other EU countries. Indeed, between 2008 and 2018, the

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[22] Keep in mind that the data is compiled on a quarterly basis (meaning that the annual data used in the study is updated with fresh statistics every quarter). As such, 0-lag regressions capture changes over a one-year period.

number of highly educated Greek expats rose by a factor of approximately 2,67; an increase which contrasts starkly with the development among the lower educated strata of the population[23] (decrease by a factor of 0,93, see Eurostat, 2019d), and among the population at large (increase by a factor of 1,32, see Eurostat, 2019d).

4.3.4. Control variable – competitiveness (unit labour cost, inflation-adjusted)

Competitiveness is operationalised as *inflation-adjusted unit labour cost* (hereafter referred to only as unit labour cost); a rather uncomplicated operationalisation considering that the price per unit of output is a widely-used definition of competitiveness (OECD, 2019c). This variable is included in regression group A as a second independent variable alongside real GDP, the rationale being that it is often the case that firms' labour intensities are not perfectly responsive to business cycle changes due to labour market regulations such as employment protection. Such rules forbid employers from relentlessly laying off workers, which implies that firms will typically have too many workers on their payroll in the direct aftermath of a recession. As such, there could potentially exist a bias between the independent variable and dependent variable. However, due to the regulatory upheaval which accompanied Greece's austerity policies (Kennedy, 2018), this bias arguably does not apply here, as regulatory upheaval in the labour market should imply that employers *could* maintain a cost-effective labour intensity. To investigate whether this was indeed the case, one may consider the progression of unit labour cost during the concerned time-period.

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[23] ISCED 2011-groups 0–4.

Diagram 4.3.4.
Greece unit labour cost (Index: 2010=100)

Source: OECD (2019b).

Evidently, unit labour cost actually went *down* during the crisis; a fact which suggests that there is no implicit bias between real GDP and real GDP per hour worked. Moreover, the fact that unit labour cost declined over the course of the crisis suggests that psychological or physiological factors such as anxiety, stress, insecurity or malnutrition do *not* constitute part of the explanation. Such variables should impact real GDP per hour worked *through* unit labour cost, as a decrease in the physical or mental health of workers would affect their production rate.

4.4. Methodological limitations

The research design as a whole is subject to at least two limitations: 1) it cannot account for reverse causality; and 2) it is not suited to investigate whether the outflow of highly productive Greek workers induces productivity *divergence* within the EU.

Concerning the issue of reverse causality, it is obvious that declines in real GDP per hour worked across the Greek economy should feed back into real GDP, which should then further depress real GDP per hour worked, and so on. While this does not constitute a problem for this investigation, learning the strength of the feedback-effect would be a nice complement to the study. However, this is not possible with the current research design. As for the second limitation, this study is too limited in scope to cover such as vast topic. Answering questions

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about productivity *divergence* rather than *decline* would presuppose an international investigation. In addition, such a study would necessitate that the effect of human capital transfers on worker productivity be isolatable in a context where worker productivity goes *up*. In light of the empirical findings presented in section 2.3., this would require a different research design altogether.

5. Results

The following paragraphs provide a detailed account of the results of the regressions. The explanatory power of the regression models is estimated using the determination coefficient R-squared, and statistical significance is evaluated through the employment of f-tests for entire regression models, and through t-tests for each of the independent variables[24]. Moreover, it is important to note that all regression coefficients are expressed in *unstandardized* form, and that, since all the data is updated with new statistics on a quarterly basis, the 0-lag regression models in regression groups B and C effectively account for 1-year lags. The intuition is the same for the 1-lag models (2-year lags), the 2-lag models (3-year lags) and the 3-lag models (4-year lags).

5.1. Regression group A: the relationship between real GDP and real GDP per hour worked

This group consists of six separate regressions; one with and one without the control variable (unit labour cost) for each of three time-periods 1995–2018, 1995–2008 and 2008–2018. In accordance with H1 and H2 (see section 3.1.), the expected result of the regressions is a strong, positive and significant correlation between real GDP and real GDP per hour worked over the time-period as a whole. With respect to unit labour cost, the relationship is expected to be strong and positive but not necessarily statistically significant, since a negative and significant relationship would suggest that there exists an implicit bias between real GDP and real GDP per hour worked. Tables 5.1.1., 5.1.2 and 5.1.3. display the results of the regressions for each of the three time-periods, both *with* unit labour cost as a control variable (model 2) and *without* (model 1).

