Essays in Applied Labour Economics and the Environment

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Abstract

Two different issues are examined in this thesis: the effects of the minimum wage in Cyprus (a country where only a number of occupations are covered by the relative legislation) and the determinants of environmental pollution as they are captured by the carbon dioxide emissions using the Bayesian Model Averaging Methodology. Chapter 1 presents an introduction and a summary of the results derived from this thesis.

Chapter 2 examines the issue of the effects of the minimum wage in Cyprus from a macroeconomic perspective. Empirical evidence for the relationship between total employment and the minimum wage is provided by analysing time series data, creating a measure of the minimum wage in Cyprus (the Kaitz index) that may be also used in future studies. After addressing the issues of stationarity, dynamic specification and endogeneity that most of the existing literature ignores, evidence is found of a significant and negative relationship between the minimum wage and total employment. This result, in the framework of recently developed search and matching models, suggests the existence of significant spill-over effects from the legal minimum wage to the occupations that are not covered by the minimum wage legislation.

Chapter 3 examines the same issue from a microeconomic perspective. An individual-level data set is used to study the impact of the official minimum wage on a host of labour market outcomes. The impact is examined separately for occupations where bipartite collective bargaining between trade unions and employers is not subject to an institutional minimum wage. The evidence indicates that the minimum wage affects workers in both the covered and the uncovered occupations, especially those workers whose earnings are close to the legal minimum wage. This result suggests that negotiations between the trade unions and the employers' organisations are affected, even if not legally bound, by the national minimum wage, because it constitutes a shadow minimum wage in uncovered sectors of the labour market.

Chapter 4 investigates the strength of empirical evidence in favour of the existence of an environmental Kuznets curve (EKC), a relationship across countries between the level of environmental pollution and per capita GDP. This is done by accounting for the model uncertainty created by the numerous candidate regressors proposed in the literature, using a Bayesian Model Averaging methodology. Strong evidence is found in favour of the existence of EKC in carbon dioxide emissions and for macroeconomic policy effects. The main conclusions reached are: (1) it is most likely that a significant portion of the regressors proposed in the literature may appear empirically significant only because the econometric strategy does not account for model uncertainty, and (2) the proposed EKC approaches cannot adequately account for the relative importance of regional heterogeneity, thus further research is needed to systematically uncover the unexplained regional variation in the levels of carbon dioxide emissions.

Περίληψη

Στη διατριβή αυτή εξετάζονται δύο ξεχωριστά θέματα: οι επιπτώσεις των κατωτάτων μισθών στην Κύπρο (μια χώρα όπου η νομοθεσία περί κατωτάτου ορίου μισθοδοσίας δεν καλύπτει σημαντικό μέρους του εργατικού δυναμικού) και οι παράγοντες που επηρεάζουν τη μόλυνση του περιβάλλοντος, όπως αυτή αντικατοπτρίζεται στο επίπεδο ρύπων διοξειδίου του άνθρακα στην ατμόσφαιρα, χρησιμοποιώντας την Μπεϋζιανή οικονομετρική μεθοδολογία. Το Κεφάλαιο 1 περιλαμβάνει μια εισαγωγή στα πιο πάνω θέματα και μια συνοπτική ανασκόπηση των αποτελεσμάτων που προέκυψαν από την εξέταση αυτών.

Στο Κεφάλαιο 2 εξετάζονται οι επιπτώσεις των κατωτάτων μισθών στην Κύπρο από μια μακροοικονομική σκοπιά. Χρησιμοποιώντας τις διαθέσιμες χρονοσειρές εξετάζεται η ύπαρξη μιας στατιστικά σημαντικής εμπειρικής σχέσης μεταξύ της συνολικής απασχόλησης και του κατώτατου μισθού, λαμβάνοντας υπόψη τις διαχρονικές αλλαγές στον αριθμό των επαγγελμάτων τα οποία καλύπτονται από τη σχετική νομοθεσία. Επιπλέον, η εγκυρότητα των οικονομετρικών μοντέλων που χρησιμοποιούνται εξετάζεται λαμβάνοντας υπόψη θέματα που δεν τυγχάνουν της πρέπουσας σημασίας στη σχετική βιβλιογραφία, όπως την ύπαρξη μοναδιαίων ριζών, την ύπαρξη διαχρονικής εξάρτησης και την πιθανή ενδογένεια στη σχέση των μεταβλητών. Τα αποτελέσματα επιδεικνύουν την ύπαρξη μιας αρνητικής σχέσης μεταξύ της συνολικής απασχόλησης και του κατωτάτου ορίου μισθοδοσίας στην Κύπρο, γεγονός που αν ερμηνευτεί στα πλαίσια ενός μοντέλου αναζήτησης και συνταιριάσματος με δύο τομείς (two-sector search and matching model), εισηγείται ότι οι επιπτώσεις του κατώτατου μισθού γίνονται αισθητές και σε επαγγέλματα που δεν καλύπτονται από τη σχετική νομοθεσία.

Το Κεφάλαιο 3 εξετάζει το ίδιο θέμα από μικροοικονομική σκοπιά, χρησιμοποιώντας διαθέσιμα στοιχεία τα οποία επιτρέπουν την εξέταση του κατώτατου μισθού ξεχωριστά στους τομείς που καλύπτονται από την σχετική νομοθεσία (κάτι το οποίο δεν ίσχυε όσον αφορά στις μακροοικονομικές χρονοσειρές). Τα στοιχεία που χρησιμοποιούνται προέρχονται κυρίως από τις Έρευνες Οικογενειακών Προϋπολογισμών για τα έτη 1990/91, 1996/97, 2002/03 και 2008/09. Τα αποτελέσματα της έρευνας επιδεικνύουν ότι το κατώτατο όριο μισθοδοσίας στην Κύπρο επηρεάζει και εργαζόμενους σε επαγγέλματα τα οποία δεν καλύπτονται από τη σχετική νομοθεσία, ειδικά μισθωτούς στον ιδιωτικό

τομέα που οι μηνιαίες τους απολαβές κυμαίνονται περί της εκάστοτε τιμής του κατωτάτου νομικού ορίου μισθοδοσίας. Αυτό το αποτέλεσμα εισηγείται ότι οι διμερείς διαπραγματεύσεις μεταξύ συντεχνιών και εργοδοτών σε επαγγέλματα που δεν καλύπτονται από το σχετικό νόμο επηρεάζονται από τον κατώτατο μισθό. Η επιρροή αυτή πιθανόν να είναι ότι ο κατώτατος μισθός αποτελεί ένδειξη μιας δίκαιης κατώτατης μηνιαίας αμοιβής ή την τελική συμβιβαστική λύση (default option) σε περιπτώσεις όπου συντεχνίες και εργοδότες δεν καταλήγουν σε συμφωνία.

Στο Κεφάλαιο 4 εξετάζεται η βαρύτητα που δίνουν διαθέσιμα εμπειρικά δεδομένα στην ύπαρξη της Περιβαλλοντικής Καμπύλης Kuznets (ΠΚΚ), η οποία αποτελεί μια θεωρητική σχέση μεταξύ της μόλυνσης του φυσικού περιβάλλοντος και του κατά κεφαλήν εισοδήματος. Αυτή η εξέταση γίνεται με τη χρήση της Μπεϋζιανής οικονομετρικής μεθοδολογίας, στην οποία μπορεί να αντιμετωπιστεί η αβεβαιότητα που δημιουργείται από την ύπαρξη εκτενούς σχετικής βιβλιογραφίας που εισηγείται μεγάλο αριθμό επιπρόσθετων παραγόντων που δύνανται να επηρεάζουν τη μόλυνση του περιβάλλοντος, πέραν από το κατά κεφαλήν εισόδημα. Επιπλέον η σχέση της μόλυνσης του περιβάλλοντος με το κατά κεφαλήν εισόδημα και το επίπεδο διεθνούς εμπορικής δραστηριότητας εξετάζεται λαμβάνοντας υπόψη την πιθανή ενδογένεια στη σχέση αυτή. Τα αποτελέσματα δίνουν μεγάλη υποστήριξη στην ύπαρξη της ΠΚΚ, εφόσον το κατά κεφαλήν εισόδημα παραμένει εκ των πιο σημαντικών παραγόντων που επηρεάζουν το επίπεδο ρύπων διοξειδίου του άνθρακα στην ατμόσφαιρα. Τα κύρια συμπεράσματα είναι: (1) πολλοί παράγοντες μπορεί να εμφανίζονται στη σχετική βιβλιογραφία ότι επηρεάζουν τη μόλυνση στην ατμόσφαιρα μόνον επειδή στα οικονομετρικά μοντέλα που χρησιμοποιούνται δε λαμβάνεται υπόψη η έμφυτη αβεβαιότητα και (2) υπάρχουν διαφορές στα επίπεδα μόλυνσης μεταξύ γεωγραφικών περιοχών οι οποίες δεν εξηγούνται επαρκώς ούτε από την ΠΚΚ ούτε από επιπρόσθετους παράγοντες που προτείνονται από τη βιβλιογραφία.

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To my parents,

Andreas and Vathoulla Mitsi.

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Chapter 1: Introduction

Chapter 2 in this thesis examines the relationship between total employment and the minimum wage in the special case where only a number of occupations are covered by the relative legislation. A theoretical background is provided by a recently developed search and matching model and empirical evidence is provided by analysing time series data from Cyprus, one of the few countries in the world and the only country in the European Union, where the minimum wage coverage is limited to only a small number of occupations. The analysis is done by addressing the issues of stationarity, dynamic specification and endogeneity that most of the existing literature ignores. In order to ensure that the estimated results are valid, the stability of the series is examined, using unit root tests under exogenous and endogenous structural breaks. Evidence is found of a significant and negative relationship between the minimum wage and total employment, despite the limited coverage of the minimum wage legislation. This suggests the existence of significant spill-over effects to the occupations that are not covered by the minimum wage legislation.

Chapter 3 contributes to the sparse, but rapidly growing, microeconomic evidence on the sectoral impact of the minimum wage in countries where the legislative coverage is limited, by producing evidence for Cyprus. Consistent with the previous study, it is found that, over the period 1990–2009 minimum wage legislation affects all workers in Cyprus, in both covered and uncovered occupations. Robust empirical evidence indicates that this outcome is probably due to the indirect effect of the legal minimum wage on bipartite labour negotiations, contrary to the predictions of a two-sector competitive model and consistent with a spill-over effect in the way described by a two-sector search and matching model. The covered and uncovered sector employment effects are both found to be negative. There are no discernible effects of the minimum wage on the wages of civil servants, whose case minimum wage legislation does not apply, or on the monthly earnings of the self-employed.

Chapter 4 examines the determinants of environmental pollution considering a large number of regressors suggested by economic theories, using a Bayesian Method Averaging methodology. The central question raised is whether the findings provide empirical evidence in favour of the existence of an Environmental Kuznets Curve (EKC), a relationship across countries between the level of environmental pollution and per capita GDP. The regressors examined include per capita GDP, trade intensity, capital-labour ratios, macroeconomic policy variables, political economy variables and regional dummy variables. Findings in traditional investigations provide strong evidence in favour of the existence of EKC in carbon dioxide emissions and for income inequality policy effects. In contrast, evidence in favour of the significance of many of these regressors disappears once model uncertainty is accounted for and robustness is examined. The Gini coefficient and the regional heteroskedasticity variables are the only additional repressors which remain significant in explaining carbon dioxide emissions, once model uncertainty has been incorporated in the estimation method. These results are robust to the use of different prior structures and modeling approaches. This suggests that a significant portion of the regressors proposed in the literature may appear empirically significant only because the empirical strategy does not account for model uncertainty. The results also indicate that social policy may influence environmental degradation and that the numerous alternative specifications in the EKC modeling do not adequately to account for the unexplained regional variation in the levels of carbon dioxide emissions.

Chapter 2: Effects of Minimum Wages on Total Employment Where the Legislative Coverage is Limited: Evidence from Cyprus Time Series Data

2.1 Introduction

The effect of statutory minimum wages is an issue that has gained a lot of attention in the literature, partly due to conflicting theories and findings from empirical studies. The "textbook" competitive labour market model predicts that when a minimum wage is introduced above the competitive wage this will lead to reduced employment. On the other hand, in monopsony models, there is a probability that a minimum wage increase may actually increase employment. In that manner, the employment effects of minimum wages crucially depend on the labour market structure and due to this plethora of proposed theoretical frameworks, the minimum wage effect remains an empirical rather than a theoretical question. Even if the empirical literature remains inconclusive today on whether minimum wages are an effective tool in driving down poverty and unemployment or they actually cause more harm than good, most of the evidence points to disemployment effects.

Something that all these studies have in common is that they are examining the case where a minimum wage has a nearly universal coverage, meaning that almost all the occupations of the economy are entitled to receive minimum wage. Since a "universal" minimum wage increase is expected to affect mainly the workers that are low in the wage pyramid, a position usually occupied by teenage employees, most of the studies carried out are usually confined to the sector directly affected (i.e. the teenagers) and abstract from the minimum wage effects in "uncovered" sectors or on total employment. The effect of minimum wages on uncovered sectors is not something new in the theoretical literature. However, this was recently examined through a new scope: the search and matching theoretical framework. This framework allows predictions on the possible outcomes that minimum wage changes have on total employment, when a sector of the economy is not covered by the minimum wage legislation.

This study considers this topic by using data from Cyprus, a country where there is a special case of minimum wage enforcement. The Cyprus Minimum Wage Law was created with the aim to protect certain categories of non-unionized workers paid low wage rates. Based on the existing legislation (Law on Minimum Wages, Chapter 183), the monthly minimum wage is currently set for nine occupational groups and in the sample period of this study (1960-2009) the actual coverage of the minimum wage legislation does not exceed the 30% of the employed population. The minimum wage rate is identical for all covered occupations, but a separate wage grid applies to workers that completed six months' experience in their current employment. The first minimum wage decree appeared in 1941 and, in the ensuing years, the minimum wage was adjusted only five times during the period 1941-1989. However, it has been adjusted annually since 1990.

For the rest of the workers bipartite wage negotiations are not subject to an institutional minimum. In Cyprus, collective bargaining has traditionally played a primary role in regulating labour relations, since there is not a tradition of state interventionism in employment issues. As a consequence, the concept of collective bargaining on the central national level (through the setting of minimum terms and conditions of employment of a binding nature for all workers) does not exist in Cyprus. The collective bargaining is considered to be decentralised, as most agreements are concluded at the enterprise level, instead of the sectoral level. It is difficult to say which level predominates (i.e. the percentages of workers whose pay is set on each level - sectoral or enterprise), since there is no monitoring of collective bargaining in Cyprus and no relevant studies or surveys have been made an on this specific issue. There are also no data available on the unionization rate. However, a comparative study of the European Industrial Relations Observatory indicates that the sectoral level predominates as far as the determination of the terms and conditions of employment is concerned.[1]

A time series analysis is conducted to determine if there is a stable relationship between total employment and minimum wage indices, taking into account the

[1] A more detailed description of the institutional background of the minimum wage and the collective bargaining in Cyprus is provided in Appendix A. See also European Industrial Relations Observatory (EIRO) (2009).

aforementioned limited legislative coverage. Vector autoregression (VAR) models are used in order to properly address the specification issues largely ignored by the existing literature: the stationarity of the variables, the dynamic specification and the potential endogeneity of the main variables.

Particular attention is given in the detection and proper consideration of possible structural breaks, since the Cyprus macroeconomic variables have been influenced by a number of political and economic events. The most eminent of them appears in 1974, when a military coup, followed by a foreign invasion, ended in the partition of the island. The seminal paper of Perron (1989) and the subsequent literature indicate that the presence of structural breaks in a series may bias the unit root tests towards incorrectly indicating non-stationarity. The sensitivity of the vector autoregression models to correct specification (especially in regards to the stationarity of the variables and the appropriate dynamic specification), therefore, suggests not accounting for the structural breaks in the data may generate invalid empirical results.

In order to generate results which are not biased from the presence of structural breaks, the stationarity of the series is carefully examined, allowing for the structural breaks to be determined both exogenously and endogenously in the sample. The evidence of structural breaks and their location then informs the multivariate analysis carried out, where the most eminent structural breaks detected are incorporated in vector autoregression models estimated. Then, the statistical adequacy of the models is tested by performing various misspecification tests.

In this chapter, the literature is extended in several ways. First, the effects of minimum wages on employment are estimated for Cyprus, a country not previously studied. Second, the impact of minimum wages is examined in one of the few countries in the world where the legislative coverage of the minimum wage is limited to only a few occupations. Third, a measure of the minimum wages in Cyprus (the Kaitz index) is calculated that may be used in future studies. The calculation of the Kaitz Index is essential because, inter alia, it allows examining the minimum wage effects separately from the coverage effects. The study examines in detail the relationship between total employment and the minimum wage and the role the exogenous variables play. It quantifies their relationship and tests its dynamic properties by examining the dynamic behaviour of one variable due to a random shock or innovation in the other variable.

The empirical results suggest the existence of a negative relationship between the minimum wage and total employment. In addition, the empirical evidence indicates that the variance of the employment variable is affected by the variability of the minimum wage measure. The estimations also suggest that the coverage effects of the minimum wage are not significant. The negative effect of the minimum wage on total employment is translated with minimum wages eventually increasing the bargaining position of the workers in the uncovered sector, making the firms more reluctant to hire new workers. In the same framework, the higher labour costs associated with increases in minimum wages discourages firms in the covered sector from expanding their personnel.

The organization of this study is as follows: Section 2.2 provides a literature review (theoretical and empirical), Section 2.3 describes the data used and in Section 2.4 the unit root analysis is carried out. Section 2.5 presents the estimation results and Section 2.6 concludes. A number of appendices provide further detail on the variables used, the calculations applied, the background of the statutory minimum wages in Cyprus (including the historical developments) and some particular aspects of the empirical results.

2.2. Literature Review

There is no consensus regarding the benefits and drawbacks of minimum wages. Supporters of the minimum wage assert that it prevents the exploitation of workers, while its opponents suggest that it reduces employment and destroys job positions. ‘Standard’ economic theory suggests that minimum wage reduces employment and until the 1990s economists generally agreed that this was the case. This consensus is weakened in the mid-1990s due to the highly influential work of David Card and Alan Krueger, which leads to a development of the alternative models examining the effect of minimum wages on employment. However, the Card-Krueger study is very controversial, since it concludes that an increase in the minimum wage may actually increase employment; and it has received a lot of criticism.

2.2.1 Theoretical Background

According to the standard economic theory, where the labour market is assumed complete and perfectly competitive, increasing the minimum wage decreases the employment of minimum wage workers. Using a demand and supply model to analyze this effect (and assuming that the supply and demand curves for labour will not change as a result of raising the minimum wage), this model suggests that since the minimum wage is set above the equilibrium wage, more labour will be willing to be provided by workers and less will be demanded by employers, creating a surplus supply of labour, i.e. unemployment. An alternate view of the labour market has low-wage labour markets dominated by monopsonist firms that have significantly more market power than the workers. Under the monopsonistic assumption, an appropriately set minimum wage (if the minimum wage is set between the existing wage and the perfectly competitive wage) could increase both wages and employment. This strand of literature is surveyed by Manning (1993, 2003) and Boal and Ransom (1997).

These approaches have in common that they consider only a one-sector labour market. Some economists disagree with that approach: many early papers on minimum wage effects, like Stigler (1964) and Gramlich (1976), argue that the standard theoretical arguments incorrectly measure only a one-sector market. They suggest a two-sector market instead, where some groups (such as the self-employed, service workers and farm workers) are typically excluded from minimum-wage coverage. Thus a complete analysis should also examine the uncovered sector and the mobility between the two sectors. A recent approach in that direction is to consider the effects of the minimum wage through the matching framework scope of Mortensen and Pissarides (1994, 1999 and 2003) and Pissarides (2000).

In the search and matching models in the labour market, the rate at which new jobs are created depends on both the workers' search decisions and on firms' decisions to open job vacancies. Flinn (2006) develops a bargaining model between firms and workers in a continuous-time search environment. His paper shows that when the contact rates[2] between individuals and firms are exogenously

[2] The rate at which workers searching for (new) employment meet with firms with opened job positions.

determined, fewer contacts will result in jobs. In this framework, when a worker and a firm contact they both able to observe the productivity level of the worker in the specific firm. Therefore, the firm will choose to employ the worker if the observed productivity level exceeds the instantaneous wage paid. Therefore, in equilibrium, the lowest wage paid by the firm will be equal to the lowest accepted productivity level. In the case which the interactions between applicants and firms are constrained by the presence of a minimum wage and the set of wages negotiated are restricted to only the ones above the minimum wage, firms would not be able to hire workers whose productivity levels do not correspond to the minimum wage and, therefore, the unemployment would be increased and the wages would be increased.

However, this implication critically depends on the assumption of a fixed contact rate. When Flinn (2006) introduces participation decision in this framework, then the imposition of a binding minimum wage will, in addition to the above negative employment effect, give incentive to non-participants to join the labour market,[3] therefore increasing the contact rate. In this case, the increase of the participation rate may result in an increase in the number of workers hired by firms that would offset the possible negative effects of a higher unemployment rate. It follows that then, in contrast to the exogenously determined contact rates, an increase in the minimum wage does not necessarily imply an increase in unemployment. Therefore, with endogenously determined contact rates the minimum wage may actually increase the steady state employment rates, due to increased inflows into the labour market.

Moser and Stahler (2009) also use the search and matching framework to examine the effects of minimum wage, but they depart from the pattern of only a one-sector labour market by introducing an additional sector and by investigating whether minimum wages exert a negative spill-over effect from the covered to the non-covered sector. They assume differences in the sector productivity and label one sector productive and the other one unproductive. The minimum wage is introduced in the unproductive sector, where the wage rates are expected to be

[3] Since wages (i.e. the expected income from employment) have increased due to imposition of the minimum wage, the situation of not seeking employment becomes less appealing (i.e. the value of staying outside of the market is decreased).

lower. In this framework, the introduction of a minimum wage will certainly reduce employment in the uncovered sector, since it increases the unemployed workers' outside option, as any employment in the unproductive covered sector now yields a higher wage. An increasing outside option improves their bargaining position and ability to demand higher wages in the productive uncovered sector, increasing the labour costs and leaving firms less willing to hire.

In the covered sector, however, the minimum wage has a dual effect. Since as the job creation in the uncovered sector falls, the chances of the covered employees to find employment in the uncovered (and more productive) sector fall as well. A lower probability of finding a job in the uncovered sector reduces the incentives of workers in the covered sector to leave their jobs and the average duration of the jobs in the covered sector will thus increase. This may trigger more job creation in the covered sector, since the possibility the hired workers leaving their jobs to seek employment in another sector discourages firms from opening new positions. On the other hand, the increase in the minimum wage in the covered sector leads to higher labour costs and thus less willingness from firms to hire new workers. Ultimately, the employment effect in the unproductive sector depends on which of these effects dominates. The effect on total employment will be determined by the sign and magnitude of the effect on covered sector.

2.2.2 Empirical Studies

The empirical effects of minimum wages are examined in a variety of ways. Stigler (1946) and Mincer (1976) are among the first papers in the area and their analyses are based on tables with average values of the minimum wages and the average changes in employment and unemployment. Most of the subsequent empirical literature (Gramlish 1976; Brown et al. 1982, 1983; Neumark and Wascher 1992; Katz and Krueger 1992; Card 1992b; and Kennan 1995) focuses on the estimation of employment and/or unemployment equations, using either time series data or panel data. Until the mid-1990s, the norm in the empirical findings is that the minimum wage reduces employment, especially among younger and low-skill workers. For example, Gramlich (1976) finds that teenagers are made worse off by the unemployment associated with the minimum wage and Brown et al. (1982; 1983) note that previous time series studies indicate that a 10 percent increase in the minimum wage is associated with a decrease in teenage employment of 1-3 percent.

One of the most influential studies in the area dates from 1992, when David Card and Alan Krueger gathered information on fast food restaurants in New Jersey (where the minimum wage increased) and eastern Pennsylvania (where it remained unchanged) in an attempt to assess the effect of the wage increase on employment within New Jersey. The authors conclude that the increase in the minimum wage increased employment in the New Jersey restaurants, contrary to the predictions of the perfectly competitive model. Card and Krueger expand their initial 1992 article in their 1995 book *Myth and Measurement: The New Economics of the Minimum Wage*, where they argued that negative employment effects of minimum wage laws are minimal if not non-existent. However, they were harshly criticized (e.g. Neumark and Wascher, 1992, 2000; and Kennan, 1995), for the methods they employ in examining the minimum wage effects. They are also criticized for some bias in interpreting their results (i.e. where there are inconclusive results, they claim this is evidence against the perfectly competitive model).

Focusing on the time series literature, which this study is concerned with, the most frequently cited studies remain the aforementioned Brown et al. (1982; 1983) and Wellington (1991) papers, where the following model is estimated:

$$E_t = a_0 + a_1 MW_t + X_t a_2 + e_t \tag{2.1}$$

$$e_t = \beta e_{t-1} + u_t, u_t \sim N(0, \sigma^2) \tag{2.2}$$

E_t is the employment rate, MW_t is the minimum wage measure (see the Kaitz Index description in section 2.3) and X_t is the vector of control variables that typically include a time trend, a cyclical control (business cycle) variable and some supply constraint variables.

In equation (2.1), the employment effects of a minimum wage are captured through coefficient a_1 which, when the equation is estimated in logs instead of levels, is actually the employment elasticity of the minimum wage. The estimated

a_1 times ten is interpreted as the percent change in employment due to a 10 per cent change in the minimum wage. Brown et al. (1982, 1983) make a synopsis of the estimated elasticities from previous minimum wage studies for U.S.A. using time series data. These studies indicate that minimum wages have a negative employment effect and that a 10 percent increase in the minimum wage is associated with a decrease in teenage employment of 1-3 percent. Wellington (1991) updates Brown et al. (1982) with data through 1986 to provide new estimates, encompassing a period when the real value of the minimum wage was declining, due to the fact that its nominal value had not increased since 1981. She finds that a 10% increase in the minimum wage decreased teenage employment by 0.6 percentage points, with no effect on either the teen or young adult unemployment rates. Neumark and Wascher (2007) in their review of the new minimum wage research, find that in the range of studies comprising the new minimum wage research, estimated elasticities are outside the range of 1% to 3% of Brown et al. (1982, 1983).

However, Card and Krueger (1995) in their influential book express their concerns regarding the methodological problems associated with estimating equation (2.1), mainly regarding the choice of the control variables and the minimum wage measure. They argue that the results should be more thoroughly checked for robustness and for potential endogeneity of the minimum wage measure and the control variables. The literature that followed indicates more econometric concerns. Williams and Mills (2001) and Bazen and Marimoutou (2002) argue that the earlier papers do not properly account for serial correlation and non-stationarity in the data. To properly address those issues, Williams and Mills (2001) estimate vector autoregression (VAR) models, with separate equations for employment and the Kaitz Index (transformed as needed to ensure stationarity). Bazen and Marimoutou (2002) choose to account for the potential non-stationarity by specifying stochastic structures for the trend, seasonal and cyclical components of the model.

2.3 Data

In this section, the data collected for the purposes of this study is briefly described. The data is selected taking into consideration that the analysis concerns a country where the legislative coverage of the minimum wage is limited, since in Cyprus there is no universal coverage from the relative legislature as is the case in other countries where the effect has been tested. The comparative study of Funk and Lesch (2005), reports that out of the 27 countries that are currently members of the European Union,[4] 20 have a statutory national minimum wage, in a way similar to the U.S.A., Canada and Japan, the countries with which most minimum wage studies are concerned. Cyprus is excluded from this group, since *"Cyprus (...) has a statutory minimum wage for a few specific occupations only"*. In the remaining 6 E.U. Member States, the sectoral level agreements are widely applied, thus constituting de facto minimum wages. A common feature of this second group of countries (Austria, Denmark, Finland, Germany, Italy and Sweden) is the high coverage rate of collectively agreed minimum wages, generally laid down in sectoral agreements. The percentage of employees covered by these collectively agreed minimum wages ranges from approximately 70% in Germany to almost 100% in Austria and Italy.[5]

Given that the minimum wage rates are announced on a yearly basis, in Cyprus the data collected is of an annual frequency and the sample period is 1960-2009, that is the whole period of the existence of the Republic of Cyprus. A background of the statutory minimum wages in Cyprus (including a list of occupations covered and main historical developments) is given in Appendix A. The core variables used in this study are the employment ratio (EMPL) and the minimum wage variables. Following the existing literature, the minimum wage is measured using the Kaitz Index,[6] the definition of which is given below. As suggested in equation (2.1), a set of control variables are added in the models: real GDP, the unemployment rate, the total population, the population share of women, the number of secondary school leavers and a linear trend.[7] A more detailed presentation of all the variables can be found in Appendix B: Table B.1 presents their definitions, Table B.3 the descriptive statistics and in Figure B.1 the graphs are given.

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[4] The study included Bulgaria and Romania, even though they were not at the time full members of the European Union.

[5] See Funk and Lesch (2005), Table 8.

[6] Named after Hyman B. Kaitz who introduced it in his 1970 paper.

[7] The control variables included are the ones suggested in the existing literature and whose data are available in Cyprus through the whole sample period.

The Kaitz Index is defined as:

$$Kaitz_t = \sum_i \frac{E_{it}}{E_t}\left[\frac{MW_{it}{}^N}{AHE_{it}} C_{it}{}^N + \frac{MW_{it}{}^S}{AHE_{it}} C_{it}{}^S\right], \qquad (2.3)$$

where E_i / E : is the number of persons employed in each industry as a proportion of the total employment; MW_i is the minimum wage set in each industry;[8] C_i^N, C_i^S are the proportions of workers employed in each industry with less or more than six months experience; and *AHE* represents the average hourly earnings (since usually the minimum wage is set at an hourly rate). The superscripts N and S stand for "newly covered" and "six months period", since a different minimum wage rate is usually set in Cyprus for workers that completed six month's experience. The Kaitz Index is not available in Cyprus and one of the contributions of this study is its calculation. This is done so that changes in the legislative coverage of the minimum wage are incorporated in the index. The Kaitz Index of Cyprus is calculated by combining data from two different surveys carried out by the Cyprus Statistical Service: the Censuses of Establishments (COE) and the Household Budget Surveys (HBS). In order to address some issues created by a change in the classification system of occupations by the Statistical Service within the sample period of this study, two alternative versions of the index are created (KAITZ1, KAITZ2) and the calculations for both of them are summarily described in Appendix C.

The graphs of the data, given in Appendix B, suggest that most of the variables have upward trend.[9] What is even more obvious is that the series are characterized by the presence of structural breaks, the most eminent of them appearing in 1974. This was when a military coup, followed by the Turkish invasion, ended in the partition of the island and as a result for the period after 1974 the data refer only to the Government Controlled Area of the Republic of Cyprus. A list of political and economic events that are significant for Cyprus is given in Table B.2 of

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[8] In the current application the superscript "*i*" of equation (2.3) refers to major occupational groups, rather than industries. This is illustrated in equation (C.2) in Appendix C.

[9] For space considerations only the graphs of the main variables are included. However, the graphs of all variables are available in an earlier version of this chapter available online at: http://papers.econ.ucy.ac.cy/RePEc/papers/05-12.pdf.

Appendix B.[10] In addition to 1974, the employment variable (EMPL) also appears to have significant breaks in 1963-64 and 1969, at the time of significant inter-communal fighting in Cyprus. The Gulf War, the Cyprus Stock Exchange crisis in 1999-2000, the accession to the European Union in 2004 and the late-2000s Global Financial Crisis also seem to have had their effect on the labour market in Cyprus.

All wage and minimum wage variables (W, MW6, MWW, KAITZ1 and KAITZ2) appear to have significant breaks in 1980 and 1985-86. The main reason behind them is the wage indexation mechanism used in Cyprus, a Cost of Living Adjustment (COLA) mechanism that adjusts wages every six months, using recent price developments. In that manner, the international events that affected the petrol oil market (like the second international oil crisis 1979-80 and the oil price collapse in 1986) had an impact on wages in Cyprus, through the national price level and the aforementioned wage indexation mechanism. In addition, there is a prominent effect on the mean wage variable (W) in 1991, the year of the Persian Gulf War. The minimum wage variables (KAITZ1, KAITZ2, MWW) contain breaks in 1985 and 1995.

As for the control variables, they also indicate a prominent effect in 1974, particularly the unemployment rate (U), the total population (POP) and the Real Gross Domestic Product (Y). The unemployment rate and the Real GDP series are, in addition, affected by the second oil crisis in 1980, the Gulf War in 1991, the stock market crisis in 1999-2000 and the recent financial crisis. The structural breaks detected visually from this basic examination need to be incorporated in the unit root analysis in the following section, in order to correctly conclude on the stationarity of the series and the incorporation of the biggest of those structural breaks using dummies in the VAR model.

2.4 Unit Root Analysis

The seminal papers of Granger and Newbold (1974) and the subsequent work on cointegration give reason to seriously doubt empirical evidence based on time

[10] Table B.2 is created by adjusting the Table 3 in Appendix A of Christofides, Kourtellos and Stylianou (2006b), to the sample period of this study.

series data if any of the variables used are non-stationary. However, Engle and Granger (1987) indicate that there may be linear combinations of integrated (non-stationary) series that are stationary. In that case the series are cointegrated and, if there is a unique linear combination that is stationary, that combination expresses their long-run relationship, from which there may be short-run deviations. Therefore, the first step in estimating the relationship of total employment and the minimum wage is to examine the stationarity of the series.

As the previous section indicates, the time series examined appear to have been influenced by a number of political and economic events. The seminal paper of Perron (1989) and the subsequent literature indicate that the presence of structural breaks in a series may bias the unit root tests towards accepting the null of the presence of a unit root. Therefore, for stationary series containing a structural break in the trend or the intercept, unit root tests, such as Augmented Dickey-Fuller (ADF) tests, may incorrectly indicate non-stationarity. In the tables presented in Appendix D, the stability of the series is examined using root tests under exogenous and endogenous structural breaks. Augmented Dickey-Fuller (ADF) tests (Dickey and Fuller; 1979, 1981) were also performed for reference reasons and the results are presented in Table D.1.

The results from Perron (1989) tests are presented in Table D.3 of Appendix D, where probable structural breaks are incorporated in the auxiliary regressions used. Given the critical values provided in the 1989 paper, the null of the presence of a unit root may be tested in such a way that structural breaks do not bias the test towards accepting the null hypothesis. The Perron tests are performed using three alternative models: Model A refers to a break in the intercept, Model B to a break in the linear trend and Model C to a structural break that affects both the trend and the intercept of the series.[11]

The results in Table D.3 indicate that two variables: the national mean wage (W) and the total population (POP), which the ADF tests in Table D.1 indicated as non-stationary, now appear stationary around a broken trend and a break in the intercept at 1% significance level. For the first version of the Kaitz Index (KAITZ1) and the plain Kaitz Index (MWW) the null of the presence of unit root

[11] The adjustment suggested by Perron and Vogelsang (1994) is made in all the auxiliary regressions used.

is accepted also, but only at 10% significance level. Table D.3 also confirms the ADF results that the employment ratio, the unemployment rate and the secondary school leavers variables are stationary. For the rest of the series, the coefficients of the Perron models indicate that they contain structural breaks in the years suggested in the previous section, but, incorporating those breaks with an appropriate version (Model) suggested by Perron (1989), does not remove the evidence of the presence of a unit root and the series are indicated as non-stationary. Those series are the second Kaitz Index (KAITZ2), the real minimum wage rates (MW6, MW), the coverage variables (CC1, CC2), the Gross Domestic Product in 1995 Constant Prices (Y) and the female ratio in the total population (GENDER).

Even if the methodology suggested by Perron (1989) for testing for unit roots in the presence of structural breaks is considered very reliable, the literature that follows, most notably Christiano (1992), criticizes the fact that the location of the structural breaks in the series is determined exogenously (i.e. by the tester) in the Perron methodology. This approach invalidates the distribution theory underlying the conventional estimation methods (the independence assumption, in particular). For that reason, the significance of the breaks indicated by the Perron tests may be overestimated and several studies have been developed using methodologies where the location of the break is endogenously determined. The most notable of them are: Banerjee, Lumsdaine and Stock (1992) and Zivot and Andrews (1992).

In order to account for the Christiano critique, Zivot and Andrews (1992) tests are also performed for the variables and their results are presented in Table D.2 of Appendix D. These types of tests use the three models suggested by Perron (1989), allowing for the breaks to be determined endogenously and providing the appropriate critical values. The Zivot and Andrews tests confirm the results of Table D.3 for the national mean wage (W), the plain Kaitz Index (MWW) and the total population (POP) – stationary around a broken trend and intercept. In addition, the real minimum wage variables (MW6 and MW), that ADF and Perron tests indicate as containing a random walk component, now appear as being trend stationary. On the other hand, the unemployment rate (U) and the secondary school leavers (LEAV) variables that both the ADF and the Perron tests indicated as stationary, now appear as non-stationary. The employment ratio (EMPL) is indicated stationary across all three tests, while the second Kaitz Index (KAITZ2), the coverage variables (CC1, CC2), the Gross Domestic Product at 1995 Constant Prices (Y) and the female ratio in the total population (GENDER), are indicated as non-stationary, whether their structural breaks are determined exogenously or endogenously.

The results from Tables D.2 and D.3 indicate that the most prominent structural breaks in the variables examined occurred in 1970 (right after an outbreak of inter-communal violence and the ratification in Cyprus of International UN Conventions on employment issues), in 1974 (at the time of the military coup and the Turkish Invasion), in 1980 (when the second international petrol oil prices crisis was on), in 1985-86 (when oil prices collapsed after OPEC countries decreased their oil production several times between 1980-1985 in order to keep prices high) and in 1995-96 (when an inter-ethnic fighting occurred that led to a political crisis and the financial sector of Cyprus was being radically reformed by the Central Bank).[12]

The evidence of structural breaks, their location and the univariate series specification that resulted from the analysis in this section informs the multivariate analysis carried out in the following section. The sensitivity of the vector autoregression models to correct specification regarding the stationarity of the variables, the appropriate dynamic specification (lag length) and endogeneity issues all suggest that the VAR specification must be carefully constructed.

2.5 Estimation and Results

In this section the short-run relationship between the total employment and the minimum wage variables is examined, using VAR models, which may capture the effects of endogeneity, dynamic specification and the non-stationarity indicated by the univariate series analysis. These models, first suggested by Sims (1980), are a simultaneous system of dynamic equations representing the relationship of

[12] A more extensive analysis on the presence and effects of structural breaks in main macroeconomic variables of Cyprus, such as GDP, price level, national mean wage, money supply and unemployment rate, is given in the following papers: Christofides, Kourtellos and Stylianou (2006a, 2006b), and Christofides and Vrahimes (2006). Those studies use quarterly data for the period 1981-2004.

the endogenous variables with their lagged values, deterministic variables such as linear trends and other variables that are considered exogenous to the system:

$$Z_t = \mathrm{A}_o + \sum_{i=1}^{\mathrm{P}} \mathrm{A}_i Z_{t-i} + \mathrm{B}D_t + \Gamma X_t + U_t, \qquad (2.4)$$

where *Z* is the vector of the endogenous variables (employment ratio and the Kaitz Index), *D* the vector of deterministic terms, *X* the vector of exogenous variables (unemployment rate, Real GDP, total population, female ratio in the total population and secondary school leavers) and *U* the vector of error terms that are normally distributed. If the results from estimating (2.4) indicate the presence of a long-run relationship between endogenous variables, this can be estimated via the use of the Vector Error Correction Model (VECM):

$$\Delta Z_t = \mathrm{A}_o + \Pi Z_{t-1} + \sum_{i=1}^{\mathrm{P}} \mathrm{E}_i \Delta Z_{t-i} + \mathrm{B}D_t + \Gamma X_t + U_t \qquad (2.5)$$

The cointegration hypothesis mentioned in the previous section is tested by examining the algebraic properties of the Π matrix.

2.5.1 VAR Estimation

Because the evidence from the previous section indicates that the employment variable (EMPL) does not contain a unit root, EMPL is not differenced in any of the models. However, for the first version of the minimum wage index (KAITZ1) the null of the presence of unit root is only marginally rejected and for the second version of the minimum wage index (KAITZ2) all the tests indicate the presence of a unit root.[13] For this reason, four VAR models are specified and estimated in order to choose the most statistically adequate for examining the relationship between the two endogenous variables. These models are differentiated only in

[13] Note that since the employment variable is found stationary, while the Kaitz index is indicated nonstationary, all estimates using the standard specification of equation (2.1) will be inconsistent.

regards to the minimum wage variable: the first and third models, VAR(KAITZ1) and VAR(KAITZ2), use the two versions of Kaitz Index in levels, while the second model and fourth models, VAR(DK1) and VAR(DK2), use the same indices in first differences. The estimation results for all four of them are given in Appendix E. For all four models, certain steps are followed, especially regarding the lag order selected and the statistical adequacy of each model. For that manner, the tests conducted include tests for Serial Correlation, Normality and Homoskedasticity and their results are presented in Table 2.2, later on.

Given the evidence for the presence of structural breaks in most of the variables,, special attention is given in the selection of appropriate dummy variables, in order to incorporate the significant breaks in the VAR models estimated. Often structural breaks characterize macroeconomic variables over a long period of time and (as indicated in the previous section) this fact is typical for Cyprus. Therefore, not incorporating such important events in the analysis could compromise the quality of the estimates, generating results which will be biased from the presence of eminent structural breaks, such as the Turkish Invasion in 1974. The presence of structural breaks also affects both the short-run and long-run relationships between the variables. Therefore, in the cointegration tests conducted in this section the critical values are estimated using a procedure that allows for the presence of the structural break dummies. Their results are presented in Table 2.1, later on.

Not all structural breaks detected in section 2.3 are incorporated in the VAR models, since then the estimations carried out would not have substantial degrees of freedom. For that reason, only the most prominent breaks are included, and thus all four models include a constant term, a linear trend and dummy variables, accounting for the structural breaks in the intercept and the trend of the variables in the years 1974 and 1980 (at the times of the Turkish Invasion and the second international oil price crisis). The one-time break in the intercept (outlier) in the minimum wage indices in 1985 is also taken into account. The dummies used to capture the effect of the breaks are the same ones used in the Perron (1989) tests carried out in the previous section.

The VAR models are used for the detection of short-run relationship between the system variables and these relationships may be tested through the Granger Causality tests, where the null hypothesis is that there is no relationship between the endogenous variables. It is very important to perform Granger Causality tests in VAR models for two reasons: the first reason is that the endogenous variables of the system should be characterized by a two-way Granger causality, or else one or more equations of the system could be omitted from the estimations. The results for the Granger Causality tests performed for all four VAR models are presented in Table E.5 of Appendix E.

The second reason for which Granger Causality tests should be performed is that if the VAR model includes control variables, those should be tested to see whether they are Granger-caused by the endogenous variables. In that case, the estimations carried out would suffer from endogeneity bias. The potential endogeneity problem of the control variables is tested with Granger Causality tests in a number of auxiliary VAR models. Out of the five control variables examined, only the unemployment rate is indicated as endogenous, not surprisingly, since as suggested in the literature review, minimum wage policies may impact unemployment rates as much as unemployment rates may impact minimum wages. For that reason the unemployment rate is omitted from all models.[14]

Another concern related with the control variables included in the models is whether they are non-stationary and thus they affect the quality of the estimates. The unit root tests performed in the previous section indicate that from the remaining four exogenous variables only Real GDP (Y) and the proportion of women in the total population (GENDER) are indicated as non-stationary by all tests. Whenever those two variables are indicated as statistically significant in levels, an auxiliary VAR was used to test the null of cointegration, and if it was rejected, the variables are used in first differences. In that manner, Y is included in two of the models in levels, due to evidence of cointegration with the endogenous variables, while GENDER is included in first differences in the other two models.