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[24] Note that time-series regressions are prone to positive auto-correlations in the residual. As such, time-series regressions tend to underestimate standard errors, and thus overestimate t-values and significance levels. This should be kept in mind when considering the p-values of the regressions.

Table 5.1.1. Real GDP (indep. var., index: 2010=100) – real GDP per hour worked (dep. var., index: 2010=100) 1995–2018

	Regression Model 1: without unit labour cost	Regression Model 2: with unit labour cost
Real GDP	0.527*** (0.064) [0.394–0.66]	0.277*** (0.044) [0.185–0.369]
Unit labour cost	-	0.254*** (0.031) [0.189–0.319]
Constant	46.317*** (5.79) [34.276–58.357]	49.827*** (2.886) [43.806–55.847]
N =	23	23
R-squared	0.76***	0.95***

* p<0,05, ** p<0,01, ***p<0,001

Standard errors in parentheses and 95% confidence intervals in brackets, *applies to all tables.*

Table 5.1.1. shows the statistical relationships between real GDP and real GDP per hour worked for the whole time-period. The first thing to note is that both models have very high R-squared values and rather strong and positive regression coefficients, all of which are significant at the 0.1% level. Moreover, there are some interesting differences between the results of the two models, notably that the value of the coefficient for real GDP is much higher in model 1 than in model 2. This may be explained by the fact that the control variable, unit labour cost, is not *consistent* in its correlation with real GDP per hour worked. Intuitively, a bias between real GDP and real GDP per hour worked *through* unit labour cost would postulate that as real GDP declines, unit labour cost should go *up.* In other words, the regression coefficient for unit labour cost should display a *negative value* rather than a positive one, at least for the post-crisis period (i.e. about half of the observations). Evidently, this is not the case; the correlation is positive and significant at the 0.01% level, a fact which suggests that the notion of an inverse relationship between unit labour cost and real GDP per hour worked is incorrect. To investigate this further, one may split the regression into two time-periods: 1995–2008 (pre-crisis) and 2008–2018 (post-crisis).

Table 5.1.2. Real GDP (indep. var., index: 2010=100) – real GDP per hour worked (dep. var., index: 2010=100) 1995–2008

	Regression Model 1: without unit labour cost	Regression Model 2: with unit labour cost
Real GDP	0.643*** (0.031) [0.574–0.712]	0.944* (0.400) [0.054–1.835]
Unit labour cost	-	-0.238 (0.314) [0.938–0.463]
Constant	33.285*** (2.900)	21.536 (15.838) [-13.763–56.816]
N =	13	13
R-squared	0.97***	0.98***

As table 5.1.2. displays, the progression of real GDP per hour worked in the pre-crisis period may be explained almost entirely by the progression of real GDP. Considering that the Greek economy grew extensively in most of those years, this result is unsurprising, and is likely to be confounded by omitted biases such as institutional improvements, human capital expansion and improvements in physical capital intensity. As such, the high R-squared values and regression coefficients for real GDP in this period are of *very limited reliability*. However, they are interesting nonetheless, as they pose a contrasting example to the findings for the post-crisis period.

Table 5.1.3. Real GDP (indep. var., index: 2010=100) – real GDP per hour worked (dep. var., index: 2010=100) 2008–2018

	Regression Model 1: without unit labour cost	Regression Model 2: with unit labour cost
Real GDP	0.296*** (0.029) [0.229–0.362]	0.245*** (0.043) [0.146–0.343]
Unit labour cost	-	0.095 (0.061) [-0.045–0.236]
Constant	69.656*** (2.260) [63.661–75.651]	66.077*** (3.355) [58.340–73.813]
N =	11	11
R-squared	0.92***	0.94***

As table 5.1.3. shows, the relationship between the independent and dependent variables in the post-crisis period is positive, moderately strong and significant at the 0.01% level. Moreover, the standard errors and 95% confidence intervals for real GDP are small, the R-squared value is nearly the same for both models and the correlation between unit labour cost and real GDP per hour worked is weakly positive and not even statistically significant. There are two essential things to note here: 1) the regression coefficient and R-squared value of model 1 in the post-crisis period are almost as high as those of model 1 in the pre-crisis period, even though, as noted in section 2.3., neither institutional quality nor physical capital could possibly have played part in inducing the post-crisis period's decline in real GDP per hour worked; and 2) the fact that unit labour cost is not inversely correlated with real GDP per hour worked suggests that Greece's worker productivity decline does *not* stem from a crisis-induced decrease in competitiveness (or psychological or physiological factors such as anxiety, stress, malnutrition etc.). With respect to H1 and H2, one may thus conclude that the euro crisis represents a structural break which caused Greece's worker productivity to sharply decline, and that this decline does not stem from any bias between real GDP and real GDP per hour worked in the form of crisis-induced jumps in unit labour cost. Hence, the null-hypotheses H01 and H02 may be rejected in favour of H1 and H2.

5.2. Regression group B: the relationship between real GDP and tertiary educated Greeks residing in other EU countries

The next step is to investigate the veracity of the causal mechanism; that is, the extent to which the correlation between real GDP decline and falling real GDP per hour worked in Greece has been mediated by an intensified flow of highly educated Greeks to other EU countries. Regression group B is constituted by a series of regression models aimed at exploring the first part of this investigation – the relationship between real GDP and the number of tertiary educated Greek expats. Table 5.2.1. displays the results of a series of regressions on this relationship.

Table 5.2.1. Real GDP (indep. var., index: 2010=100) – tertiary educated Greek expats (dep. var., thousands) 1995–2018

	Lag = 0	Lag = 1	Lag = 2	Lag = 3
Real GDP	-0.351 (0.606) [1.611–0.908]	-0.463 (0.629) [-1.779–0.853]	-0.391 (0.646) [-1.747–0.966]	-0.243 (0.658) [-1.631–1.145]
Constant	97.197 (54.799) [-16.783–211.140]	110.613 (57.492) [-9.721–230.946]	106.265 (59.383) [-18.495–231.024]	95.205 (60.898) [-33.278–223.689]
N =	23	21	20	19
R-squared	0.02	0.03	0.02	0.01

Consider the results of the 0-lag model. The regression coefficient is 0.351 and the standard error is 0.606, thus giving a t-test-generated p-value far higher than the maximum 0.05 required for the relationship to be deemed statistically significant at the 5% level. The same is true of the model's R-squared value; exceedingly low and statistically insignificant. At first glance, this suggests that there is no significant relationship between real GDP and tertiary educated Greek expats. It is possible, however, that a 0-lag regression model cannot adequately capture the relationship, since workers' migration decisions could be subject to time-lags. Essentially, there are inconveniences to migration – selling off property, finding new work abroad, family-related obstacles and sentimentality – which may cause workers to refrain from migrating for some time. Thus, it is essential to control for such lags. This may be done by running the same regression model with different time intervals, for instance two, three and four years. The results of these models are also displayed in table 5.2.1. Much like the 0-lag model, the 1-lag, 2-lag and 3-lag models yield statistically insignificant results, thus suggesting that there is no connection between real GDP and the extent to which highly educated Greeks opt to leave the country.

However, one may question whether the relationship between real GDP and the number of tertiary educated Greek expats is consistent throughout the time-period. Indeed, while it is intuitive that educated workers would leave in the event of a crisis, it is not equally intuitive that economic booms would be associated with the opposite pattern. If this is not the case –

that is, if the number of tertiary educated Greek expats increased over the *entire* time-period, but with varying intensity – the results displayed in table 5.2.1. are unreliable, as they then show a diluted "average" of two periods which are intuitively very different. As such, it is necessary to regress the two periods, pre-crisis and post-crisis, in isolation from one another. The results of four regressions models with different time-lags for the pre-crisis period read as indicated in table 5.2.2.