[14] Estimation of trivariate VAR models were also attempted, where the unemployment rate was the third endogenous variable, but those were abandoned, since the limited number of observations led to an exhaustion of the degrees of freedom of the models from the early stages of specification.

Table 2.1: Tests for Cointegration

Endogenous Variables	Null Hypothesis	Maximal Eigenvalue	Critical Value	Trace Statistic	Critical Value	Johansen et al. (2000)
EMPL, KAITZ1	r = 0	80.08	19.39	94.89	25.87	36.06
	r = 1	14.81	12.52	14.81	12.52	18.29
EMPL, DK1	r = 0	41.25	19.39	66.42	25.87	36.06
	r = 1	25.17	12.52	25.17	12.52	18.29
EMPL, KAITZ2	r = 0	78.48	19.39	87.10	25.87	33.53
	r = 1	8.62	12.52	8.62	12.52	16.88
EMPL, DK2	r = 0	27.51	19.39	49.24	25.87	33.53
	r = 1	21.73	12.52	21.73	12.52	16.88

Note 1: Critical Values at 5% significance level.

Note 2: The alternative hypothesis for the Maximal Eigenvalue Test is that the rank of Π matrix in equation (2.5) is equal to: r + 1.

Note 3: The alternative hypothesis for the Trace Test is: rank(Π) > r.

As indicated in the VAR model estimates presented in the tables of Appendix E, there is evidence of a short-run relationship between employment and minimum wages, since the lagged values of the one endogenous variable appear to have significant effects on the other. In order to check whether there is also a long-run relationship between the endogenous variables it is necessary to determine the cointegrating rank of the model. The test procedure used is the one introduced by Johansen (1991, 1995), but the critical values are estimated using the procedure of Johansen et al. (2000) to allow for the presence of the structural break dummies. The results are presented in Table 2.1.

From Table 2.1 it is evident that only one of the four estimated VAR models has a cointegrating rank equal to one and thus may be estimated in a VECM form (where the long-run relationship between the variables of the system and the short-run dynamics may be simultaneously estimated.). However, in this model a potentially integrated variable (Kaitz Index 2) is not differenced and theoretically the error term will not be stationary and the results spurious. The other three VAR models are indicated as stationary. In the Misspecification Testing results presented in Table 2.2 below the VAR models employing the first Kaitz Index are indicated as suffering from serial correlation problems, either in levels or in first differences (no matter what number of lags were used). Since the tests in Tables

2.1 and 2.2 indicate presence of short-run relationship between total employment and the differenced minimum wage measure (DK2), this model is used in order for the relationship to be identified in a VAR specification.

Table 2.2: Misspecification Tests

	VAR (KAITZ1)	VAR (DK1)	VAR (KAITZ2)	VAR (DK2)
Breusch–Godfrey LM Test	0.093	0.046	0.740	0.957
Jarque-Bera Normality Test	0.000	0.000	0.000	0.000
White Heteroscedasticity Test	0.783	0.934	0.704	0.341

Note 1: The p-values of the tests are reported.

Note 2: The null hypothesis in the Breusch–Godfrey LM Test is 'No Autocorrelation', in the Jarque-Bera Test the null hypothesis is 'Normality', and in the White Test the null hypothesis is 'No Heteroscedasticity'.

In the Granger Causality tests in Table E.5 in Appendix E there is strong evidence for DK2 Granger causing EMPL, but less evidence for vice versa. In the Variance Decomposition results from Table E.6 the EMPL has a prominent impact on the variance of DK2, which is evidence against the employment variable being exogenous with respect to the minimum wage. The direction of this relationship (if one variable positively or negatively affects another variable), and how long a shock impacting one variable will affect another variable, is examined by the Impulse Response Analysis in the next section of the present study.

2.5.2 Dynamic Analysis

The Variance Decomposition Analysis results (Table E.6 of Appendix E), indicate that the minimum wage index has a prominent impact on the variance of the employment variable. In the tenth period after a positive shock in the minimum wage, about 12% of the variation of the employment variable is due to the minimum wage. On the other hand, the variation in employment accounted for less than 5% of the variation on the minimum wage index, ten periods after a positive shock on the employment.

The Impulse Response Analysis provides information to analyze the dynamic behaviour of a variable due to a random shock or innovation in other variables. Specifically, the impulse response functions trace out the effects on current and future values of the endogenous variables of one standard deviation shock to a variable. In the Impulse Response Analysis graphs, also in Appendix E, it is indicated that a positive shock in the minimum wage has a negative effect in total employment which converges towards zero after two years.

The results suggest that a positive shock in the growth of the Kaitz Index (minimum wages) results in a decrease in employment ratio. The shock in the Kaitz Index itself is large and tends to be persistent (it takes three years to die out). This dynamic reaction of the minimum wage measure can be attributed to the small variation of the index in the periods for which there were no changes in the legislative coverage of minimum wages and to the fact that the most severe shocks that Cyprus experienced were absorbed through the use of dummy variables. So, even a small shock in the index causes unexpectedly large effects in its future values. A shock in the employment ratio on minimum wages is very small and it fluctuates around zero before it dies out. This effect may suggest that current employment rates are an important consideration when formulating future minimum wage policy. The effect on employment ratio itself is large but not persistent.

According to the results presented above, there is a negative relationship between employment and the statutory minimum wage in Cyprus. Given that the coverage of the minimum wage legislation is limited to only nine occupations, the fact that the relationship is indicated as significant is really important. In the framework of Moser and Stahler's (2009) analysis, the introduction of a minimum wage only unambiguously reduces job creation and employment in the uncovered sector, whereas its employment effect on the covered sector is ambiguous. A minimum wage may increase employment in the covered sector by increasing the job duration or decrease it because of the associated rise in the labour costs of the firms. In that manner, the minimum wage effect on the covered employment depends on which one of these effects dominates, while the effect on total employment depends on the sign and magnitude of the effect on the covered sector. A negative impact of the minimum wage on total employment indicates that the minimum wage in Cyprus decreases employment in the uncovered sector, while in the covered occupations the effect is either negative as well, or positive but not sufficient to counterbalance the effect in the uncovered sector.

Thus, in the Moser and Stahler framework, the negative effect on total employment suggests a situation where the minimum wages increase improves the bargaining position of the employees in the uncovered occupations, their ability to demand higher wages and leaves firms less willing to hire. The effect of the minimum wage in the covered sector is either negative (due to the firm's costs associated with minimum wage increases exceeding the benefits associated from an increase in the duration of employment), or positive, but not large enough to exceed the negative effect in the uncovered sector.

2.5.3 Evidence from Decomposition of the Kaitz Index

The studies mentioned in section 2.2 all use variants of the Kaitz Index as the measure of the minimum wage in their estimations. As discussed by Brown et al. (1983), this measure is desirable because it incorporates both a relative minimum wage and an adjustment for the actual coverage. However, it has some disadvantages, one of them being that it constrains the minimum wage and the coverage effects to be the same, although there is no reason to impose this restriction a priori. Given that this study is about a country where the legislative coverage is limited, the usual practice of breaking the Kaitz index is followed (e.g. Brown et al. 1983 and Wellington 1991), where the index is decomposed into:

$$MWW_t = \frac{MW6_t}{W_t} \tag{2.6}$$

$$CC_t = \sum_i \frac{E_{it}}{E_t} \Phi_{it} C_{it}^S \tag{2.7}$$

$MW6_t$: is the minimum wage rate set for the employees after they reach six months of experience and W_i: is the national mean wage. E_i / E: is the number of persons employed in each main occupational group, as a proportion of the total employment (=the 'employment weight'), Φ_i: is the proportion of the workers in each occupational group that are covered by the Minimum Wage Law (=the 'coverage weight') and C_i^S: is the proportion of workers employed in each occupational group with more than six months' experience (=the 'experience proportion').

The effect of those two alternative measures of the minimum wage are investigated with an additional VAR model, where the MWW variable (the ratio of minimum wage to the national mean wage) substitutes DK2 as an endogenous variable and the related coverage variable (CC2) is added to the control variables.[15] The results from the estimations and the tests (misspecification, Granger Causality and Cointegration) are presented in Appendix F, where it is indicated that this VAR model is stationary and thus a cointegration analysis could not be carried out.

An interesting result, though, is that the coverage variable (CC2) is not significant is this model, even if used in first differences, indicating that the results above are due to the minimum wage rather than coverage effects. This result is not something new in the literature, since the findings in most of the papers where the Kaitz Index is segmented indicate a weak, if any, coverage effect.[16] Neumark and Wascher (2007) also indicate that the weak empirical evidence, in combination with the lack of available data, led more recent studies to ignore the coverage effect altogether. In Cyprus, where there is a very limited legislative coverage, this result is consistent with the Moser and Stahler (2009) analysis, where the minimum wage creates significant spill-over effects to the uncovered sector and thus the proportion of the occupations covered by the minimum wage legislation becomes of less importance, since even those not covered are affected.

2.6 Conclusion

This study investigates the relationship between total employment and the minimum wage, in a case where the coverage of minimum wage is very limited. The most frequently cited results about minimum wage effects on employment come from time series studies, carried out in countries where the minimum wage is legally binding for nearly all occupations, while in Cyprus the legislative coverage of the minimum wage law is concentrated to specific occupations. It is also stressed that in the existing time series literature the econometric concerns for stationarity and endogeneity of the control variables used are not emphasized.

[15] An even more analytical method in decomposing the Kaitz Index effect is to use the real minimum wage as endogenous variable and both the real national mean wage and the coverage as controls. However, the real mean wage was indicated as endogenous in the preliminary tests and thus could not be added as control in the model.

[16] See Brown et al. (1983) for a discussion of those papers.

Neither is the dynamic relationship between minimum wages and employment examined in detail. These topics are crucial in obtaining consistent and robust results, and for that reason vector autoregression models are applied in this study, where those concerns are adequately checked and dealt with.

Given the small number of observations and the presence of structural breaks in the sample period (both being caveats when testing for unit roots), the stationarity of the series is carefully examined, allowing for the structural breaks to be determined both exogenously and endogenously in the sample. The evidence of structural breaks and their location then informs the multivariate analysis carried out, where the most eminent structural breaks detected are incorporated in the vector autoregression models estimated. Since two variants of the Kaitz Index, the most popular minimum wage measure, are calculated, more than one VAR models are examined in order to examine the relationship between employment and minimum wage. It is found that there is a negative and significant relationship between total employment and the minimum wage, despite the fact that the legislative coverage is limited to a number of occupations only.

It is found that there is a negative and significant relationship between total employment and the minimum wage, despite the fact that the legislative coverage is limited to a number of occupations only. The Variance Decomposition Analysis indicates that the variance of the employment variable is affected by the variability of the minimum wage measure. According to the most recent two-sector search and matching framework, this result arises from the fact that the minimum wage has a negative spill-over effect in sectors that are not covered by the minimum wage legislation. Those spill-overs occur when increases in the minimum wage in the covered sector act as a reference point, raise bargaining power and trigger higher wage settlements in the uncovered sector which discourage employment.

The estimations also suggest that the coverage effects of the minimum wage on total employment are not significant. This result is not new in the literature. However, in the case of Cyprus, the legislative coverage is limited and, thus, the insignificance of the coverage effects may be interpreted as additional evidence in favour of the existence of significant spill-over effects from the minimum wage to the uncovered sector.

Appendix A: The Minimum Wage Background in Cyprus

In Cyprus there is a unique standard regarding protecting remunerations at the bottom of the labour market. Wages and salaries are set as the result of bipartite negotiations between the most representative employers' organisations and trade unions, at the sectoral and enterprise levels. However, the parties to the collective agreements are not bound by the principle of a national statutory minimum wage. Based on the existing legislation (Law on minimum wages, Chapter 183), the monthly minimum wages are currently set for the nine occupational groups listed in Table A.1.[17]

Table A.1: Occupations Covered by the Minimum Wage Law in Cyprus

Occupations Covered	Period of Coverage
1. Salespersons 2. Clerks	1944 – currently
3. Auxiliary Healthcare Staff 4. Auxiliary Staff in Nursery Schools 5. Auxiliary Staff in Crèches 6. Auxiliary Staff in Schools	1990 – currently
7. Guards 8. Caretakers Working in Clinics, Private Hospitals and Nursing Homes	2008 – currently
9. Cleaners in Business/Corporate Premises	2010 – currently

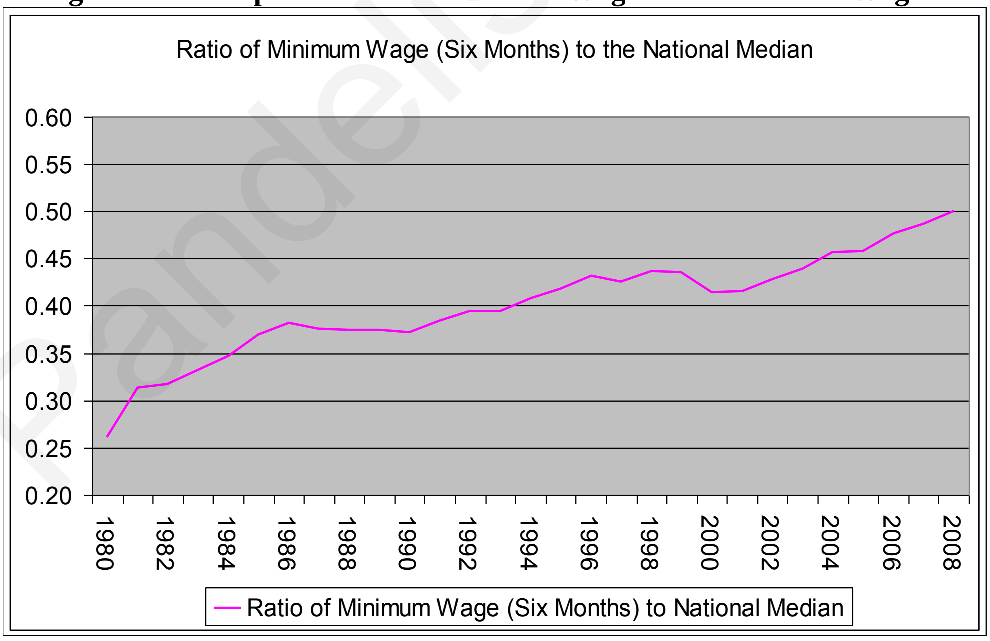
The Cyprus Minimum Wage Law was created in 1941 in order to protect the rights of mining workers. In 1944 the Law was amended in order to include salespersons and clerks and in 1957 the Law ceased to include mining workers.

[17] In 2009, the minimum wage for Guards started to be set at an hourly rate instead. In 2011 the same happened to the Cleaners of Business/Corporate Premises.

Initially the minimum wage rate was being increased periodically (1951, 1974, 1977, 1979), but as of 1981 a minimum wage rate is set every year. In 1990 a new amendment of the Law was carried out, in order to cover four additional occupations: auxiliary health staff and auxiliary health staff in schools, crèches and nursery schools. As is the case in other countries, a different minimum wage is set for the employees after they reach six months of experience.

In 2005 the European Industrial Relations Observatory (EIRO) comparative study on minimum wages indicated that the national minimum wage in Cyprus was approximately 60% of the corresponding average in the 15 EU countries having a statutory national minimum wage. According to the Labour Institute of Cyprus (INEK) the minimum wage in 2004 was only 41% of the national average gross wage (net wage plus employee contributions to social security for full time employees). As this was considered very low, the percentage increases of the minimum wage from 2002 and after aimed at gradually bringing the minimum wage up to 50% of the national median by 2008 (Ministerial Decision No 55.535, 24 April 2002). As may be seen in Figure A.1, this goal was achieved.

Figure A.1: Comparison of the Minimum Wage and the Median Wage



In 2008 guards and carers were added to the covered groups and in 2010 the Law was amended once again in order to include the cleaning personnel in business/corporate buildings, after this was suggested by the findings of an ad-hoc study carried out by the Statistical Service of Cyprus.

A.1 Conflicting Opinions

The statutory minimum wage was launched with the aim to cover certain categories of non-unionized workers paid at unreasonably low wage rates. However, not all the parties to the collective agreements agree on its necessity.

In the opinion of the Employers' and Industrialists' Federation of Cyprus (O.E.B.), the reasons that made legislation covering certain categories of non-unionized workers necessary in the past, have long since disappeared. The reason for this is the particularly high level of union density in Cyprus that has made the continuation of the current practice unnecessary. This, among other things, distorts the system of collective bargaining, since it pushes wages, freely agreed in collective agreements, upwards. They also express concerns about potential disemployment effects.

The Cyprus Chamber of Commerce and Industry (K.E.B.E.), is not in favour of the abolition of the minimum wage. Nevertheless, they maintain that labour market conditions should be examined first and that minimum wage rates should be adjusted accordingly. Otherwise, the minimum wage may be raised to such a degree that it endangers collective bargaining. In this context, K.E.B.E.'s opinion is that the minimum wage should cease to be renewed, because the recent minimum wage changes have overcome the level agreed upon in the collective agreements. K.E.B.E., like O.E.B., also maintains that there is no need for new sectors of the economy or new occupations to be covered by the minimum wage.

On the other hand, trade unions urge that the minimum wage should be maintained and improved. In particular, they believe that it is necessary to strengthen control mechanisms for monitoring the implementation of the minimum wage. It was also expressed that there is a need for collective labour agreements to acquire a legally binding content, if not in their entirety then at least with regard to the basic terms and conditions of employment.

A.2 Enforcement

The implementation of the minimum wage is carried though the provisions of the Law on minimum wages, Chapter 183, Article 5(1): any employer or representative of the employer who fails to comply with the provisions of the law, and in particular the minimum rates set by the Council of Ministers, may be fined with an amount that does not exceed £100 (€171), together with an additional amount for every day of non-compliance that does not exceed £25 (€43).

There are no data available on the degree of compliance or non-compliance, but there are indications that in some sectors of the economy, such as in retail, the law on minimum wages is often violated. For example, according to data from the Ministry of Labour given to social partners in 2005, in the retail sector out of 936 saleswomen that participated in the survey, 20% are paid less than the minimum wage upon hiring. In this context, the Pancyprian Federation of Labour (Π.Ε.Ο.) recognises that there is a problem with the control mechanisms in place for monitoring the implementation of minimum wage.

Appendix B: Data Description

Table B.1: Variable Description and Sources

Variable	Description	Source
EMPL	Gainfully Employed Population	CYSTAT
KAITZ1 *KAITZ2*	The Kaitz Indices are calculated using the minimum wage, the mean national wage and weights calculated from two surveys of the Statistical Service of Cyprus. Their calculation is described in Appendix C.	CYSTAT, ERC and MOL
MWW	Minimum Wage at Six Months / Mean Wage (The simplest version of the Kaitz Index)	CYSTAT and MOL
MW6	Minimum Wage at Six Months / Consumer Price Index (Base Year 1992)	MOL
MW	Minimum Wage at Start / Consumer Price Index (Base Year 1992)	MOL
W	Mean National Wage / Consumer Price Index (Base Year 1992)	CYSTAT
CC1 *CC2*	The Legislative Coverage of the Minimum Wage is calculated in two variants, using data from the Census of Establishment's (COE) and the Household Budget Surveys (HBS) of the Statistical Service of Cyprus. Their calculation is described in Appendix C.	CYSTAT and ERC
U	The Unemployment Rate: unemployed persons as % of Economically Active Population	CYSTAT
Y	Gross Domestic Product (GDP) at 2005 Constant Prices	CYSTAT
POP	Total Population	CYSTAT
GENDER	The share of women in the total population	CYSTAT
LEAV	Total Secondary School Leavers / Total Population	CYSTAT

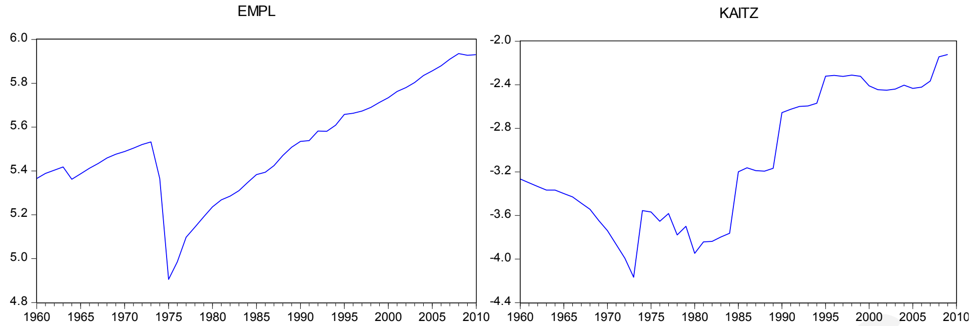
Note 1: All variables are in natural logarithms, except the unemployment rate.

Note 2: CYSTAT: Statistical Service of Cyprus, ERC: Economics Research Centre of the University of Cyprus, and MOL: Industrial Relations Department of the Ministry of Labour.