Table 5.2.2. Real GDP (indep. var., index: 2010=100) – tertiary educated Greek expats (dep. var., thousands) 1995–2008

	Lag = 0	**Lag = 1**	**Lag = 2**	**Lag = 3**
Real GDP	0.648*** (0.071) [0.492–0.804]	0.669*** (0.0776) [0.493–0.844]	0.682*** (0.119) [0.407–0.957]	0.601** (0.117) [0.325–0.877]
Constant	-17.332* (6.554) [-31.758–-2.906]	-17.689* (7.145) [-33.853–1.526]	-16.383 (10.759) [-41.194–8.428]	-6.098 (10.311) [-30.481–18.285]
N =	13	11	10	9
R-squared	0.88***	0.89***	0.80***	0.79**

It is evident from these results that the nature of the relationship was different before the crisis compared to the whole time-period; while table 5.2.1. shows correlations which are negative, table 5.2.2. indicates positive correlations and significance levels of either $p<0.01$ or $p<0.001$ for all four models. This means that the number of tertiary educated Greeks residing in other EU countries *increased* incrementally with real GDP, and that the negative correlation found for the whole time-period is indeed diluted by a positive correlation in the prosperous pre-crisis years. Thus, one would expect the regression coefficients for the post-crisis regression models to be profoundly negative and more significant than those found for the whole time-period. As indicated by the regression results displayed in table 5.2.3., this is indeed the case.

Table 5.2.3. Real GDP (indep. var., index: 2010=100) – tertiary educated Greek expats (dep. var., thousands) 2008–2018

	Lag = 0	Lag = 1	Lag = 2	Lag = 3
Real GDP	-2.052** (0.617) [-3.447–0.657]	-2.040** (0.430) [-3.013–1.068]	-2.118*** (0.331) [-2.868–1.369]	-2.198*** (0.360) [-3.014–1.383]
Constant	276.574*** (55.587) [150.827–402.321]	280.340*** (39.855) [190.241–370.558]	292.344*** (31.462) [221.171–363.517]	303.936*** (34.857) [225.084–382.787]
N =	11	11	11	11
R-squared	0.55**	0.71**	0.82**	0.81***

The first thing to note about these results is the strong and negative correlation indicated by the 0-lag model (-2.052). The standard error is quite high (0.617), however, the magnitude of the negative correlation means that the results are nonetheless significant at the 1% level. Interestingly, the three lagged models (lag = 1, 2 and 3) indicate a pattern whereby the strength of the negative correlation and the size of the standard error and 95% confidence interval (and the significance level) are rather stable, notwithstanding that the standard error appears to be diminishing with longer time-lags. Against this background, delayed migration decisions do not seem to constitute any significant bias, at least not when the regressions are performed using annual data.

Taken together, the results of regression group B indicate that there was a correlation between real GDP decline and outward migration of tertiary educated Greeks throughout the euro crisis. Indeed, considering that the number of tertiary educated Greeks who reside in other EU countries increased incrementally even before 2008, the crisis appears to have constituted a structural break which dramatically changed the relationship between the two variables. With respect to H3, then, it appears rather clear that the euro crisis initiated an *intensified* outflow of highly productive Greek workers. Whether this may explain Greece's worker productivity decline is the subject of the next section.

5.3. Regression group C: the relationship between tertiary educated Greek citizens residing in other EU countries and real GDP per hour worked

To recap, the findings of regression group B suggest that the time-period 1995–2018 may be split into two distinct parts; the pre-crisis period (1995–2008), during which the correlation between real GDP and cumulative net emigration of tertiary educated Greeks was *positive* and likely *spurious*, and the post-crisis period (2008–2018), during which the correlation between the two variables was *strongly negative* and *non-spurious*. As such, dwelling on the relationship between human capital outflow and real GDP per hour worked for the whole period and the pre-crisis period would be rather meaningless, as the results would be either insignificant or bland anyway[25]. Against this background, it is sensible to focus regression group C solely on the post-crisis period. The results of regression group C, which consists of four regression models with different time-lags, are presented in table 5.3.1.