Table B.2: Significant political and economic events in Cyprus

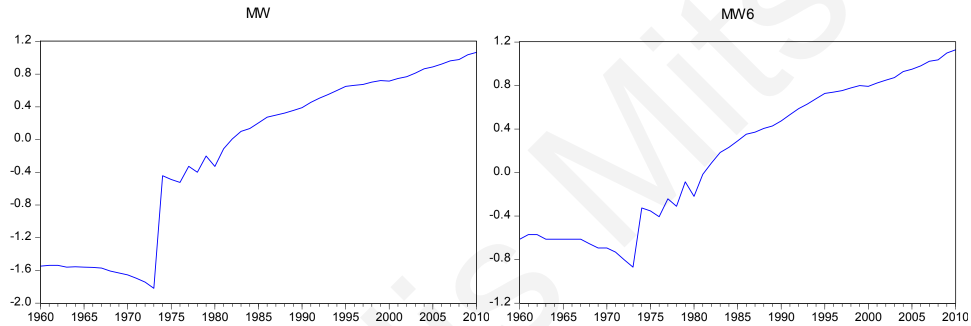
Date	Description
1963-1964	An inter-ethnic fighting broke out that led to many areas of Cyprus being bombed and napalmed.
1968-1969	The International UN Conventions on Economic, Social and Cultural Rights and on the Political Rights of Women were ratified in Cyprus. Another outbreak of inter-communal violence occurred in the same period.
1973-1974	1973 international oil crisis that started in October 1973 and lasted until March 1974.
1974	A military coup, followed by Turkey invading Cyprus, ended in the partition of Cyprus along the UN-monitored Green Line which still divides Cyprus today.
1979-1980	1979 (or second) oil crisis.
1985-1986	1986 oil price collapse after OPEC countries decreased oil production several times between 1980-1985 in order to keep prices high.
1987	A Protocol referring to the contents of the second stage of the 1972 Cyprus-EEC Association Agreement leading to a Customs Union was signed.
1991	Persian Gulf War.
1992	On June 1992 the Cyprus Pound was pegged to the ECU. On the following September, UK and Italy, two of Cyprus trading partners, withdrew from ERM (European Exchange Rate Mechanism).
1999-2000	Cyprus Stock Exchange crisis.
2001	September 11th terrorist attacks on the U.S.A. Cyprus interest rates were liberalized.
2004	Cyprus becomes a full member of the European Union.
2008	Cyprus completed the third stage of the Economic and Monetary Union of the European Union (EMU) and thus adopted the Euro as its official currency.
2008-2010	Late-2000s Global Financial Crisis.

Figure B.1: Graphs of the Main Variables



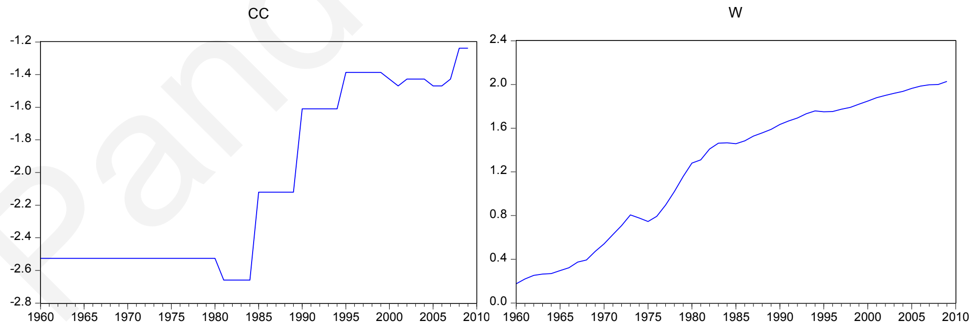
EMPL: The natural logarithm of the Gainfully Employed Population in Cyprus, measured in hundreds of thousands of workers.

KAITZ : The natural logarithm of the Kaitz Index 2, calculated by combining data from two different studies of the Statistical Service of Cyprus.



MW: The natural logarithm of the legal minimum wage rate, expressed in real terms with the use of the Consumer Price Index (Base Year 1992).

MW6: The natural logarithm of the legal minimum wage rate, after six months of continuous employment, expressed in real terms with the use of the Consumer Price Index (Base Year 1992).



CC: The natural logarithm of the legislative coverage of the minimum wage in Cyprus, calculated by combining data from two different studies of the Statistical Service of Cyprus.

W: The natural logarithm of Mean National Wage, expressed in real terms with the use of the Consumer Price Index (Base Year 1992).

Table B.3: Descriptive Statistics

Label	Mean	Median	Standard Deviation	Max	Min
EMPL	-0.115	-0.095	0.059	-0.061	-0.384
KAITZ1	-2.632	-2.598	0.318	-2.068	-3.404
KAITZ2	-3.102	-3.231	0.613	-2.122	-4.166
MW6	0.163	0.290	0.647	1.127	-0.869
MW	-0.157	0.204	0.993	1.067	-1.819
W	1.249	1.464	0.623	2.027	0.175
MWW	-0.805	-1.033	0.537	0.299	-1.491
CC1	-1.592	-1.666	0.209	-1.171	-1.832
CC2	-2.065	-2.323	0.528	-1.237	-2.659
U	0.033	0.029	0.025	0.134	0.009
Y	8.042	8.049	0.701	9.098	6.756
POP	6.413	6.399	0.133	6.684	6.209
GENDER	-0.682	-0.682	0.005	-0.673	-0.691
LEAV	8.727	8.834	0.402	9.256	7.472

Note: All variables are in natural logarithms, except the unemployment rate.

Appendix C: Calculation of the Kaitz Index for Cyprus

As defined in section 2.3, the Kaitz Index is calculated as the weighted sum of the minimum wage from each industry, accounting for the fact that a different minimum wage rate is set for workers that completed six months' experience. In other words, it is merely the ratio of the legal minimum wage to the average earnings weighted by its coverage in each industry:

$$MW_t = \sum_i \frac{E_{it}}{E_t} \left[\frac{MW_{it}^{N}}{AHE_t} C_{it}^{N} + \frac{MW_{it}^{S}}{AHE_t} C_{it}^{S} \right] \tag{C.1}$$

In Cyprus such an index is not available and is calculated in this study as follows:

$$Kaitz_t = \sum_{i=1}^{M} \frac{E_{it}}{E_t} \Phi_{it} \left[\frac{MW_t^{N}}{W_t} C_{it}^{N} + \frac{MW_t^{S}}{W_t} C_{it}^{S} \right] \tag{C.2}$$

E_i / E : is the number of persons employed in each main occupational group, as a proportion of the total employment (=the 'employment weights'), Φ_i : is the proportion of the workers in each occupational group that are covered by the Minimum Wage Law (=the 'coverage weights'), C_i^N, C_i^S : are the proportions of workers employed in each occupational group with less or more than six months' experience (=the 'experience proportions'), MW^B, MW^S : are the corresponding minimum wage rates and W : the national mean wage. The superscripts "N" and "S" stand for "newly covered" and "six-month period".

Minimum wage data are available from the Industrial Relations Department of the Ministry of Labour and the mean wage rates are collected from the Labour Statistics publications of the Statistical Service of Cyprus. The employment weights, the coverage weights and the proportions of the workers that completed six months' experience are calculated using the available microdata. In order for this calculation to be possible, the occupations that are covered by the Minimum Wage Law had to be identified in the occupational code used by the Statistical Service of Cyprus (CYSTAT).

C.1 Identification of the Covered Occupations

As mentioned in Appendix A, the occupations that are covered by the Minimum Wage legislation in Cyprus (as of 1 April 2010) are: 1. salespersons, 2. clerks, 3. auxiliary healthcare staff, 4. auxiliary staff in nurseries, 5. auxiliary staff in crèches, 6. auxiliary staff in schools, 7. guards and 8. caretakers working in clinics, private hospitals and nursing homes. (The ninth category, cleaners of corporate premises, is excluded, because it was added in 2010 and falls outside the sample period of this study).

Table C.1: Identification of the Covered Occupations in ISCO-1988

Occupations Covered by the Minimum Wage Law	ISCO-1988 Occupational Codes
1. Salespersons	5220, 5230.
2. Clerks	3432, 4111, 4112, 4113, 4114, 4115*, 4141, 4142, 4143, 4144, 4190, 4211, 4221, 4222, 4223, 4290.
3. Auxiliary Healthcare Staff	3221, 3225, 3231*, 3232*.
4. Auxiliary Staff in Nursery Schools 5. Auxiliary Staff in Crèches 6. Auxiliary Staff in Schools	2332*, 3310, 3320, 5131.
7. Guards	5169, 9152.
8. Caretakers Working in Clinics, Private Hospitals and Nursing Homes	5132, 9131.

The Statistical Service of Cyprus (CYSTAT) uses the International Standard Classification of Occupations (ISCO) in recording individual data for the occupations practiced within the country. The International Standard Classification of Occupations (ISCO) is one of the main international statistical standards and classifications for which the International Labour Office (ILO), represented by its Bureau of Statistics (STAT), is responsible. The version currently used by CYSTAT is ISCO-1988 and a synopsis of the identification of covered occupations in ISCO-1988 is presented in Table C.1.

With the help of CYSTAT, 30 occupations were identified matching the eight occupations covered by the Minimum Wage Law. Each unique 4-digit numerical code in the second column in Table C.1 corresponds to an occupational category that is covered by the Law. For example, the code "5220" corresponds to the category "Shop salespersons and demonstrators". The asterisk (*) indicates an occupational category that may include occupations not covered by the minimum wage legislation (e.g. "3231" – "Nursing associate professionals").

Table C.2: Occupational Groups Covered under ISCO-1988

Occupational Groups	ISCO-1988 Occupational Codes
Professionals	**2** (2332)
Technicians and associate professionals	**3** (3221, 3225, 3231*, 3232*, 3310, 3320, 3432)
Clerks	**4** (4111, 4112, 4113, 4114, 4115*, 4141, 4142, 4143, 4144, 4190, 4211, 4221, 4222, 4223, 4290)
Service Workers and Shop and Market Sales Workers	**5** (5131, 5132, 5169, 5220, 5230)
Elementary Occupations	**9** (9131, 9152)

In Table C.2 the covered occupations are organized according to the main occupational groups, as recorded by CYSTAT. The Kaitz Index (equation C.2) is calculated according to this classification.

C.2 Calculation of the Employment and Coverage Weights

Since the employment variable used in this study is the Gainfully Employed Population, the employment weights (E_i / E) for each of the occupational groups described in the first column in Table C.2, refer to total employment. For the years 1976, 1981, 1985, 1989, 1995 and 2000 those are calculated from the Census of Establishments (CEO) surveys, while for the years 2000-2009 the employment weights are calculated from the Statistical Abstracts, an annual publication of CYSTAT.

The coverage weights (Φ_i) refer to salary earners, that is, to the share of the total employed population that is directly affected by the Minimum Wage Law.[18] They are calculated as the ratio of covered employees (salary earners) to the total number of employees, in each of the occupational groups recorded in the first column in Table C.2. The sources of the data used are the Census of Establishments (CEO) publications, the only CYSTAT publication that classifies employment data analytically (i.e. in the 4-digit numerical ISCO-1988 classification system described previously). The CEO surveys take place every 4-6 years and the data used in this study is collected from the surveys of 1976, 1981, 1985, 1989, 1995 and 2000.[19]

C.3 Calculation of the Experience Proportions

Since the CEO surveys do not record the level of experience of the workers, the proportions of persons employed according to experience (C_i^N, C_i^S) are estimated from a different database, the Household Budget Surveys (HBS). These surveys are conducted by CYSTAT every 7 years to a representative sample of the households in Cyprus and amongst the variables collected is the level of the workers' experience. The figures of the latest four HBS surveys are unified into a common database by the Economics Research Centre of the University of Cyprus (ERC).[20] The ERC database contains data from the surveys of 1984/85, 1990/91, 1996/97 and 2002/03.

In order to correspond to the coverage weights calculated from the CEO data (which they refer to salary earners), the experience proportions for each occupational group described in the first column in Table C.2 are calculated only for the "full-time employees that receive labour income on a monthly instead of a weekly basis".

[18] In the 1976 and 1981 publications, the salary earners are not recorded separately and the coverage weights are calculated from the total employment data (i.e. including self-employed) for each selected occupation.

[19] After 2000 this publication ceased to record the employment data by occupation and as a result the *Census of Establishments 2005* records the employment data only by the economic activity coding system (NACE).

[20] See Georgiou, Komodromou and Polykarpou (2005).

C.4 International Standard Classification of Occupations in 1968 and 1988

In Tables C.1 and C.2 the covered occupations are categorized under the International Standard Classification of Occupations version of 1988 (ISCO-1988). However, for the years 1976, 1981 and 1985 CYSTAT uses a different version of this categorization system, the ISCO-1968.

In that manner, the occupations identified in Tables C.1 and C.2 had to be identified under the ISCO-1968 classification system also. This identification is made with the assistance of CYSTAT personnel and the results could be easily cross-checked using data from the *Census of Establishments 1989*, where the employment figures are recorded in both coding systems (ISCO-1968 and ISCO-1988). As described in Appendix A, in the period 1960-1989 only two occupations were covered by the Minimum Wage Law (Clerks and Salespersons) and their identification under ISCO-1968 is summarized in Table C.3.

Table C.3: Occupational Groups Covered under ISCO-1968

Occupational Groups	ISCO-1968 Occupational Codes
Clerical and Related Workers	**3** (321, 322, 331, 339, 341, 342, 370, 380, 393, 394, 395, 399)
Sales Workers	**4** (451)

However, the ISCO-1968 coding classification was less analytical than the ISCO-1988 and for that reason for some of the occupational categories in Table C.2 there is no satisfying match with the 13 occupational categories in Table C.3 (even when merging of some categories was attempted). The occupational categories with a non-satisfying match are indicated with an underline.

C.5 Two Alternative Kaitz Indices

Since not a perfect match between the two classification systems was possible, two versions of the Kaitz Index are calculated. The first version (KAITZ1) uses the coverage weights calculated using all occupations given in Table C.3, for the period 1960-1989, and all occupations in Table C.2, for the period 1990-2009. On the other hand, the second version (KAITZ2) uses for both periods only the occupational categories that were perfectly or satisfactory matched in both classification systems, i.e. the categories in Tables C.2 and C.3 that are not underlined.

Comparing the two alternative calculations, KAITZ1 has the benefit that it calculates the total coverage of the minimum wage law using all the available information, and the disadvantage that it overestimates the legislative coverage for the period 1960-1989 and, thus, causes a structural break in the index in 1990. KAITZ2, on the other hand, is consistently calculated across the whole period, since it includes more or less the same occupational categories before and after 1990. However, in order to be consistent, it sacrifices some accuracy in the period 1990-2009, since it excludes 8 occupational categories that are covered by the minimum wage law in that period. The differences between the two alternative calculations are summarized in Table C.4. As described in Appendix A, in 1990 and 2008 the Minimum Wage Law was amended in order to include more occupations and in that manner the Kaitz Index would be expected to incorporate those changes. In Table C.4 it is indicated that KAITZ2 reflects changes in the legislative coverage of the minimum wage law, since it increased from 0.04 to 0.07 in 1990 and from 0.09 to 0.12 in 2008. KAITZ1 only reflects the change in the legislative coverage in 2008.

Table C.4: Summary of the Alternative Calculations of the Kaitz index

Label	1960	1989	1990	2007	2008
KAITZ1	0.08	0.08	0.08	0.10	0.12
KAITZ2	0.04	0.04	0.07	0.09	0.12

As described in section 2.5.3, in the existing literature the Kaitz Index is usually broken down into the minimum wage and the coverage component. For that reason the legislative coverage of the minimum wage is also calculated separately as:[21]

$$CC_t = \sum_{i=1}^{M} \frac{E_{it}}{E_t} \Phi_{it} C_{it}^{S} \qquad \text{(C.3)}$$

[21] Following the related literature, only the proportion of salary earners with more than six months' experience is used, since in the HBS data, the more experienced employees account for 92-96% of the covered categories, in all periods.

As with the Kaitz Index, the legislative coverage is calculated in two variants: one using all the occupational categories listed in Table C.2 (CC1), and one using only the occupational categories used in calculating KAITZ2 (CC2). The differences between the two alternative calculations are summarized in Table C.5 below.

Table C.5: Summary of the Alternative Calculations of the Coverage Variable

Label	1960	1989	1990	2007	2008
CC1	17%	23%	22%	26%	31%
CC2	8%	12%	20%	24%	29%

As indicated above, the second variant of the calculation of the legislative coverage of the minimum wage law in Cyprus (CC2) increases from 12% to 20% in 1990 and from 24% to 29% in 2008. In that manner it incorporates the most significant minimum wage law amendments. On the other hand, the first variant of the legislative coverage calculation (CC1) only accounts for the 2008 minimum wage law amendment.

Appendix D: Unit Root Tests Results

Table D.1: Augmented Dickey-Fuller Unit Root Tests

Label	Type	Lagged Diffs	Test Statistic	Critical Values 1%	5%	10%
EMPL	3	1	-3.586**	-4.157	-3.504	-3.182
KAITZ1	3	0	-2.378	-4.157	-3.504	-3.182
KAITZ2	3	0	-2.158	-4.157	-3.504	-3.182
MW6	3	0	-2.577	-4.157	-3.504	-3.182
MW	3	0	-2.139	-4.157	-3.504	-3.182
W	2	1	-1.353	-3.574	-2.924	-2.600
MWW	2	0	-2.602	-3.571	-2.922	-2.599
CC1	3	0	-2.274	-4.157	-3.504	-3.182
CC2	3	5	-2.625	-4.181	-3.516	-3.188
U	2	1	-4.941***	-3.571	-2.922	-2.599
Y	3	1	-3.112	-4.161	-3.506	-3.183
POP	3	0	-1.061	-4.157	-3.504	-3.182
GENDER	1	0	0.501	-2.613	-1.948	-1.613
LEAV	3	0	-3.925**	-4.166	-3.509	-3.184

Note 1: The null hypothesis is unit root in the series. The null is rejected if the test statistic is smaller than the critical value.

Note 2: *** denotes significance at 1%, ** at 5%, and * at 10%.

Table D.2: Zivot-Andrews (1992) Unit Root Tests

Label	Model	Break	Lagged Diffs	Test Statistic	Critical Values 1%	5%	10%
EMPL	A	1969	2	-4.07*	-5.34	-4.80	-4.58
KAITZ1	C	1985	0	-3.94	-5.57	-5.08	-4.82
KAITZ2	C	1985	0	-4.06	-5.57	-5.08	-4.82
MW6	C	1974	1	-4.88*	-5.57	-5.08	-4.82
MW	C	1974	0	-13.65***	-5.57	-5.08	-4.82
W	C	1979	2	-4.93*	-5.57	-5.08	-4.82
MWW	C	1971	3	-5.67***	-5.57	-5.08	-4.82
CC1	C	1985	0	-5.63***	-5.57	-5.08	-4.82
CC2	C	1985	5	-3.89	-5.57	-5.08	-4.82
U	C	1978	3	-4.72	-5.57	-5.08	-4.82
Y	C	1974	1	-4.30	-5.57	-5.08	-4.82
POP	C	1975	0	-22.86***	-5.57	-5.08	-4.82
GENDER	C	1971	0	-2.42	-5.57	-5.08	-4.82
LEAV	C	1988	0	-4.31	-5.57	-5.08	-4.82

Note 1: The null hypothesis is unit root in the series. The null is rejected if the test statistic is smaller than the critical value.

Note 2: Model A involves a break in the intercept, Model B a break in the slope and Model C a break in both intercept and slope.

Note 3: *** denotes significance at 1%, ** at 5%, and * at 10%.

Table D.3: Perron (1989) Unit Root Tests

Label	Model	Break	Lagged Diffs	Test Statistic	Critical Values 1%	Critical Values 5%	Critical Values 10%
EMPL	A	1970	1	-4.79***	-4.39	-3.77	-3.47
EMPL	A	1973	1	-5.12***	-4.39	-3.76	-3.46
EMPL	C	1979	1	-4.94***	-4.81	-4.22	-3.95
KAITZ1	C	1969	0	-3.65*	-4.65	-3.99	-3.45
KAITZ2	A	1969	0	-2.28	-4.39	-3.77	-3.47
KAITZ2	C	1973	0	-2.12	-4.78	-4.17	-3.87
KAITZ2	A	1979	0	-2.37	-4.34	-3.72	-3.44
KAITZ2	B	1984	0	-3.09	-4.56	-3.96	-3.68
KAITZ2	A	1989	0	-2.15	-4.45	-3.76	-3.47
MW6	A	1971	1	-2.03	-4.39	-3.77	-3.47
MW6	C	1973	1	-1.61	-4.78	-4.17	-3.87
MW6	A	1979	1	-3.65*	-4.34	-3.72	-3.44
MW6	C	1984	1	-1.81	-4.90	-4.24	-3.96
MW	A	1971	0	-4.58***	-4.39	-3.77	-3.47
MW	C	1973	0	-1.95	-4.78	-4.17	-3.87
MW	C	1979	0	-3.05	-4.81	-4.22	-3.95
MW	C	1984	0	-3.22	-4.90	-4.24	-3.96
W	C	1984	1	-4.09*	-4.88	-4.24	-3.95
W	C	1989	1	-3.96*	-4.88	-4.24	-3.95
MWW	C	1969	0	-5.08***	-4.65	-3.99	-3.45
MWW	C	1971	0	-4.80***	-4.65	-3.99	-3.45
CC1	A	1971	0	-2.73	-4.39	-3.77	-3.47
CC1	A	1973	0	-2.61	-4.39	-3.76	-3.46
CC1	C	1984	0	-3.08	-4.90	-4.24	-3.96
CC1	A	1994	0	-2.23	-4.42	-3.80	-3.51
CC2	A	1984	5	-2.37	-4.32	-3.76	-3.46
U	A	1973	3	-4.00**	-4.39	-3.76	-3.46
U	C	1974	3	-4.04*	-4.78	-4.17	-3.87
U	B	1979	3	-3.72*	-4.41	-3.80	-3.49
Y	A	1973	1	-2.51	-4.39	-3.76	-3.46
POP	C	1974	0	-5.20***	-4.78	-4.17	-3.87
GENDER	C	1973	0	-2.12	-4.78	-4.17	-3.87
LEAV	A	1989	0	-3.57***	-4.39	-3.77	-3.47

Note 1: The null hypothesis is unit root in the series. The null is rejected if the test statistic is smaller than the critical value. The critical values are based on Perron's (1989) Tables IV.B, V.B and VI.B.

Note 2: Model A involves a break in the intercept, Model B a break in the slope and Model C a break in both intercept and slope. Note that the break

Note 3: In the context of Perron (1989), the year indicated is the one immediately preceding the year when the structural break occurs.

Note 4: *** denotes significance at 1%, ** at 5%, and * at 10%.

Appendix E: VAR Estimation Results

Table E.1: VAR Model with Kaitz Index 1 in Levels (KAITZ1)

Variable	EMPL	KAITZ1
EMPL(-1)	0.242*	0.793
	(0.085)	(0.622)
EMPL(-2)	-0.342*	-0.860
	(0.084)	(0.615)
EMPL(-3)	-0.043	1.328*
	(0.075)	(0.543)
EMPL(-4)	-0.179*	-0.696
	(0.062)	(0.450)
KAITZ1(-1)	-0.002	0.810*
	(0.018)	(0.132)
KAITZ1(-2)	0.044*	-0.084
	(0.018)	(0.134)
KAITZ1(-3)	-0.023	-0.001
	(0.018)	(0.120)
KAITZ1(-4)	0.002	-0.118
	(0.015)	(0.110)
CONSTANT	-5.516*	-11.214*
	(0.682)	(4.968)
TREND	-0.034*	-0.075*
	(0.005)	(0.033)
T1970	0.003*	-0.003
	(0.001)	(0.009)
O1974	-0.115*	0.047
	(0.027)	(0.198)
T1974	0.007*	0.055*
	(0.002)	(0.017)
O1980	-0.021	-0.288*
	(0.013)	(0.097)
T1980	0.003*	-0.005
	(0.001)	(0.005)
O1985	0.001	0.280
	(0.009)	(0.067)
Y	0.362*	0.362
	(0.035)	(0.256)
POP	0.474*	1.264*
	(0.074)	(0.538)

Note 1: Standard errors are reported in parentheses. The asterisk (*) denotes significance at 5%

Note 2: "T19xx" indicates a dummy variable accounting for a structural break in the trend in the year 19xx, while "O19xx"indicates a dummy variable accounting for a one-time break (outlier) in the year 19xx.

Table E.2: VAR Model with Kaitz Index 1 in First Differences (DK1)

Variable	EMPL	DK1
EMPL(-1)	0.188	1.036
	(0.195)	(0.778)
EMPL(-2)	0.012	-0.550
	(0.180)	(0.715)
EMPL(-3)	-0.487*	1.223*
	(0.153)	(0.610)
DK1(-1)	-0.060*	-0.182
	(0.028)	(0.111)
DK1(-2)	0.075*	-0.119
	(0.030)	(0.120)
DK1(-3)	0.038	-0.053
	(0.032)	(0.126)
CONSTANT	-0.866	4.358
	(0.725)	(2.886)
TREND	0.007	-0.010
	(0.005)	(0.021)
T1970	0.001	-0.004
	(0.002)	(0.009)
O1974	-0.021	0.503*
	(0.033)	(0.132)
T1974	-0.008	0.015
	(0.002)	(0.010)
O1980	0.010	-0.261*
	(0.021)	(0.084)
T1980	0.005	-0.003
	(0.001)	(0.005)
O1985	0.007	0.330*
	(0.019)	(0.075)
D(Y)	-1.015	0.571
	(1.154)	(4.593)
POP	0.217	-0.670
	(0.110)	(0.439)
D(GENDER)	4.413	2.697
	(2.296)	(9.136)
LEAV	-0.086*	0.037
	(0.033)	(0.133)

Note 1: Standard errors are reported in parentheses. The asterisk (*) denotes significance at 5%

Note 2: "T19xx" indicates a dummy variable accounting for a structural break in the trend in the year 19xx, while "O19xx"indicates a dummy variable accounting for a one-time break (outlier) in the year 19xx.

Note 3: D() indicates that the variable in parentheses is in first differences.

Table E.3: VAR Model with Kaitz Index 2 in Levels (KAITZ2)

Variable	EMPL	KAITZ2
EMPL(-1)	0.266*	1.696
	(0.102)	(1.001)
EMPL(-2)	-0.375*	-1.107
	(0.088)	(0.864)
EMPL(-3)	-0.011	2.056*
	(0.083)	(0.818)
EMPL(-4)	-0.193*	0.015
	(0.071)	(0.699)
KAITZ2(-1)	-0.002	0.763*
	(0.015)	(0.145)
KAITZ2(-2)	0.036*	-0.155*
	(0.015)	(0.152)
KAITZ2(-3)	-0.017	-0.139
	(0.016)	(0.161)
KAITZ2(-4)	0.006	0.058
	(0.012)	(0.120)
CONSTANT	-4.289	21.830
	(0.837)	(8.248)
TREND	-0.023*	-0.161*
	(0.006)	(0.051)
O1974	-0.076	-0.463
	(0.039)	(0.380)
T1974	0.003	0.109*
	(0.003)	(0.033)
O1980	-0.025	-0.147
	(0.016)	(0.157)
T1980	0.003*	-0.021*
	(0.001)	(0.010)
O1985	0.002	0.396*
	(0.011)	(0.108)
Y	0.312*	1.280*
	(0.048)	(0.466)
POP	0.331*	1.920*
	(0.082)	(0.811)

Note 1: Standard errors are reported in parentheses. The asterisk (*) denotes significance at 5%

Note 2: "T19xx" indicates a dummy variable accounting for a structural break in the trend in the year 19xx, while "O19xx"indicates a dummy variable accounting for a one-time break (outlier) in the year 19xx.

Table E.4: VAR Model with Kaitz Index 2 in First Differences (DK2)

Variable	EMPL	DK2
EMPL(-1)	0.404*	0.006
	(0.173)	(1.091)
EMPL(-2)	-0.155	-0.622
	(0.169)	(1.063)
EMPL(-3)	-0.254*	0.229
	(0.120)	(0.756)
DK2(-1)	-0.069*	-0.111
	(0.020)	(0.128)
DK2(-2)	0.043*	-0.128
	(0.020)	(0.128)
DK2(-3)	-0.004	-0.128
	(0.021)	(0.131)
CONSTANT	0.6125*	2.010
	(0.269)	(1.695)
TREND	0.011	-0.013
	(0.003)	(0.016)
O1974	-0.016	0.607
	(0.029)	(0.183)
T1974	-0.010*	0.015
	(0.002)	(0.012)
O1980	0.010	-0.276*
	(0.021)	(0.130)
T1980	0.003*	0.003
	(0.001)	(0.007)
O1985	0.001	0.526
	(0.019)	(0.117)
D(GENDER)	5.192*	2.037
	(1.942)	(12.242)
LEAV	-0.099*	-0.243
	(0.036)	(0.224)

Note 1: Standard errors are reported in parentheses. The asterisk (*) denotes significance at 5%

Note 2: "T19xx" indicates a dummy variable accounting for a structural break in the trend in the year 19xx, while "O19xx"indicates a dummy variable accounting for a one-time break (outlier) in the year 19xx.

Note 3: D() indicates that the variable in parentheses is in first differences.

Table E.5: Tests for Granger Causality

Causality Hypothesis	Test Value	P-Value
KAITZ1 to EMPL	7.58	0.108
EMPL to KAITZ1	8.31	0.081
DK1 to EMPL	24.07	0.000
EMPL to DK1	0.74	0.863
KAITZ2 to EMPL	9.23	0.056
EMPL to KAITZ2	7.67	0.104
DK2 to EMPL	18.37	0.000
EMPL to DK2	4.74	0.192

Note 1: The null hypothesis is that lagged values of the one time series do not provide statistically significant information about future values of the other ('No Granger Causality').

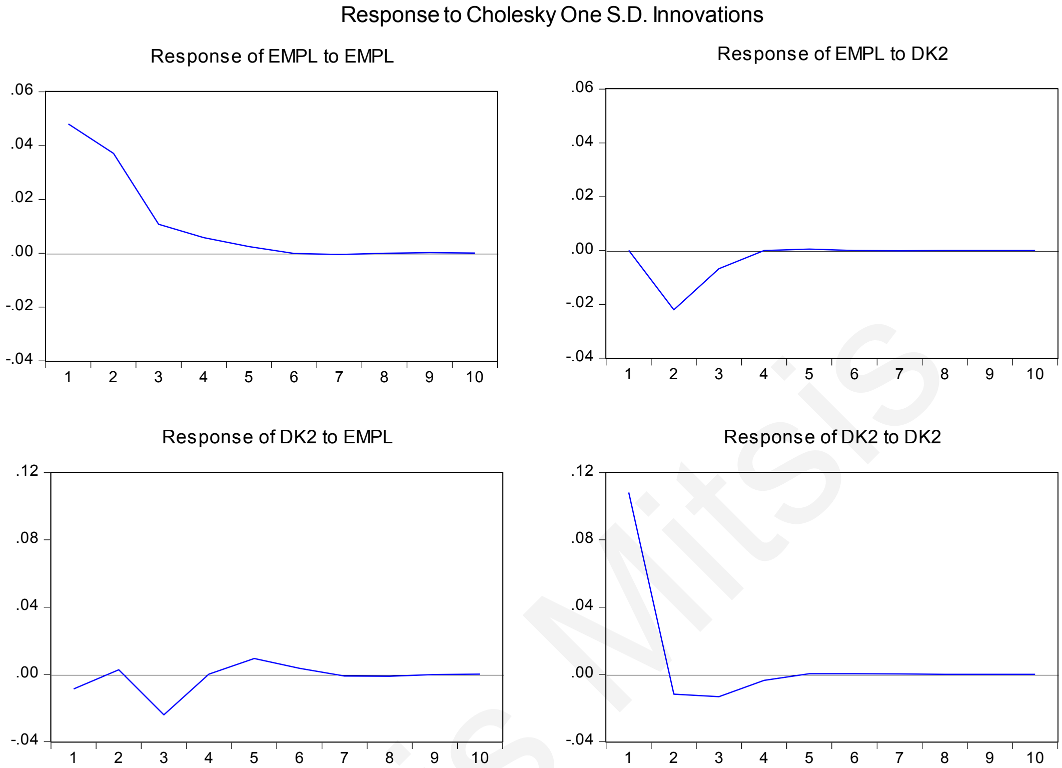
Note 2: The null is tested through F-tests. The p-values of the tests are reported.

Table E.6: Variance Decomposition Analysis

Variable	Period	S.E.	EMPL	DK2
EMPL	1	0.048	100.000	0.0000
	2	0.064	88.297	11.702
	3	0.065	87.675	12.324
	4	0.066	87.770	12.229
	5	0.066	87.782	12.217
	6	0.066	87.782	12.217
	7	0.066	87.782	12.217
	8	0.066	87.782	12.217
	9	0.066	87.782	12.217
	10	0.066	87.782	12.217
DK2	1	0.108	3.045	96.954
	2	0.154	4.134	95.865
	3	0.179	3.552	96.447
	4	0.194	3.864	96.135
	5	0.205	4.119	95.880
	6	0.217	3.906	96.093
	7	0.231	3.782	96.217
	8	0.244	3.663	96.336
	9	0.257	3.613	96.386
	10	0.268	3.668	96.331

Note: Variance Decomposition analysis illustrates the impact of a positive shock in an endogenous variable to the variance of another and, in that manner, provides another way of characterizing the dynamic behaviour of a VAR system. If, for example, shocks to the differenced Kaitz Index 2 (DK2) fail to explain the forecast error variances of the employment variable (EMPL) at all horizons, then the employment variable is said to be exogenous with respect to the minimum wage.

Figure E.1: Impulse Response Function Analysis



Note: The Impulse Response Functions analyze how a variable responds to a one-time random shock created by another endogenous variable or from the series itself. Specifically a shock with size one standard deviation is created in one equation and the response to this shock by each variable is plotted against time (measured in years).

Appendix F: Additional Estimation Results

Table F.1: VAR Model with Decomposed Kaitz Index (MWW)

Variable	EMPL	MWW
EMPL(-1)	0.162	0.272
	(0.172)	(0.459)
EMPL(-2)	0.074	-0.356
	(0.171)	(0.458)
EMPL(-3)	-0.314*	1.123*
	(0.133)	(0.356)
EMPL(-4)	-0.110	-0.342
	(0.112)	(0.299)
MWW(-1)	-0.048	0.517*
	(0.057)	(0.152)
MWW(-2)	0.172*	0.089
	(0.038)	(0.103)
MWW(-3)	0.015	0.254*
	(0.044)	(0.119)
MWW(-4)	-0.037	-0.084
	(0.040)	(0.106)
CONSTANT	0.407	0.130
	(0.207)	(0.554)
TREND	0.009*	-0.016*
	(0.003)	-0.007
T1970	0.002	-0.010
	(0.002)	(0.005)
O1974	0.036	0.302*
	(0.040)	(0.106)
T1974	-0.011	0.027
	(0.002)	(0.006)
O1980	-0.010	-0.303*
	-0.022	(0.060)
T1980	0.005*	-0.002
	(0.001)	(0.003)
D(CC2)	0.028	0.033
	(0.019)	(0.051)
D(GENDER)	4.406*	-5.289
	(1.807)	(4.831)
LEAV	-0.062*	-0.027
	(0.027)	(0.073)

Note 1: Standard errors are reported in parentheses. The asterisk (*) denotes significance at 5%

Note 2: “T19xx” indicates a dummy variable accounting for a structural break in the trend in the year 19xx, while “O19xx”indicates a dummy variable accounting for a one-time break (outlier) in the year 19xx.

Note 3: D() indicates that the variable in parentheses is in first differences.

Table F.2: Misspecification Tests

Misspecification Tests	VAR (MWW)
Breusch–Godfrey LM Test	0.507
Jarque-Bera Normality Test	0.681
White Heteroscedasticity Test	0.586

Note 1: The p-values of the tests are reported.

Note 2: The null hypothesis in the Breusch–Godfrey LM Test is 'No Autocorrelation', in the Jarque-Bera Test the null hypothesis is 'Normality' and in the White Test the null hypothesis is 'No Heteroscedasticity'.

Table F.3: Granger Causality Tests

Causality Hypothesis	Test Value	P-Value
MWW to EMPL	46.17	0.000
EMPL to MWW	20.78	0.000

Note 1: The null hypothesis is that lagged values of the one time series do not provide statistically significant information about future values of the other ('No Granger Causality').

Note 2: The null is tested through F-tests. The p-values of the tests are reported.

Table F.4: Cointegration Tests

Endogenous Variables	Null Hypothesis	Maximal Eigenvalue	Critical Value	Trace Statistic	Critical Value	Johansen et al. (2000)
EMPL, MWW	r = 0	25.30	19.39	25.30	25.87	36.06
	r = 1	0.00	12.52	0.00	12.52	18.29

Note 1: Critical Values at 5% significance level.

Note 2: The alternative hypothesis for the Maximal Eigenvalue Test is that the rank of Π matrix in equation (5) is equal to: r + 1.

Note 3: The alternative hypothesis for the Trace Test is: rank(Π) > r.

Chapter 3: The Impact of the Minimum Wage on Wages and Work in Cyprus

3.1 Introduction

This chapter contributes to the understanding of the effects of minimum wage legislation on wage and employment outcomes, in the context where the legislative coverage is limited to only a few occupations and in the remaining occupations bipartite collective bargaining is not subject to an institutional minimum. As discussed below, microeconomic evidence on the impact of minimum wage legislation in countries with limited coverage is sparse, but in developing countries more evidence is rapidly coming to light. However, given the variance across countries in the levels and structures of minimum wages and their enforcement, much more evidence is needed to form a consensus on the impact of minimum wages on workers in the covered and uncovered sectors.

According to standard economic theory, where the labour market is assumed to be perfectly competitive, increasing the minimum wage decreases the employment of minimum wage workers. The competitive model suggests that if the minimum wage is set above the equilibrium wage, more labour will be willing to be provided by workers and less will be demanded by employers, creating a surplus supply of labour, i.e. unemployment. An alternate view of the labour market has low-wage labour markets dominated by monopsonistic firms that have significantly more market power than the workers. Under the monopsonistic assumption, an appropriately set minimum wage could increase both wages and employment. This strand of the literature is surveyed by Manning (1993, 2003) and Boal and Ransom (1997).

If the minimum wage legislation does not cover 100% of the workforce, then the question arises as to its indirect impact on the uncovered sector. The classical two-sector competitive model predicts that workers whose marginal product falls below the new minimum will be priced out of the covered sector market and will look for work in the uncovered sector, lowering wages and raising employment there (see e.g., Gramlich, 1976; Mincer, 1976). Moser and Stahler (2009) use the search and matching framework lens of Mortensen and Pissarides (1994, 1999 and 2003) and Pissarides (2000) to examine the effects of the minimum wage in the uncovered sector by investigating whether minimum wages exert a negative spill-over effect from the covered to the non-covered sector. In their framework, contrary to the two-sector competitive model predictions, the introduction of a minimum wage will certainly reduce employment in the uncovered sector, since it increases the unemployed workers' outside option, improves their bargaining position and increases labour costs, leaving firms less willing to hire.

On the question of the empirical impact of the minimum wage on uncovered sectors, there is sparse but growing evidence on the effects of minimum wage legislation on the "informal sector", defined as workers not covered by social security legislation. In the studies of Brazil and Mexico, where the "informal" sector is defined as workers who do not have a signed work permit, there is some evidence that minimum wages affect wages there (see e.g. Fajnzylber, 2001, for Brazil; and Bosch and Manacorda, 2010, for Mexico). Most of the evidence for developing countries points to negative employment effects from the minimum wage in the informal sector, in particular when wages are set at relatively high levels in relation to the median wage (see e.g. Fajnzylber, 2001, for Brazil; and Arango and Panchon, 2004, for Colombia).

On the other hand, when the informal sector is defined as the self-employed, there is evidence that the minimum wage does not affect their earnings distribution (see e.g. Maloney and Núñez, 2004, for Colombia; Montenegro and Pagés, 2004, for Chile; Gindling and Terrell, 2005, for Costa Rica; Gindling and Terrell, 2009, for the Honduras; and Alaniz et al, 2011, for Nicaragua). However, there is some evidence of an effect in studies and for Brazil (see Fajnzylber, 2001) and Kenya (see Andalon and Pagés; 2008). Studies investigating the employment effects of the minimum wages in the self-employed sector find positive such effects in Nicaragua (see Alaniz et al, 2011) and Chile (Montenegro and Pagés, 2004) and negative effects in Brazil (Fajnzylber; 2001) and Colombia (Bell, 1997; and Maloney and Núñez, 2004).

An empirical result of a particular interest is that in virtually all of these countries there is evidence of what has been termed as the "Lighthouse effect".[22] That is, the formal sector minimum wage serves as a benchmark for “fair” remuneration (a “numeraire”) throughout the economy, including sectors not legally bound by it. Therefore, it does not only increase wages in the formal (covered) sector, but also wages in the uncovered sectors, contrary to the two-sector competitive model predictions and in accordance with Moser and Stahler (2009).

The goal of this chapter is to contribute to this growing literature by producing evidence for Cyprus, a country where a minimum wage is set for only a few occupations. Chapter 2 is the only other existing study examining the minimum wage effects in Cyprus, using time series macroeconomic data to examine the relationship between total employment and the minimum wage, addressing the issue of the limited legislative coverage of the minimum wage law with an appropriately measured minimum wage index (Mitsis, 2012). That study finds evidence of a significant and negative relationship between the minimum wage and total employment, while the proportion of workers covered by the legislation does not have a statistically significant impact on total employment. If this result were interpreted in the aforementioned Moser and Stahler (2009) framework, it would suggest existence of significant spill-over effects to the occupations that are not covered by the minimum wage legislation.

A second goal of this chapter is to examine further whether there is indeed a spill-over effect from the covered to the uncovered sectors in Cyprus, triggered by the minimum wage. In consistence with the previous study, it is found that, over 1990–2009 minimum wage legislation affects all workers in Cyprus, in both covered and uncovered occupations. Robust empirical evidence indicates that this outcome is probably due to the indirect effect of the legal minimum wage on bipartite labour negotiations, which is consistent with a spill-over effect in the way described by Moser and Stahler. The covered and uncovered sectors employment effects were both found to be negative. There are no discernible effects of the minimum wage on the wages of civil servants in whose case

[22] The original reference of the Lighthouse Effect is found with reference to Brazil in Souza and Baltar (1979). For more recent references, see Lemos (2004) as well as Gindling and Terrell (2009).

minimum wage legislation does not apply, or on the monthly earnings of the self-employed.

The organization of this study is as follows: Section 3.2 describes the data set used, section 3.3 checks for compliance with the minimum wage, section 3.4 provides the econometric framework used in examining the minimum wage impact on wages and employment, section 3.5 presents the estimation results and section 3.6 concludes.

3.2 Data

The data for this study come from two principal sources: 1) the minimum wage decrees of the Cyprus Ministry of Labour and Social Insurance and 2) the Household Budget Surveys of the Statistical Service of Cyprus.

The Cyprus Minimum Wage Law was created in 1941 with the aim to protect certain categories of non-unionized workers paid low wage rates. In that manner, the minimum wage legislation covers only a number of occupations, and for the rest of the workers bipartite wage negotiations are not subject to an institutional minimum. The minimum wage rate is identical for all covered occupations, but a separate wage grid applies to workers that completed six months' experience in their current employment. The first minimum wage decree appeared in 1941 and, in the ensuing years, the minimum wage was adjusted only five times during the period 1941-1989. However, it has been adjusted annually since 1990.[23] Based on the existing legislation (Law on Minimum Wages, Chapter 183), the monthly minimum wage is currently set for the nine occupational groups listed in Table A.1 of Appendix A. The changes in the monthly legal minimum wage for the periods analyzed are summarized in Table 3.1, further on.