Table 5.3.1. Tertiary educated Greek expats (indep. var., thousands) – real GDP per hour worked (dep. var., index: 2010=100) 2008–2018

	Lag = 0	Lag = 1	Lag = 2	Lag = 3
Tertiary educated expats	-0.095*** (0.020) [-0.139–0.051]	-0.108** (0.025) [-0.164–0.051]	-0.119** (0.029) [-0.185–0.052]	-0.126** (0.032) [-0.198–0.055]
Constant	104.958*** (1.904) [100.652–109.264]	105.266*** (2.202) [100.284–110.248]	105.375*** (2.372) [100.009–110.74]	105.161*** (2.345) [99.857–110.465]
N =	11	11	11	11
R-squared	0.72***	0.67**	0.64**	0.64**

The first thing to note about these results is the relatively similar value of the regression coefficients across the board: the coefficients range from -0.095 (for the 0-lag model) and -0.126 (for the 3-lag model), and all four models yield correlations which are statistically significant at either the 0.01% level or the 0.1% level. At first glance, the values of the

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[25] The insipid nature of these regressions is evident; insignificant and near non-existent R-squared and correlation values for 1995–2018, and superficially significant and high R-squared and correlation values for 1995–2008 which are undoubtedly spurious since it makes no sense that *losing* qualified labour would increase average worker productivity (see appendix).

coefficients are quite low; however, it is important to keep in mind that the mediating variable (independent in these models) is operationalised as "thousands of tertiary educated Greek expats" while the dependent variable, real GDP per hour worked, is indexed so that 2010=100. In other words, for every 1000 tertiary educated workers who have left Greece, the country's real GDP per hour worked has declined by about 0.1% of the 2010-level. Considering that the cumulative net emigration of tertiary educated Greeks between 2008–2018 was 91,6 thousand (Eurostat, 2019d), and that the decline in real GDP per hour worked over the same period was 9,6 index-points (OECD, 2019a), there seems to be a close match between the progression of the two variables. As such, these results suggest that relocation of tertiary educated migrants has had a *very* heavy impact on worker productivity rates in Greece since the outbreak of the crisis.

Moreover, the relative stability of the results across the different models suggests that the possible bias of productivity disparities and skewed migration within the ISCED 5–8 group is negligible. If such skewed migration existed, one would expect to see more pronounced differences, either in terms of the value of the models' regression coefficients (because longer time-lags should smooth out irregularities) or in terms of the 0-lag model's significance level (because the higher standard errors entailed by a non-lagged model would imply a lower t-test value). Indeed, the low standard error and high significance level of the 0-lag model disperses any suspicions that such skewed migration is distorting the regression results.

Thus, with respect to H3, one may conclude that Greece's worker productivity predicament in the aftermath of the euro crisis has indeed been mediated by an intensified outflow of human capital. In combination with the findings of regression group B, these results suggest that the null-hypothesis H03 may be rejected in favour of H3. All three hypotheses have thus been accepted, and all null-hypotheses rejected.

6. Analysis & discussion

This chapter aims to relate the regression results presented above to the thesis question posed in the concluding paragraph of the introductory chapter:

Did the euro crisis initiate an intensification of the outflow of human capital from Greece, and if so, to what extent can this outflow account for the country's declining worker productivity since 2008?

Against the background of the results of regression group B, it is rather evident that the euro crisis *did* intensify the outflow of human capital from Greece; while the number of tertiary educated Greek expats increased before as well as after the crisis outbreak, the pre-crisis increase was very slow and not even monotonic in nature. Indeed, a juxtaposition of the pre- and post-crisis relationships between real GDP and tertiary educated Greek expats suggests that the financial collapse constitutes a structural break which completely redefined the nature of the correlation between the two variables. Before the crisis outbreak, they were positively correlated. After the crisis outbreak, they became strongly and inversely correlated. Furthermore, as is evident from the results of regression groups A and C, one may conclude both that Greece's worker productivity decline correlated with the crisis-induced real GDP decline, and that a significant portion of this correlation may be explained by reference to the human capital outflow that the crisis triggered. Indeed, the seemingly close relationship between the progression of the two variables suggests that human capital outflow is one of, if not *the* most important factor in explaining Greece's worker productivity decline. As such, *the euro crisis did initiate an intensification of the outflow of human capital from Greece, and this outflow may to a significant extent account for the country's declining worker productivity since 2008.*