The second source of data is the Cyprus Household Budget Survey (HBS), a nationally representative survey of households in Cyprus. Data are used from only the latest four surveys: 1990/91, 1996/97, 2002/03 and 2008/09, since the purpose of the surveys conducted before that did not extend beyond merely gathering data to consistently calculate the weights of the items included in the Cyprus

[23] The information on minimum wages was gathered from information provided by staff of the Ministry of Labour and Social Insurance in Cyprus and the minimum wage decrees available from the Ministry's website.

Consumer Price Index (CPI). The latest surveys are more comprehensive with respect to both the coverage and the objective.[24] The HBS reports a wealth of information about the personal characteristics of each individual, including age, education, place of residence and marital status.[25] It also includes information about individual employment status, the industry of employment, whether an individual is employed in the private or the public sector and his or her occupation. In addition, the HBS provides data on the individual's income level and sources, primarily his/her monthly/weekly wage, income from self-employment and non-labour income such as rents, interest received and dividends. The basic survey instrument does not change appreciably in the time-span 1990–2009 and, therefore, the available data are comparable (average of 3,400 individuals in each period). However, these are not panel data on the same workers.

The analytical sample used in the employment regressions consists of 14,909 observations on working age individuals that declare to be either employed (14,262) or unemployed (647) and for whom other reliable data are available.[26] Thus, only individuals participating in the labour force are included in the sample.[27] For the wage regressions, a sub-sample of 12,110 observations is used, consisting of workers who are in paid employment and declare a non-zero wage (11,127) and individuals reporting a non-zero income from self-employment (983).[28] In Cyprus the minimum wage is set at a monthly rate: for workers

[24] The HBS 1984/85 is similar in scope with the latest surveys, but it does not include data on the education level of each individual and it is therefore excluded from the sample.

[25] A more extensive description of the information included in HBS is given in the following papers: Georgiou, Komodromou and Polykarpou (2005), and Andreou, Koutsambelas and Polykarpou (2012).

[26] The pensionable age in Cyprus is 65 years for both men and women, but early retirement is common. Early retirement pensions could, until very recently, be drawn without reduction in benefits at the age of 63 under certain conditions. While incentives are provided for postponing retirement, these have, until now, not been enough to offset the incentives provided by the absence of an early retirement penalty. Hence, the average effective retirement age is about 63.6 years (Simone, 2011).

[27] Pensioners, persons declared unable to work due to illness or disabilities, housewives, men in compulsory military service and students are excluded from the sample, since only individuals who are allowed, willing and capable to work are considered part of the labour force. Persons below the age of 20 are also excluded. One may argue that should some of these groups, e.g. housewives, decide to enter the labour force, that may alter the effects of minimum wage on employment and thus they should be included in the sample. However the scope of this study is to determine the impact of minimum wage on wage levels and the chance of being employed, not on the labour market participation rates.

[28] Except from individuals not reporting their labour income, the wages sample also excludes 312 employers and 152 persons who not declare their employment group (i.e. employee, self-employed or employer). The wages sample is more analytically described in Table 3.2 of Section 3.3.

declaring a weekly wage, their monthly-equivalent earnings are calculated by multiplying the weekly wage (provided in the HBS) by the number of weeks in a year (52) and dividing by the number of months (12). For the self-employed, monthly-equivalent earnings are imputed by dividing their annual income by twelve. Table A.3 of Appendix A contains descriptive statistics for each major employment group.

Given that the HBS also provides information on the number of months and weeks each person has been employed in his/her current job, it is possible to append to each individual in the sample the minimum wage that corresponds to his/her working experience. The monthly full-time workers are assigned the higher minimum wage rate if they have continuous working experience with their current employer that exceeds six months.[29] Workers on weekly pay are accordingly assigned the higher minimum wage rate if they are employed in their current employment for a continuous period that exceeds 26 weeks.

In addition to the characteristics included in the HBS, each individual is assigned an output growth variable, which is the change in the log of real value-added in the industry he or she belonged to between time t and t+1.[30] Unemployed persons are assigned the change in the log of real value-added of their declared industry (most probably the industry they used to be employed in), while unemployed persons not declaring an industry of employment (mainly newcomers to the labour force) are assigned the change in the log of national real GDP. The change in the log of real GDP is summarized in Table 3.1, along with the annual changes in the monthly legal minimum wage and the national median wage expressed in real terms (with the use of the Consumer Price Index, Base Year 1992) in the periods analyzed. It seems that real minimum wage in Cyprus tends to outgrow GDP growth. This is more prominent in the period 2008/2009, when the economy is in recession, but the percentage change of the real minimum wage rate is the highest in the periods covered by this study. This may be the result of social measures by the Ministry of Labour aiming to protect people more likely to be

[29] Data for part-time employees with non-zero wage are not included in the wages sample (519 observations in total) due to the difficulty involved in obtaining their full-time equivalent earnings out of the information they declared.

[30] To circumvent endogeneity, the change in GDP (and value-added of each industry) is calculated using the previous calendar year, not the years that correspond to the previous HBS. Source: Statistical Service of Cyprus (2012), *National Accounts 1995-2009* and supplementary sources.

affected by the recession, or of the government policy explained in the following paragraph.

Table 3.1: Real Minimum Wage (Euros per Month) in Cyprus, HBS Periods

	1990	**1991**	**1996**	**1997**	**2002**	**2003**	**2008**	**2009**
Real MW	273	291	358	363	399	409	482	512
Real Median Wage	734	757	829	852	932	932	991	1,018
Kaitz Index	37%	38%	43%	43%	43%	44%	49%	50%
%Change in Real MW	6.8%		1.3%		2.8%		6.1%	
%Change in Median Wage	3.3%		2.1%		1.9%		2.8%	
%Change in Real GDP	2.6%		2.9%		1.8%		-1.9%	

Source: Author's calculations using the minimum wage decrees and data from the Statistical Service of Cyprus. The wages are expressed in real terms with the use of the Consumer Price Index (Base Year 1992). The real GDP growth rates are taken from: Statistical Service of Cyprus (2012), *National Accounts 1995-2009*.

The minimum wage increases relative to the national median wage in the period examined. The Kaitz Index (i.e. the ratio of the minimum wage to the national median wage - a widely used measure to assess the "bite" of the minimum wage) rises from 37%-38% in 1990/91 to 43% in 1996/97, remains constant during 2002/03 and climbs to 49%-50% in 2008/09. The latter dramatic increase is the result of a government decision (Ministerial Decision No 55.535, 24 April 2002), which considered the 2002 level of the minimum wage very low and aimed at gradually bringing it up to 50% of the national median wage by 2008. As may be seen in Table 3.1, this goal was finally achieved in 2009. The current study utilizes the Kaitz Index as an alternative measure to the real minimum wage, in order to check the robustness of the estimates. In each HBS period, both measures of the minimum wage take the value corresponding to the last year included (which comprises most of the sample in each period).

3.3 Compliance with Minimum Wage

As mentioned in the previous section, in Cyprus not all workers are covered by the minimum wage legislation. The occupations covered are: salespersons and clerks (since 1944), auxiliary healthcare staff, auxiliary staff in nurseries, auxiliary staff in crèches, auxiliary staff in schools (since 1990), guards and caretakers working in clinics, private hospitals and nursing homes (since 2008) and cleaners of corporate premises (since 2010). The covered sector in this study consists of the workers in these occupations.[31] The uncovered sector consists of workers whose occupations are not covered by the minimum wage legislation, with the self-employed included in a separate category. Before examining the impact of minimum wage legislation on wages and employment, it is important to detect in which of these sectors of the labour market there is compliance with the minimum wage legislation.

The implementation of the minimum wage is carried though the provisions of the Law on minimum wages, Chapter 183, Article 5(1): any employer or representative of the employer who fails to comply with the provisions of the law, and in particular the minimum rates set by the Council of Ministers, may be fined, together with an additional fine for every day of non-compliance. There are no data available on the degree of compliance or non-compliance, but there are several ways in which compliance in the data may be checked.

3.3.1 Comparing the Distribution of Wages and Legal Minimum Wages

A straightforward method to check for compliance in the data is to look whether the wage distributions are censored below the minimum wage. Given the two different levels of the minimum wage in Cyprus (accounting for working experience) the graphical analysis is simplified by plotting the kernel density estimate of the log wage minus the log minimum wage for each worker group. In these figures a zero indicates that the worker is earning the legal minimum wage. To test for different levels of compliance, density estimates are constructed for five different groups: the covered sector, the uncovered sector, private sector employees in the uncovered sector, public sector employees in the uncovered

[31] The HBS assigns each worker to one of nine general occupational groups: armed forces, managers, professionals, clerks, service workers, salespersons, agriculture-forestry workers, skilled and unskilled workers. For the purposes of this study the covered sector is measured as the persons belonging to two of those groups: clerks and salespersons. The decision on which HBS groups should be included or not in the covered sector is based on calculations on data from another study of the Statistical Service of Cyprus, the Census of Establishments (COE), where the analytical occupational classification of the individuals is more fine-grained. An HBS group is included in the covered sector if, as calculated from the COE, it contains more than 50% persons covered by the minimum wage legislation. The related calculations are given in Table A.2 of Appendix A.

sector and the self-employed. A density estimate for the total sample (all workers) is also provided.

The rationale for analyzing two groups in the uncovered sector separately is to separate out the public sector workers, who tend to have higher wages in Cyprus. Since the statutory minimum wage in Cyprus was launched with the aim to cover certain categories of non-unionized workers paid at low wage rates, another reason is to decipher the extent to which bipartite negotiations between the trade unions and the most representative employers' organisations are affected, even if not legally bound, by the national minimum wage. The limited coverage of the minimum wage legislation is justified by appealing to the fact that, in the remaining sectors unions provide an effective protection for their members. The self-employed, whose earnings may also be affected through the mobility of workers across sectors in response to changes in the minimum wage, are included in a separate category.

The kernel density estimates are presented in Figure 3.1, along with a normal distribution fitted to the data for comparison. To construct the kernel estimates for monthly workers, earnings are compared with the legal monthly minimum wage, while for weekly workers their monthly earnings are imputed by multiplying their weekly wage by 52 and dividing the annual total by 12. As mentioned before, a value above (below) zero indicates that those workers earn above (below) the legal minimum wage. If legal minimum wages (MWs) are enforced in a particular sector, we would expect to see the distribution of wages censored from below at the level of the MW, with no (or very few) workers earning below the MW. We might also expect to see a spike in the distribution at zero (at the MW) that is higher in the covered sector than in the uncovered sector.

Figure 3.1 suggests that the legal minimum wage has an impact on the covered sector, since the wage distribution of covered workers shows evidence of censoring below the level of minimum wage, with a spike near the level of minimum wage. There is also some evidence for compliance in the uncovered sector. The kernel density estimate of the wage distribution for uncovered workers indicates that the probability mass below the minimum wage is smaller than the one of the fitted Normal distribution in the area below the minimum wage. This does not hold for observations above the minimum wage. For uncovered workers employed in the private sector this censoring is even more profound. And it is also evident on the density estimate for all workers. On the other hand, the kernel density estimates for the uncovered workers employed in the public sector and the self-employed are not censored below the minimum wage and look very close to a normal distribution.

The evidence for some compliance in the uncovered private sector is consistent with the expectation that the bipartite negotiations between trade unions and employers' organisations in many private sector occupations are affected by the national minimum wages, even if they are not legally bound by it. The policy of the Ministry of Labour and Social Insurance to include only non-unionized occupations in the scope of the minimum wage legislation seems well-justified.

There is a question whether Figure 3.1 is not capturing compliance clearly because of potential measurement error of the monthly earnings imputed for the weekly workers. As a result, kernel estimates are provided for the sub-sample of monthly workers in Figure 3.2. It is clear that the main findings in Figure 3.1 are not compromised by measurement error, since the censoring from below the level of the minimum wage is still evident in the wage distributions of the covered workers and the uncovered private workers, and absent from the wage distributions of the uncovered public workers.

In summary, the kernel density estimates provide evidence of compliance with minimum wages in the covered sector and the uncovered private sector and non-compliance in the uncovered public sector and for the self-employed.

3.3.2 Comparing the Proportion of Workers Earning Minimum Wage

Another way to summarize the information of compliance is to calculate the average share of workers earning less than minimum wage, near minimum wage, or more than minimum wage within each group of interest. A bound of 25% is used to allow for measurement error so that what is actually measured is the share of workers earning: i) less than 0.75 of the minimum wage, ii) within 0.75 and 1.25 of the minimum wage and iii) more than 1.25 of the minimum wage. These data are reported in Table 3.2. The groups of interest are the same as those in the previous section: the covered sector, the uncovered sector, private sector employees in the uncovered sector, public sector employees in the uncovered sector, the self-employed and the total wages sample (all workers).

Table 3.2: Percent of Workers in Cyprus Earning Within 25%, Below and Above the Legal Minimum Wage by Sector (Averages over 1990/91 – 2008/09)

Sectors	Below MW	At MW	Above MW	Sample Size
All Workers	**4.1%**	**12.4%**	**83.4%**	**12,110**
All Employees	**4.1%**	**12.7%**	**83.2%**	**11,127**
Covered Workers	0.8%	22.4%	76.8%	2,270
Uncovered Workers	5.0%	10.2%	84.9%	8,857
Uncovered Private Workers	6.8%	13.0%	80.2%	6,246
Uncovered Public Workers	0.7%	3.3%	96.1%	2,610
Self-Employed	**4.6%**	**9.9%**	**85.5%**	**983**
Monthly Employees	**4.8%**	**12.8%**	**82.4%**	**9,232**
Covered Workers	0.8%	22.3%	76.9%	2,222
Uncovered Workers	6.0%	9.8%	84.1%	7,010
Uncovered Private Workers	9.1%	13.6%	77.3%	4,480
Uncovered Public Workers	0.6%	3.2%	96.2%	2,528

Note: For workers paid on a weekly basis monthly earnings are calculated from reported regular weekly wages, assuming 4.33 weeks of work per month. For the self-employed, monthly-equivalent earnings are imputed by dividing their annual income by twelve. The calculations in the second panel of the table utilize only workers paid on a monthly basis,

Source: Author's calculations using the Households Budget Surveys (HBS) data and information from the Ministry of Labour and Social Insurance. The sample consists of workers who are in paid employment and declare a non-zero wage and self-employed persons declaring a non-zero income from self-employment.

In Table 3.2, there is evidence that compliance is greater in the covered sector than in the uncovered sector. While 22.4% of workers in the covered sector earn within 25% of the minimum wage, only 10.2% of the uncovered workers fall in the same proportion. The share of workers earning below minimum wage is 5.0% in the uncovered sector, contrary to the covered sector, where this share is close to zero. While this constitutes evidence for non-compliance in the uncovered sector, the implied non-compliance is far from universal. Significantly more workers earn within 25% of the minimum wage in the uncovered private sector (13.0%)

than in the uncovered public sector (3.3%). The share of workers earning within minimum wage is 12.4% in the total sample, while a significant portion of workers earn more than the minimum wage (83.4%).

In the self-employed sector, the non-compliance is greater, since for as much as 4.6% of them their imputed monthly earnings are below 25% of the minimum wage, while only 9.9% earn within the minimum. In examining the calculated proportions from the incomes of the self-employed it is necessary to take into account that they tend to underreport their earnings. However, it is clear that a significant portion of the self-employed earn more than the minimum wage (85.5%), second in magnitude only to the same proportion for employees in the uncovered sector civil servants (96.1%).

As with the kernel density estimates, the proportions of workers earning below, within and above the legal minimum wage are also calculated using monthly workers' wages data, in order to account for any measurement errors in the imputed monthly earnings of the workers paid weekly (approximately about 25% of all workers). The percentages in the second panel of Table 3.2 indicate that the proportions of covered and uncovered monthly workers earning within the minimum wage is similar to the previous results. However, the share of monthly workers in the uncovered private sector earning less than the minimum wage (9.1%) is substantially larger than the share of all uncovered private sector workers (including workers paid on a weekly basis), which amounts to 6.8%.

Hence the combined evidence of the wage distribution and the average share earning below and at the minimum wage level point to a greater impact of minimum wages in the covered sector than the uncovered sector. There is weak evidence for an impact in the uncovered private sector, where it is conjectured that there is an indirect influence through the negotiations between trade unions and employers' organizations. The uncovered public workers and the self-employed persons, who tend to have higher earnings in Cyprus, appear not to be affected by legal minimum wages at all.

3.4 Econometric Methodology

Given the information from the previous section and guided by the predictions of the two-sector competitive model, the impact of the minimum wage is estimated separately for workers in the covered sector, the uncovered sector, the self-employed and the total sample (i.e. including all types of workers). This section provides the basic econometric framework used to estimate the wage and employment effects of the legal minimum wage in Cyprus.

3.4.1 Wage Equation

In order to estimate the minimum wage effects on wages for each of the employment sectors defined in the previous section, a reduced form equation of the following form is estimated using the data set constructed from the legal minimum wage data, the industrial value added and the data taken from the HBS:

$$\ln W_{i,t} = a_o + a_1 \ln MW_{i,t} + a_2 \Delta \ln GDP_{I,t} + X'_{1,i,t}\gamma_1 + u_{1,i,t}\,, \tag{3.1}$$

where the dependent variable, $\ln W_{it}$, is the log of the real wage of individual i at the period t, $\ln MW_{i,t}$ is the log of the real minimum wage at time t that applies to that worker's experience level, $\Delta \ln GDP_{I,t}$ is the change in the log of real value-added in the industry (I) that the worker belongs to at period t,[32] and the vector $X_{1,i,t}$ consists of characteristics taken from the HBS (such as age group, education level, place of residence, marital status, whether the individual is working in the public sector, his/her working experience and his/her occupation). To control for endogenous changes in the survey design and any time-specific factors (such as aggregate supply and aggregate demand shifts or changes in the timing of the surveys), dummy variables for each sample period are also included. The coefficient a_1 is an estimate of the impact of the legal minimum wage on actual wages. If the minimum wage is complied with in the groups of interest, then the coefficient a_1 is expected to be positive and statistically significant. Therefore, the wage equations provide another test of whether sectors are complying with the minimum wage legislation.

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[32] The change in GDP is calculated using the previous calendar year, not the year corresponding to the previous HBS. The log of real GDP (value added) only varies by industry (*I*) and period (*t*). However, the equations do not include dummy variables describing which industry each person is/was employed in, since those are highly correlated with the dummy variables expressing the occupational groups.

Since it is expected that legal minimum wages will have a larger impact on the wages of workers who earn near the minimum wage, the impact of minimum wages on the wages of workers who are within 25% of the legal minimum wage in each period t is also examined. For a robustness check, the equations are also estimated using only data for monthly workers who are within 25% of the minimum wage to control for measurement error. For additional robustness and specification tests see Section 3.5.4.

In addition to estimating the wage equations for the covered employees, the wage equations for the uncovered employees and the self-employed are also estimated as a placebo test. If minimum wages are being enforced in the covered sector, but not in the uncovered sectors (self-employed persons and employees not covered by the minimum wage law), then the minimum wage should positively affect the wages of only those in the covered sector and have no effect on the wages (incomes) of the uncovered sector workers.[33]

3.4.2 Employment Equation

The impact of minimum wages on employment is examined using binomial Probit analysis, estimating employment equations of the following form:

$$\Pr(EMPL_{i,t} = 1) = \beta_o + \beta_1 \ln MW_{i,t} + \beta_2 \Delta \ln GDP_{I,t} + X'_{2,i,t}\gamma_2 + u_{2,i,t}, \qquad (3.2)$$

where the dependent variable, $\Pr(EMPL_{i,t} = 1)$, is equal to one if individual i is employed in any industry at the period t, and zero if individual i is unemployed. The explanatory variables are the same as those in the wage equations, with the difference that here the vector $X_{2,i,t}$, (characteristics observed from the HBS) excludes variables that pre-suppose that the individual is employed (e.g. whether the individual is working in the public sector) and includes, in addition, a variable

[33] Even if the minimum wages are not complied with among the self-employed, it is possible that higher legal minimum wages in the covered sector could have an indirect impact (spill-over effect) on the incomes the self-employed. For example, higher legal minimum wages in the covered sector could cause reduced employment in that sector, pushing workers into self-employment, increasing the labour supply in those sectors and driving down the incomes of the self-employed individuals.

expected to have an effect on whether an individual is employed or not, but not on his/her wage rate (i.e. whether the individual has children or not).

In the estimations of equation (2), the uncovered sector is not separated into private and public employees.[34] Given the evidence from Section 3.3, the impact of minimum wages on the probability of employment of workers who are within 25% of the legal minimum wage at each period t are examined separately. Similarly with the wage regressions, the employment equations are also estimated using only data for the monthly workers who are within 25% of the minimum wage at period t, to control for measurement error. For additional robustness and specification tests see Section 3.5.4.

3.5 Empirical Findings

The first step in estimating equations (3.1) and (3.2) is to examine the stationarity of the continuous variables used. The null of unit root is rejected for all variables used.[35] The findings from the estimation of equations (3.1) and (3.2) are presented in the sections 3.5.1 and 3.5.2. The estimated standard errors in all regression estimates reported (wage and employment equations) are robust to heteroskedasticity and correct for clustering of the errors in the occupational category of the worker (which also corresponds to whether the worker is covered by the minimum wage legislation or not). Robustness checks are provided in section 3.5.4.

3.5.1 Wage Effects

Table 3.3 reports the estimated coefficients a_1 for all samples described in both panels of Table 3.2 in Section 3.3. These estimates may be interpreted as the upper bounds of the elasticities – the percentage change in actual wages given a

[34] Since the variable that states that the worker is employed in the public pre-supposes that the individual is employed, it is not possible to analyze the impact of the minimum wage on the probability of an individual being employed in the uncovered public sector. The sample does include some unemployed workers that state they belong to the public sector, but these are very limited and correspond to only one out of the four surveys (HBS 1996/97).

[35] Testing for stationarity in panel data models is directly motivated, since the presence of unit roots in the variables used raises concerns for spurious regressions. The results of the unit root tests are provided in Table B.10 of Appendix B.

one percent increase in the legal minimum wage – and as evidence for compliance to the minimum wage law.[36]

Table 3.3: Impact of the Legal Minimum Wage on Wages

For Workers in the Following Sectors:	All Workers (1)		All Workers Within 25% of the MW (2)		Monthly Workers Within 25% of the MW (3)	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
All Workers	0.571	(0.349)	0.862***	(0.243)	0.574*	(0.310)
Covered Workers	1.735*	(0.947)	0.896*	(0.474)	0.879*	(0.480)
Uncovered Workers	-0.315	(0.573)	0.899***	(0.348)	0.515	(0.395)
Private Workers	0.478	(0.531)	0.891**	(0.350)	0.521	(1.310)
Public Workers	-3.257	(2.410)	1.953	(1.399)	1.683	(1.469)
Self-Employed	-8.279	(5.588)	-	-	-	-

Notes: Table 3.3 presents estimates for α_1 in equation (3.1) for samples identified by row and column. The dependent variable is the log of the real monthly earnings of each worker and the key independent variable is log of the real minimum wage. Reported standard errors (in brackets) are robust for heteroskedasticity. Marginal impacts of variables other than the minimum wage are given in Table B.1 of Appendix B.

*** denotes significance at 1%, ** at 5%, and * at 10%.

"-" denotes cases where estimations could not be carried out due to insufficient number of observations.

The estimates of the coefficients on the minimum wage variable do provide evidence that the legal minimum wage is complied within the covered sector. The estimated wage effects are positive and statistically significant. Specifically, an increase of 1% in the minimum wage raises wages for all workers (Column 1) in the covered sector by 1.735%. The estimated effect in wages near the minimum

[36] A caveat in straightforwardly interpreting α_1 as the elasticity of the wage with respect to the minimum wage is that changes in average wages could be positively and significantly correlated with increases in minimum wages for two reasons: (i) some workers see their wages increase to the new, higher, minimum wage and/or (ii) some workers (presumably those earning less than or at the minimum wage before the minimum wages increase) may lose their jobs, and are therefore no longer included in the sample used to calculate the average wage in each worker group. Either reason indicates that there is compliance with minimum wages legislation, but should only (i) be true, each worker would see his/her wage rise because of a minimum wage increase. Hence $\alpha 1$ is an overestimate of the elasticity of the wage with respect to minimum wages and may be more safely interpreted as an upper bound on the elasticity of the wage with respect to minimum wage.

wage is 0.9%, whether they are paid on a monthly or a weekly basis (Columns 2 and 3).

There is also evidence in the estimated wage effects that the legal minimum wage also influences wages in the uncovered sector. Specifically, an increase of 1% in the minimum wage raises the wages of uncovered workers by 0.899%, but only for those workers whose wages are near the minimum wage (Column 2). The results for the total sample (all workers) are quite similar to the ones for uncovered workers, since a 1% increase in the legal minimum wage raises the income for those workers who's the monthly earnings are near the minimum wage by 0.862% (Column 2).

When the wage effects are estimated separately for the uncovered private workers and for the uncovered civil servants, it is evident that the aforementioned wage increases in the uncovered sector are relevant only to the uncovered private sector employees. As also suggested from the kernel density plots and calculations in Section 3.3, there is no significant minimum wage impact on the earnings of uncovered public sector employees and the self-employed. In summary, the estimated wage effects suggest that the minimum wage law in Cyprus influences wages in both the covered and the uncovered private sector, especially those wages which are near the legal minimum. There is no significant evidence in favour of a negative impact on the earnings of the self-employed or the uncovered civil servants.

The estimated wage effects for the uncovered sector are not in line with the standard two-sector competitive model's major prediction following a minimum wage increase, since wages in the uncovered sector increase rather than fall as a result of a minimum wage increase. However, they are consistent with previous empirical evidence for minimum wage affecting workers in the uncovered sector, by acting as a "numeraire" in labour contracts (Maloney and Nuñez, 2004). This is, thus, evidence that the uncovered private sector in Cyprus is using increases in the minimum wage as a guide in adjusting wages or that the minimum wage may act as a default option when bipartite negotiations between the most representative employers' organisations and trade unions fail to reach an agreement. Wages in the uncovered sector increasing by a minimum wage increase is also consistent with the prediction of the Moser and Stahler (2009) model that an increase in the minimum wage increases the unemployed workers' outside option, improves their bargaining position and their ability to demand higher wages.

3.5.2 Employment Effects

The estimates of the impact of minimum wages on the probability of employment are reported in Table 3.4. A negative estimate indicates than a higher minimum wage reduces the probability that a worker is gainfully employed. The results imply that an increase in the legal minimum wage will result in a statistically significant fall in employment in the occupations covered by the minimum wage legislation. A 1% increase in the legal minimum wage will result in a decrease in the probability that a worker is employed in the covered sector by 0.266% for all workers (Column 1), a decrease of 0.712% in covered workers with wages near the minimum wage (Column 2) and a similar 0.608% fall for covered monthly workers with wages near the minimum wage (Column 3).

Table 3.4: Marginal Impact of the Minimum Wage on the Probability of Employment

For Workers in the Following Sectors:	**All Workers (1)**		**All Workers Within 25% of the MW (2)**		**Monthly Workers Within 25% of the MW (3)**	
	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error
All Workers	-0.180***	(0.057)	-0.545**	(0.248)	-0.991***	(0.252)
Covered Workers	-0.266**	(0.113)	-0.712*	(0.390)	-0.608*	(0.373)
Uncovered Workers	-0.287***	(0.061)	-0.904***	(0.249)	-1.074***	(0.299)
Self-Employed	-0.287***	(0.104)	-	-	-	-

Notes: Table 3.4 presents marginal effects evaluated at the means of all variables, from estimates of β_1 in equation (3.2) in Section 3.4.2 using Probit regressions, for samples identified by row and column. The key independent variable is log of the real minimum wage and a positive coefficient means that higher minimum wages increase the probability that a worker is gainfully employed in the indicated sector. Reported standard errors (in brackets) are robust for heteroskedasticity. Marginal effects of variables other than the minimum wage are given in Table B.3 of Appendix B.

*** denotes significance at 1%, ** at 5%, and * at 10%.

"-" denotes cases where estimations could not be carried out due to insufficient number of observations.

The results imply that an increase in the legal minimum wage will also result in a statistically significant fall in employment in the occupations not covered by the minimum wage legislation. A 1% increase in the legal minimum wage will result in a decrease in the probability that a worker is employed in the uncovered sector by 0.287% for all uncovered workers (Column 1), a decrease of 0.904% in uncovered workers with wages near the minimum wage (Column 2) and a 1.074% fall for uncovered monthly workers with wages near the minimum (Column 3). A statistically significant negative employment impact of minimum wages is also found in the self-employed: a 1% increase in the minimum wage results in a 0.287% fall in the probability that an individual is gainfully self-employed.

The result that covered and uncovered sectors employment effects are both found negative challenge the standard two-sector competitive model which cannot explain the effect of the minimum wage on the covered and uncovered sectors in Cyprus. It is consistent, though, with evidence from empirical studies pointing to negative employment effects when wages are set at relatively high levels in relation to the median wage (as it does in Cyprus, according to Table 3.1). This result is also consistent with the evidence from the previous section of minimum wages used as a “numeraire” in labour contracts even in the uncovered sector, which according to the Moser and Stahler (2009) model leaves firms less willing to hire.

If evaluated using the total sample (i.e. including all workers) a 1% increase in the legal minimum wage results in a 0.180% fall in the probability to be gainfully employed, a 0.545% fall in persons with earnings near the minimum wage and a 0.991% fall for monthly earnings near the legal minimum. In summary, the evidence is consistent with the hypothesis that increases in legal minimum wages in Cyprus result in increased probability of unemployment, even in the sectors not covered by the minimum wage legislation, where it is conjectured that there is an indirect impact of the legal minimum wage through the negotiations between the trade unions and the employers’ organizations.

3.5.3 Spill-over Effects

In Tables 3.3 and 3.4, is indicated that over 1990–2009 the minimum wage legislation affects all workers in Cyprus, in both covered and uncovered occupations. The estimated wage effects are consistent with previous empirical evidence for minimum wage affecting workers in the uncovered sector, by acting as a “numeraire” in the labour contracts. The employment effects are also consistent with the “numeraire effect” (or “Lighthouse effect”) and, therefore, provide additional evidence for the existence of significant spill-over effects to the occupations that are not covered by the minimum wage legislation triggered by the minimum wage.

The empirical findings of the previous sections suggest that those spill-over effects are of a considerable magnitude, since in many cases the marginal impacts of the minimum wage on the uncovered sector are at least as high as in the covered sector. More specifically, an increase of 1% in the minimum wage raises the wages of the covered workers earning within 25% of the minimum wage by 0.896% and the wages of uncovered workers by 0.899% (Table 3.3, Column 2). In regards to the employment effect, a 1% increase in the legal minimum wage will result in a decrease in the probability that a worker is employed in the covered sector by 0.266% and a similar 0.287% fall in the probability that a worker is employed in the uncovered sector (Table 3.4, Column 1). Note that for the workers earning near the minimum wage, the decrease in the probability of employment is actually greater in the uncovered sector (0.904%) than in the covered sector (0.712%).

The presence of substantial spill-over effects of the minimum wage on uncovered workers is consistent with the findings from the literature which is summarised in Section 3.1. In particular, most of the evidence for developing countries points to negative employment effects from the minimum wage in the uncovered sector, especially when wages are set at relatively high levels in relation to the median wage (as it does in Cyprus, according to Table 3.1). In regards to the effects of the minimum wage on the wages of the uncovered sector, in virtually in all countries with large uncovered sectors (such as Cyprus) there is empirical evidence of the "Lighthouse effect", where the minimum wage serves as a benchmark for “fair” remuneration throughout the economy. Therefore, it does not only increase wages in the covered sector, but also wages in the uncovered sectors. In fact, the influence of the minimum wage seems far stronger on the wages of the uncovered (informal) sector than the covered (formal) sector in many countries, including Brazil (Fajnzylber, 2001), Mexico (Bell, 1997) and Argentina (Maloney and Nuñez, 2004).

The findings in Tables 3.3 and 3.4 also corroborate the results in Chapter 2. More specifically, an increase of 1% increase in the legal minimum wage results in a 0.180% fall in the probability to be gainfully employed, if the sample includes all workers (Table 3.4, Column 1). A negative effect of the minimum wage on the overall probability of being employed in Cyprus is consistent with the results in Chapter 2, where evidence is found of a significant and negative relationship between the minimum wage and total employment, while the proportion of workers covered by the legislation does not have a statistically significant impact on total employment. If this result were interpreted in the Moser and Stahler (2009) framework, it would suggest existence of significant spill-over effects to the occupations that are not covered by the minimum wage legislation.

More specifically, the Moser and Stahler (2009) model predicts that an increase in the minimum wage increases the unemployed workers' outside option (as any employment in the covered sector now yields a higher wage), improves their bargaining position and their ability to demand higher wages. This is consistent with the results in Table 3.3, where wages in the uncovered sector increase as a result of a minimum wage increase. Moser and Stahler (2009) also predicts that as a result of the wages increase in the uncovered sector, the labour costs will rise, leaving firms less willing to hire. This is consistent with the results in Table 3.4, where an increase in the legal minimum wage will result in a statistically significant fall in employment in the uncovered sector.

3.5.4 Robustness

Equations (3.1) and (3.2) are also estimated using different specifications and empirical methods, in order to examine the robustness of the estimates and also provide a deeper analysis of the effect of the legal minimum wage in Cyprus.

<u>Robustness of Estimates:</u>

The wages and employment equations are re-estimated: i) substituting the log of the real minimum wage with the Kaitz index described in Section 3.2, ii) excluding the GDP growth as an independent variable and iii) using only data from workers aged 20-59. The estimated marginal effects from these specifications are summarized in Tables B.4 and B.5 of Appendix B. The results are quite similar to those in Tables 3.3 and 3.4 in terms of sign and significance. Thus, the results of the previous sections do not appear to be sensitive to the minimum wage measure used, to the inclusion or exclusion of the GDP variable, or suffer from measurement error bias created by including workers near the retirement age in the sample.[37] In addition to these robustness checks, the results in Table B.2 provide evidence that the selected wage sub-samples are representative of the larger employment sample, i.e. the estimates in Table 3.3 do not suffer from selection bias.

<u>Variation of the Impact of the Minimum Wage by Age Group:</u>

To test empirically whether the minimum wage has a different impact on workers of different ages, I also estimate specifications of equations (1) and (2) that include interaction terms of the log of the minimum wage with the age group dummy variables. In interpreting the results, one must keep in mind that the coefficient of each interaction term expresses the additional effect of the minimum wage in the related age group in comparison with the group of reference (workers aged 40-49), and not the total effect of the minimum wage in the particular age group.

Table B.6 of Appendix B presents the estimated effects on wages for each of the main employment groups. In the case of covered sector workers, the coefficients of the interaction terms are close to zero, negative in sign and statistically significant only for the workers aged 20-39. This is evidence that despite the

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[37] An additional robustness check could be an application of the Arellano and Bond (1991) procedure to address the potential violation of the strict exogeneity assumption. The strict exogeneity assumption is violated if there is feedback from the dependent variable in period t to an independent variable in a future period (Wooldridge, 2002). This may occur in the estimates of the wage equation, for example, if a bad (or good) wage shock in the past year affects decisions to increase education. For example, a higher wage at time t might make it affordable for a low-income worker to complete higher education at time $s > t$. Such feedback is usually captured by including a lagged dependent variable in the regression. In order to account for the potential bias created (as the lagged dependent variable will be correlated with the error term in the regression), Arellano and Bond develop a dynamic panel data model that addresses the problems of the correlation between the lagged dependent variable and the error terms (and also the potential problem of first-order auto-correlated errors) using the values of the exogenous variables lagged two or more periods as additional instruments for the potentially endogenous independent variables. However, the Arellano and Bond procedure cannot be applied in this study without compromising the sample size, since the HBS panel data set is unmatched and unbalanced and so the observations of exogenous variables (i.e. the worker's characteristics) from previous periods are not identical in both number and group of individuals, in each period t. Period-specific fixed effects included in all specifications of equations (1) and (2) control for the endogenous correlation of the dependent variable and potentially endogenous variables across time. In that manner, standard fixed effects control for endogeneity that may arise from changes over time, such as different rates of change in demand. Since there is not regional variation in legal minimum wages, the remaining variation is captured by the fixed effects, so my results will not suffer from endogeneity/simultaneity bias that exist in many studies which compare changes in a single minimum wage to changes in actual wages (e.g. Maloney and Nunez, 2004, and Fajnzylber, 2001).

minimum wage positively affecting the earnings of the covered workers on all ages, the effect on the younger employees the effect is significantly less. This is not the case with the uncovered workers, where the minimum wage effect appears insignificant across age groups, with the notable exception of the youngest workers, where the additional effect of the minimum wage appears positive. In the case of the self-employed, there is evidence for the minimum wage affecting negatively the earnings of the individuals in the lowest and highest age groups.

What is striking in the results for all workers is that the minimum wage variable is significant (at 10% significance level), contrary to the results in Table 3.3, as are all the interaction terms. This is evidence in favour of the minimum wage affecting the earnings of workers in different age groups in opposite directions, in a manner which makes the overall effect appear insignificant. Overall, the comparisons of wage effects by age provide mixed results. Younger workers (especially the ones aged 20-24) are less affected by the minimum wage increases than adults aged 40-39 in the covered sector and the self-employed, but they are more affected among the uncovered sector workers.

Table B.7 of Appendix B presents the estimated effects on the probability of being employed for each of the main employment groups. There is very little evidence here for the minimum wage impact varying by the age of workers. The marginal effects of the interaction terms are found significant only for workers aged 50-59 in the covered occupations and the self-employed sector and for self-employed aged 25-29.

<u>The Minimum Wage Effect at Different Levels of the Wage Distribution:</u>

In Table 3.3 the marginal impact of the minimum wage on wages is estimated at the mean of the wage distribution. By contrast, quantile regression examines the relation between the dependent variable and the covariates at various points of the distribution and makes it possible to estimate the effect of the minimum wage throughout the wage distribution (Dickens et al, 1999). In Table B.8 of Appendix B the wage effects are estimated at the 10th, 25th, 50th, 75th and 90th percentiles. The results suggest that while the estimated wage effects are large and significant at the top of the distribution in the covered sector, they are smaller and only significant at lower percentiles in the uncovered sector.

This evidence shows that the minimum wage compresses the wage distribution of both sectors. The compression effect extends higher in the covered sector wage distribution, but it is stronger at the bottom of the uncovered sector wage distribution. The results for all workers are quite similar to the ones for uncovered workers and thus are consistent with the international literature, where wage effects have been found to be positive and larger at lower percentiles, compressing the wage distribution (see e.g. Card and Krueger, 1995, for U.S.A; and Lemos, 2004, for Brazil). [38]

The estimates for the self-employed are found significant and negative at the bottom of their earnings distribution and positive for higher quantiles. This suggests that the minimum wage redistributes in favour of the richer in this sector, within the standard two-sector competitive model predictions. However, the wage effect in the 50th percentile (median), which is a better measure of the central tendency (being less sensitive to extreme values in the upper and lower tails) is insignificant – the same with the estimation at the mean of the distribution (Table 3.3, column 1). I do not see a natural explanation for this, other than the difficulty in capturing accurately the minimum wage effect in a segment of the labour market that is as diverse and fluid as the self-employed (a quite heterogeneous group, comprising a wide range of activities that also tend to underreport their earnings).

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[38] Lemieux (2011) proposes a procedure that allows estimating the effect of the minimum wage on the distribution of wages and employment. He makes use of the term 'rescaled survivor function', which summarizes the information about the probability of working and earning a wage rate of at least w (see also Lemieux, 2002). The effect of a minimum wage increase is estimated at different point of the wage distribution (w), where the dependent variable is the empirical analog of rescaled survivor function ($RS_{pt}(w)$: the fraction of individuals in province p at time t who are employed and earn a wage of at least w); and the right hand side of the regressions includes the term:

$f(W_m, w) = \Sigma_k \pi_k(w) D_{k,pt}$, where $D_{k,pt}$ are a set of indicators defined as:

$D_{k,pt} = 1$ if $k-.5 < W_{m,pt} \leq k+.5$,

$D_{k,pt} = 0$ otherwise, where k is the value of the minimum wage.

The parameters $\pi_k(w)$, then, capture the effect of raising the minimum wage from W_m to W_m' at different points of the wage distribution (w). What Lemieux proposes is the comparison of estimated $\pi_k(w)$ with their size and magnitude as predicted by four different models, in order to conclude which of the empirical evidence supports the most. No matter how interesting would it be to implement this procedure using Cyprus data, this is not feasible due to the lack of regional variation in the legal minimum wage. Both the empirical analog of the rescaled survivor function, $RS_{pt}(w)$, and the minimum wage measure, $f(W_m, w)$ in the Lemieux methodology assume a large variation in minimum wages over provinces. Without this regional variation the minimum wage indicators, $D_{k,pt}$, will de identical with year-specific fixed effects, which also incorporate endogenous changes in the survey design and other time-specific factors (such as aggregate supply and aggregate demand shifts or changes in the timing of the surveys).

Differential Minimum Wage Effect between Covered and Uncovered Workers:

In order to test empirically for differences in the minimum wage effect between the covered and uncovered workers, equation (3.1) is also estimated including a dummy variable for the workers in the occupations not covered by the minimum wage legislation (as defined in Table A.2 of Appendix A) and its interaction with the minimum wage variable. Similarly with the results in Tables B.6 and B.7, the coefficient of the interaction term expresses the additional effect of the minimum wage in the wages of the uncovered employees in comparison with the group of reference, which in this case are the covered employees. The additional wage effect is also estimated at different points of the wage distribution using quantile regressions.

The results in Table B.9 of Appendix B (column 1) indicate that the estimates of the additional effect are negative and significant. The results from the quantile regressions (columns 2-6) provide additional evidence that the legal minimum wage affects the wages of the uncovered employees at a lesser degree than the wages of the covered employees, but only at the bottom half of the wages distribution (as also suggested in the results of Table B.8). Thus, the wages of the highest-paid employees tend to be affected at the same degree by the minimum wage, which is also evidence of the numeraire effect (Fajnzylber, 2001).

3.6 Conclusion

This study examines the sectoral impact of the minimum wage on wages and employment in Cyprus, a country where the legislative coverage is limited to only a few occupational groups and for the remaining occupations the bipartite wage negotiations are not subject to an institutional minimum. The microeconomic evidence of the minimum wage effects in countries with limited coverage is sparse, so more evidence is needed to form a consensus on the impact of minimum wages on workers in the sectors covered by this legislation versus those in uncovered sectors. In addition, this chapter investigates whether the main finding of Chapter 2 (a negative impact of the minimum wage on total employment and spill-over effects in the uncovered sector).

Therefore this chapter re-examines the effect of the minimum wage on employment suggested by the macroeconomic analysis in Chapter from a microeconomic perspective and corroborate findings based on time-series: in particular the existence of spillover effects. Those spill-overs occur when increases in the minimum wage in the covered sector act as a reference point, raise bargaining power and trigger higher wage settlements in the uncovered sector, which may also discourage employment.

Summarizing the results beginning with the covered sector, the estimated wage effects suggest that a higher minimum wage increases wages there. This result, combined with those of the kernel density estimates and the wage proportions, leads to the conclusion that the minimum wage legislation is effective in the covered sector. The results also indicate a significant and positive wage effect on the uncovered workers whose monthly earnings are near the legal minimum, while the employment effects are significantly negative and large, which is contrary to the predictions from the two-sector competitive model.