This conclusion carries important implications for the body of existing theoretical and empirical research. Notably, it suggests, contrary to the assumptions of the three OCA variations discussed in chapter 2, that flexibility, if asymmetric in nature, may constitute a shock *exacerbating* phenomenon in times of crises. This could have adverse effects for the *symmetry* of the currency area; worker productivity depression by way of human capital relocation ought to exacerbate disparities in sectoral composition among the constituent economies. In turn, this could mean that member countries' exposure to various kinds of

economic shocks differs markedly; a predicament which would make the conduction of a common monetary policy ever more complicated. This paints an uneasy picture of the sustainability of the EMU in its current shape and form: structural asymmetries in combination with inadequate risk-sharing mechanisms induce asymmetric crises which drain the worst-hit member states of their human capital, thus depressing those countries' worker productivity rates and exacerbating structural asymmetries, ultimately making the Eurozone *less* of an optimum currency area.

Obviously, the veracity of this causal chain cannot be evaluated on the back of the results of this study. Thus, further studies are required. For instance, in order to make any diagnoses on the progression of the optimality of the Eurozone *as a whole*, the prospect of *structural divergence* must be empirically investigated. One particularly intriguing aspect of such an investigation would be the disparate development of worker productivity rates among the PIGS countries. Unlike in the case of Greece, the worker productivity rates of Portugal, Italy and Spain have never fallen below 2010-levels (OECD, 2019a). This begs the question what distinguishes these three countries from Greece: Could it be that emigration is less asymmetric in Portugal, Italy and Spain, and if so, why is this? In addition, it would be prudent to investigate the possible implications of the fact that many of those who left the PIGS countries during the crisis were relatively young (see Cenci, 2015; Dustmann & Frattini, 2014). If these individuals do not return to their countries of origin, fiscal problems associated with a perverse age structure could be inbound for all four PIGS countries. However, such an investigation would have to be conducted in due course, when the extent of return migration may be accurately assessed. In any case, it may be concluded at this time that, provided the severity of the euro crisis in Greece is interpreted as an interplay between the common currency and Greece's relatively low state of economic development, the current Eurozone design appears to be indirectly harming the worker productivity of Greece – the currency union's economically weakest member state.

7. Conclusions

This thesis has investigated the issue of declining worker productivity in Greece in the aftermath of the euro crisis; particularly the extent to which this decline may be explained by reference to changes in the migration patterns of tertiary educated Greek workers after the crisis onslaught. The rationale for this research topic is best understood against the background of existing theoretical and empirical contributions on the subject of optimum currency areas, which suggest that a currency area devoid of symmetry, worker flexibility and transfer mechanisms/integration cannot be functional. While the predicament of the Eurozone emboldens this hypothesis, existing research falls short of explaining why Greece has seen its worker productivity (measured as real GDP per hour worked) consistently decline since the crisis struck in 2008. Moreover, the fact that neither of the other PIGS countries has experienced a similar development adds to the puzzling nature of Greece's worker productivity progression.

Drawing on neoclassical economic growth theory, the theoretical framework of this thesis was centred around the possibility that worker flexibility within the Eurozone is inherently asymmetric in that workers, depending on their level of educational attainment, have wildly different prospects of finding employment in other EU countries. As such, worker flexibility can not only be the shock mitigating or shock neutral phenomenon outlined in different variations of OCA theory; it may also constitute a shock *exacerbating* phenomenon by relocating human capital-rich workers from economically weak member states, notably Greece, to other EU countries. Thus, the hypotheses of this thesis were that Greece's worker productivity decline is a consequence of the euro crisis, and that the decline does not stem from a crisis-induced fall in competitiveness, but rather from a crisis-initiated intensification of the outflow of tertiary educated workers from Greece.

The results of the thesis's empirical analysis staunchly suggest that all the hypotheses are correct. Firstly, worker productivity, operationalised as real GDP per hour worked, closely tracked the progression of real GDP throughout the time-period 1995–2018, as well as over the pre-crisis period (1995–2008) and post-crisis period (2008–2018). While spuriousness cannot be ruled out for the pre-crisis period (due to the fact that productivity factors other than human capital cannot be controlled for in years when real GDP per hour worked increased), the regression coefficients and significance levels for the post-crisis regressions suggest an

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intimate relationship between the two variables over the course of the crisis, when real GDP per hour worked consistently fell and all other neoclassical productivity factors – physical capital, institutional quality and technological sophistication – either increased, stagnated or lacked explanatory value. Secondly, adding unit labour cost as an explanatory variable alongside real GDP does not alter the conclusion of the regressions; indeed, the relationship between unit labour cost and real GDP per hour worked is not even statistically significant. As such, the worker productivity decline does not stem from an implicit bias between real GDP and real GDP per hour worked, and it appears the productivity decline is not a matter of declining competitiveness. What is more, this effectively rules out psychological and physiological factors such as stress, anxiety, insecurity and malnutrition (as these factors would impact unit labour cost), and strongly indicates that the decline mainly stems from human capital outflow.

Thirdly, there appears to be a strong connection between the start of the euro crisis and the frequency of Greece's human capital outflow. When running the regressions for the whole time-period, none of the models yield statistically significant results. However, after diving the period into pre- and post-crisis, the results suggest that the migration behaviour of tertiary educated Greeks was completely redefined by the euro crisis, as the correlation between the two variables was weak and positive before the crisis, and grew strong and negative after the crisis onslaught. As such, it may be concluded that the crisis dramatically intensified the outflow of human capital from Greece. Finally, the regression results paint a picture in which this human capital outflow is responsible for a large part of Greece's worker productivity decline, as the correlations are strong, negative and very similar across models with different time-lags. Thus, the conclusions of this thesis hint that the Eurozone, by its current design, is indeed emptying the school of Athens.

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Appendix

These two tables display the results of regressions on the relationship between tertiary educated Greek expats and real GDP per hour worked in the periods 1995–2018 and 1995–2008, respectively.

Tertiary educated Greek expats (indep. var., thousands) – real GDP per hour worked (dep. var., index: 2010=100) 1995–2018

	Lag = 0	Lag = 1	Lag = 2	Lag = 3
Tertiary educated expats	0.059 (0.045) [0.035–0.153]	0.025 (0.048) [-0.076–0.125]	0.005 (0.048) [-0.097–0.106]	-0.023 (0.050) [-0.129–0.083]
Constant	89.703*** (3.329) [82.779–96.626]	93.269*** (3.355) [86.246–100.291]	95.201*** (3.155) [88.573–101.829]	97.295*** (3.110) [90.734–103.857]
N =	23	21	20	19
R-squared	0.07	0.01	0.00	0.01

As noted, the regressions for the entire time-period yield statistically insignificant results. With respect to the pre-crisis period, the results are significant and the regression coefficients are not negligible; however, the fact that the coefficients are positive strongly suggests that the correlations are spurious and therefore scientifically meaningless.

Tertiary educated Greek expats (indep. var., thousands) – real GDP per hour worked (dep. var., index: 2010=100) 1995–2008

	Lag = 0	Lag = 1	Lag = 2	Lag = 3
Tertiary educated expats	0.871*** (0.111) [0.627–1.116]	0.800*** (0.167) [0.421–1.179]	0.778** (0.156) [0.418–1.139]	0.856** (0.194) [0.398–1.315]
Constant	55.622*** (4.773)	60.573*** (7.186)	64.395*** (6.365)	62.923*** (7.703)

	[45.116–66.128]	[44.317–76.829]	[49.718–79.071]	[44.708–81.138]
N =	13	11	10	9
R-squared	0.85***	0.72***	0.76**	0.74**