It is concluded that the uncovered sector is also affected by the minimum wage legislation, but only as far as private sector employees are concerned. This is evidence in favour of an indirect impact of the legal minimum wage on the negotiations between the trade unions and employers' organizations, acting as a "numeraire" in labour contracts. This result is robust to empirical technique and specification of the regressions. Additional estimations indicate that the legal minimum wage affects the wages of the uncovered employees at a lesser degree than the wages of the covered employees and also affecting the earnings of workers in different age groups in opposite directions. When the minimum wage effects are estimated using the total sample, the empirical findings provide evidence that the legal minimum wage reduces the overall probability of employment, while it only affects the earnings of individuals whose monthly-equivalent income is within 25% of the legal minimum.

Thus the overall results reinforce the evidence from Chapter 2 for the existence of an effective minimum wage in the covered sector of Cyprus influences wage setting in the uncovered sector. This finding suggests that the policy of the Ministry of Labour and Social Insurance to include only non-unionized occupations in the scope of the minimum wage legislation seems justified, since the wages of the workers in the rest of the occupations are effectively protected by their unions. However, the results indicate that whereas minimum wage policy in Cyprus improves the earnings of workers who remain employed, it also creates large disemployment effects in both the covered and uncovered sectors. Hence, it is concluded that a policy dialogue is needed in Cyprus (between the government, the trade unions and the employers associations), in order to determine whether the goal of minimum wage legislation to protect certain categories of non-unionized workers is achieved. In that manner, the Ministry of Labour and Social Insurance should also reconsider its current policy to increase the minimum wage rate annually since 1990.

Appendix A: Data Description

In Cyprus, wages and salaries are set as the result of bipartite negotiations between the most representative employers' organisations and trade unions, at the sectoral and company levels. However, the parties to the collective bargaining agreements are not bound by the principle of a national statutory minimum wage. The Cyprus Minimum Wage Law was created in 1941 in order to protect the rights of mining workers. In 1944 the Law was amended in order to include salespersons and clerks and in 1957 the Law ceased to include the mining workers. Based on the existing legislation (Law on minimum wages, Chapter 183), monthly minimum wages are currently set for the nine occupational groups listed in Table A.1.[39]

Table A.1: Occupations Covered by the Minimum Wage Law in Cyprus

Occupations Covered	Period of Coverage
1. Salespersons	1944 – currently
2. Clerks	
3. Auxiliary Healthcare Staff	1990 – currently
4. Auxiliary Staff in Nursery Schools	
5. Auxiliary Staff in Crèches	
6. Auxiliary Staff in Schools	
7. Guards	2008 – currently
8. Caretakers Working in Clinics, Private Hospitals and Nursing Homes	
9. Cleaners in Business/Corporate Premises	2010 – currently

[39] In 2009, the minimum wage for Guards started to be set at an hourly rate instead. In 2011 the same happened to the Cleaners of Business/Corporate Premises.

Table A.2: Proportions of Covered Workers in the HBS Occupational Groups

Occupational Groups in the HBS	ISCO 1988 Classification	HBS 1990/91	HBS 1996/97	HBS 2002/03	HBS 2008/09
Armed Forces	0.0	0.0%	0.0%	0.0%	0.0%
Managers	1.0	0.0%	0.0%	0.0%	0.0%
Professionals	2.0, 3.0	3.8%	4.6%	4.3%	4.3%
Clerks	4.0	49.7%	61.9%	60.1%	60.1%
Services Workers	5.1	2.7%	3.0%	3.0%	9.3%
Sales Workers	5.2	100.0%	100.0%	100.0%	100.0%
Agriculture and Forestry	6.0	0.0%	0.0%	0.0%	0.0%
Skilled Workers	7.0, 8.0	0.0%	0.0%	0.0%	0.0%
Unskilled Workers	9.0	0.0%	0.0%	0.0%	30.7%

Note: Table A.2 reports the proportion of the workers that are covered by the minimum wage law in each of the occupational groups recorded by the Household Budget Survey (HBS). These proportions are calculated from the Census of Establishments (COE). Both HBS and COE use the same system of classification (International Standard Classification of Occupations, Version 1988), but CEO has a finer classification for workers' occupations and thus makes it easier to identify which of the workers in the broad categories of HBS (listed above) belong to the covered occupations (listed in Table A.1).

The 1984/85 HBS was conducted for 3,759 households and 12,818 individuals residing in the Government-controlled areas; these households and individuals represent 2.52 per cent of the total household population. This survey, however, exhibits some deficiencies concerning both the collection and the processing of the figures and is excluded from the sample of this chapter. The 1990/91 survey provides data on 2,708 households and 9,062 individuals, residing in the Government-controlled areas, and representing 1.60 percent of the total population. The 1996/97 survey contains data for 2,644 households and 8,637 individuals, or 1.30 percent of the population. The 2003 HBS was based on a sample of 2,990 households and 9,408 individuals, that is, 1.25 per cent of the total household population residing in the Government controlled areas. Finally, the 2009 survey provides data for 2,707 households and 7,976 individuals, which represent 1.00 per cent of the total household population residing in the Government-controlled areas.

These surveys provide the best available information on the income and expenditure of Cypriot households. While the focus of this study is on the impacts of minimum wages, the variables collected in the survey make it more likely that it will also improve understanding of the wage and employment determination process in Cyprus, netting such out the contribution of the minimum wage from the effect of characteristics such as experience and education.

Table A.3: Characteristics of Workers in Each Group of Interest, Averages over 1990/91 – 2008/09

Variable	All Workers	Covered Workers	Uncovered Workers	Self-Employed
Gender:				
Male	0.57	0.33	0.61	0.71
Female (*)	0.43	0.67	0.39	0.29
Age and Family Status:				
20 – 24	0.09	0.13	0.08	0.04
25 – 29	0.12	0.17	0.12	0.08
30 – 39 (*)	0.28	0.30	0.28	0.28
40 – 49	0.27	0.24	0.28	0.27
50 – 59	0.19	0.13	0.19	0.24
60 – 64	0.05	0.03	0.05	0.09
Married	0.77	0.73	0.77	0.87
Has Children	0.65	0.66	0.64	0.73
Education Level:				
Illiterate	0.04	0.01	0.05	0.07
Elementary (*)	0.30	0.13	0.31	0.46
Lyceum	0.37	0.59	0.33	0.29
College	0.12	0.19	0.11	0.06
University	0.17	0.08	0.20	0.12
Occupational Group:				
Armed Forces	0.01		0.01	
Manager	0.03		0.04	0.01
Professional	0.23		0.31	0.16
Clerk (*)	0.12	0.67		0.02
Services Worker	0.09		0.11	0.12
Sales Worker	0.08	0.33		0.13
Agriculture Worker	0.04		0.03	0.10
Skilled Worker (*)	0.24		0.28	0.39
Unskilled Worker	0.16		0.22	0.07
Sector:				
Private (#)	0.76	0.84	0.71	
Public (#)	0.24	0.16	0.29	
Period:				
1990-1991 (*)	0.26	0.16	0.26	0.27
1996-1997	0.23	0.23	0.23	0.29
2002-2003	0.27	0.33	0.27	0.26
2008-2009	0.24	0.28	0.24	0.18
Real Wage / Income: (#)	947	784	982	1,010
Employment Sample:	14,909	2,585	9,985	1,875
Wages Sample:	12,110	2,270	8,857	983

Notes: Sample means of basic control variables for the main groups identified in each column. The last two rows provide the corresponding sample sizes. The means of all variables are calculated using the employment sample, except for the ones marked with a (#), where the wages sample is used instead. (*) denotes variables not included when estimating equations (3.1) and (3.2) (i.e. the reference groups). The income variables (wage and income from self-employment) are expressed in real terms with the use of the Consumer Price Index, Base Year 1992.

Appendix B: Robustness Checks and Additional Estimation Results

Table B.1: Coefficients from Wage Equations (Estimated with OLS)

Variable	All Workers	Covered Workers	Uncovered Workers	Self-Employed
Real Minimum Wage:	0.571	1.735*	-0.315	-8.279
Growth:	-0.789***	0.002	-0.612***	-0.285
Gender:				
Male	0.378***	0.318***	0.404***	0.457***
Age and Family Status:				
20 – 24	-0.345***	-0.350***	-0.348***	-0.546***
25 – 29	-0.262***	-0.269***	-0.298***	-0.110*
30 – 39	-0.127***	-0.114***	-0.162***	-0.003
50 – 59	0.060***	0.033	0.101***	-0.058
60 – 64	-0.036*	-0.038	0.003	-0.246***
Married	0.124***	0.127***	0.129***	0.137***
Education Level:				
Illiterate	-0.072***	-0.091	-0.074***	-0.232***
Lyceum	0.076***	0.128***	0.101***	0.017
College	0.141***	0.171***	0.180***	0.133*
University	0.309***	0.261***	0.339***	0.208***
Occupational Group:				
Armed Forces	0.186***		0.382***	
Manager	0.576***		0.526***	0.166
Professional	0.264***		0.296***	0.125*
Clerk	0.111***	0.179***		0.124
Services Worker	0.011		0.064***	-0.095
Sales Worker	-0.051***			-0.028
Agriculture Worker	-0.114**		-0.122***	-0.313**
Unskilled Worker	-0.305***		-0.264***	-0.257***
Period:				
1996-1997	0.024	-0.279	0.161	
2002-2003	0.121	-0.296	0.230	1.198
2008-2009	0.170	-0.733	0.330	3.014
Constant	2.913***	-3.995	7.598***	54.485*
Number of Observations	12,100	2,270	8,857	983
R-squared	0.536	0.421	0.561	0.317

Notes: Table B.1 presents results from estimating equation (3.1) for samples identified by column using OLS. The estimates are robust for heteroskedasticity. Besides the control variables mentioned in the table, all specifications include area and province dummies (not reported). The complete set of results is available upon request.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.2: Coefficients from Wage Equations (Estimated with ML)

Variable	All Workers	Covered Workers	Uncovered Workers	Self-Employed
Real Minimum Wage:	0.424	1.310	-0.454	-9.736*
Growth:	-0.902***	0.410	-1.053***	-0.282
Gender:				
Male	0.369***	0.330***	0.361***	0.463***
Age and Family Status:				
20 – 24	-0.333***	-0.266***	-0.282***	-0.547***
25 – 29	-0.262***	-0.271***	-0.257***	-0.108*
30 – 39	-0.126***	-0.113***	-0.142***	-0.005
50 – 59	0.047***	0.031	0.085***	-0.057
60 – 64	-0.386	-0.410	0.030	-0.246*
Married	0.121***	0.140***	0.110***	0.136***
Education Level:				
Illiterate	-0.071**	-0.096	-0.051	-0.232***
Lyceum	0.072***	0.142***	0.072***	0.018
College	0.129***	0.171***	0.131***	0.138*
University	0.304***	0.270***	0.345***	0.221***
Occupational Group:				
Armed Forces	0.170***		0.201***	
Manager	0.486***		0.483***	0.166
Professional	0.248***		0.265***	0.117
Clerk	0.101***	0.194***		0.126
Services Worker	-0.001		0.003	-0.092
Sales Worker	-0.073***			-0.070
Agriculture Worker	-0.240***		-0.182***	-0.318**
Unskilled Worker	-0.303		-0.296***	-0.258***
Period:				
2002-2003	0.021	-0.173	0.089**	1.396**
2008-2009	-0.104	-0.485	0.206**	3.538*
Constant	3.813*	-1.752	8.625***	62.955**
Number of Observations	9,891	1,732	6,742	991
Chi-square Test	0.000	0.000	0.000	0.000
Rho Coefficient (ρ)	0.045	0.227	0.214	0.105
Wald Test (*Ho: ρ = 0*)	0.660	0.634	0.189	0.721

Notes: Table B.2 examines whether the selected wage sub-sample is representative of the larger employment sample by estimating a two-equation system using a Probit mechanism and the Maximum Likelihood (ML) method. This method considers whether the selection from the employment samples into the selected wage sub-samples is conditioned by a correlation between the random error terms in the selection and the wage equation. The selection bias hypothesis is examined by testing whether the correlation coefficient (*ρ*) is significantly different from zero, since then there is no selection issue and the two equations may be estimated separately. This procedure warrants the Probit equation to include factors that influence the paid employment outcome, but are not likely to affect the actual wage earned. These factors are: a) whether an individual has children or not and b) income from sources other than employment. Since the HBS 1990/1991 does not include data on non-labour income, the selection bias tests are performed only using data for the period 1996/97– 2008/09.

Table B.3: Results from Employment Equations (Probit Regressions)

Variable	All Workers	Covered Workers	Uncovered Workers	Self-Employed
Real Minimum Wage:	-0.180***	-0.266**	-0.287***	-0.287***
Growth:	0.065***	0.049	0.047***	-0.012
Gender:				
Male	0.008***	-0.002	0.005**	0.002
Age and Family Status:				
20 – 24	-0.015***	-0.004	0.006	-0.001
25 – 29	-0.003	-0.004	0.010**	0.003
30 – 39	0.003	0.005	0.002	0.007**
50 – 59	0.000	-0.005	0.001	0.001
60 – 64	-0.010***	-0.009	-0.008**	-0.001
Married	0.016***	0.010**	0.009***	0.005
Has Children	0.006**	0.007*	-0.001	-0.003
Education Level:				
Illiterate	-0.005		-0.006	
Lyceum	0.001	0.003	0.007***	-0.001
College	-0.004	0.006	0.002	0.005
University	-0.008*	0.014*	-0.010**	0.008
Occupational Group:				
Armed Forces	0.024		0.016	
Manager	0.028***		0.005	
Professional	0.024***		0.005	0.002
Clerk	0.010***	0.001		
Services Worker	0.010***		-0.002	0.000
Sales Worker	0.015***			0.006
Agriculture Worker	0.044***		0.042***	-0.001
Unskilled Worker	-0.003***		-0.001	-0.002
Period:				
1996-1997	0.032**	0.058**	0.054***	
2002-2003	0.053***	0.082**	0.081***	0.038***
2008-2009	0.092***	0.149**	0.159***	0.099***
Constant	1.028***	1.476**	1.607***	1.700***
Number of Observations	14,020	2,532	9,709	1,424
Pseudo R-squared	0.245	0.386	0.335	0.122

Notes: Table B.3 presents marginal effects estimated from Probit regressions of equation (3.2) for samples identified by column. A positive estimate indicates an increase in the probability a worker is gainfully employed. The estimates are robust for heteroskedasticity. Besides the control variables mentioned in the table, all specifications include area and province dummies (not reported). The complete set of results is available upon request.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.4: Robustness Checks for the Impact of the Legal Minimum Wage on Wages

For Workers in the Following Sectors:	Using Kaitz Index (1)		Excluding GDP Variables (2)		Omitting Workers aged 60-64 (3)	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
All Workers	0.571	(0.102)	0.540	(0.351)	0.641*	(0.360)
Covered Workers	1.735*	(0.947)	1.735*	(0.946)	1.877**	(0.947)
Uncovered Workers	-0.314	(0.573)	-0.243	(0.579)	-0.381	(0.588)
Private Workers	0.478	(0.531)	0.571	(0.548)	0.396	(0.543)
Public Workers	-3.257	(2.410)	-3.240	(2.400)	-3.277	(2.498)
Self-Employed	-8.279	(5.588)	-8.347	(5.617)	-10.124*	(5.411)

Notes: This table presents estimates of the marginal effects of the minimum wage on wages using alternative specifications of equation (3.1) identified by column. (In the estimations in column (3) the specification is the same, but the sample omits workers near the retirement age.) Notice that column (1) is almost identical to column (1) of Table 3.3. Reported standard errors (in brackets) are robust for heteroskedasticity.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.5: Robustness Checks for the Marginal Impact of the Minimum Wage on the Probability of Employment

For Workers in the Following Sectors:	Using Kaitz Index (1)		Excluding GDP Variables (2)		Omitting Workers aged 60-64 (3)	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
All Workers	-0.179***	(0.057)	-0.184***	(0.058)	-0.195***	(0.058)
Covered Workers	-0.266***	(0.113)	-0.281***	(0.113)	-0.274***	(0.106)
Uncovered Workers	-0.287***	(0.061)	-0.304***	(0.062)	-0.323***	(0.064)
Self-Employed	-0.375***	(0.150)	-0.290***	(0.104)	-0.254**	(0.107)

Notes: This table presents estimates of the marginal effects of the minimum wage on the chance of being employed using alternative specifications of equation (3.2) identified by column. (In the estimations in column (3) the specification is the same, but the sample omits workers near the retirement age.) Notice that column (1) is almost identical to column (1) of Table 3.4. Reported standard errors (in brackets) are robust for heteroskedasticity.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.6: Impact of the Legal Minimum Wage on Wages by Age

Covered Workers	Estimate	Standard Error	**All Workers**	Estimate	Standard Error
MW * Age (20-24)	-0.058***	(0.004)	MW * Age (20-24)	-0.345***	(0.015)
MW * Age (25-29)	-0.045***	(0.004)	MW * Age (25-29)	-0.262***	(0.012)
MW * Age (30-39)	-0.019***	(0.004)	MW * Age (30-39)	-0.127***	(0.009)
MW * Age (50-59)	0.005	(0.005)	MW * Age (50-59)	0.059***	(0.011)
MW * Age (60-64)	-0.007	(0.009)	MW * Age (60-64)	-0.037*	(0.021)
MW	1.781*	(0.947)	MW	0.571*	(0.317)
Sample Size	2,270		Sample Size	12,110	
R-squared	0.4202		R-squared	0.5355	
Uncovered Workers	Estimate	Standard Error	**Self-Employed**	Estimate	Standard Error
MW * Age (20-24)	0.197**	(0.092)	MW * Age (20-24)	-0.546***	(0.141)
MW * Age (25-29)	-0.062	(0.070)	MW * Age (25-29)	-0.109*	(0.066)
MW * Age (30-39)	-0.026	(0.059)	MW * Age (30-39)	-0.003	(0.043)
MW * Age (50-59)	0.012	(0.068)	MW * Age (50-59)	-0.058	(0.044)
MW * Age (60-64)	0.117	(0.120)	MW * Age (60-64)	-0.246***	(0.062)
MW	-0.381	(0.571)	MW	-8.279	(5.589)
Sample Size	8,857		Sample Size	983	
R-squared	0.5616		R-squared	0.3166	

Notes: Table B.6 presents the estimated effects of the minimum wage on wages for workers in different age groups identified by row. The estimates are made using a specification of equation (3.1) that includes interaction terms of the log minimum wage variable with age groups dummy variables. Each of the four panels reports the results for a different employment group. Notice that the results in the last raw of each panel (MW) are comparable to the ones in column (1) of Table 3.3. Reported standard errors (in brackets) are robust for heteroskedasticity.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.7: Impact of the Legal Minimum Wage on the Probability of Employment by Age

Covered Workers	Marginal Effect	Standard Error	**All Workers**	Marginal Effect	Standard Error
MW * Age (20-24)	-0.016	(0.021)	MW * Age (20-24)	-0.011	(0.015)
MW * Age (25-29)	-0.003	(0.021)	MW * Age (25-29)	-0.008	(0.014)
MW * Age (30-39)	0.007	(0.022)	MW * Age (30-39)	-0.010	(0.014)
MW * Age (50-59)	-0.052*	(0.032)	MW * Age (50-59)	-0.029*	(0.017)
MW * Age (60-64)	-0.070	(0.045)	MW * Age (60-64)	-0.016	(0.021)
MW	-0.233**	(0.105)	MW	-0.169***	(0.058)
Sample Size	2,532		Sample Size	14,020	
Pseudo R-squared	0.3908		Pseudo R-squared	0.2444	
Uncovered Workers	Marginal Effect	Standard Error	**Self-Employed**	Marginal Effect	Standard Error
MW * Age (20-24)	0.006	(0.017)	MW * Age (20-24)	0.162***	(0.093)
MW * Age (25-29)	-0.018	(0.018)	MW * Age (25-29)	-0.026***	(0.021)
MW * Age (30-39)	-0.017	(0.012)	MW * Age (30-39)	-0.005	(0.009)
MW * Age (50-59)	-0.023	(0.014)	MW * Age (50-59)	-0.011**	(0.010)
MW * Age (60-64)	-0.178	(0.017)	MW * Age (60-64)	-0.010	(0.011)
MW	-0.277***	(0.061)	MW	-0.162***	(0.092)
Sample Size	9,709		Sample Size	1,424	
Pseudo R-squared	0.3367		Pseudo R-squared	0.3166	

Notes: Table B.7 presents the estimated marginal effects of the minimum wage on the chance of being employed in different age groups identified by row. The estimates are made using a specification of equation (3.2) that includes interaction terms of the log minimum wage variable with age groups dummy variables. Each of the four panels reports the results for a different employment group. Notice that the results in the last raw of each panel (MW) are comparable to the ones in column (1) of Table 3.4. Reported standard errors (in brackets) are robust for heteroskedasticity.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.8: Impact of the Legal Minimum Wage on Wages on Different Levels of the Wage Distribution

	All Workers (1)	**Covered Workers (2)**	**Uncovered Workers (3)**	**Self-Employed (4)**
10^{th} Percentile	0.764*	0.297	-0.343	-12.805***
	(0.439)	(1.011)	(0.743)	(2.874)
25^{th} Percentile	0.633**	1.594	0.633**	-13.797***
	(0.292)	(1.252)	(0.297)	(3.943)
50^{th} Percentile (Median)	0.522*	1.028	0.533	-5.625
	(0.286)	(1.016)	(0.473)	(3.486)
75^{th} Percentile	0.156	1.556***	0.245	8.484**
	(0.337)	(0.135)	(0.525)	(3.577)
90^{th} Percentile	0.651	2.131***	0.238	3.976***
	(0.457)	(0.261)	(0.656)	(1.508)
Mean	0.571	1.735*	-0.314	-8.279
	(0.349)	(0.947)	(0.573)	(5.588)

Notes: Table B.8 presents the estimated marginal effects of the minimum wage on wages for the employment groups identified by column, at different points of the wage distribution. The coefficients are estimated using quantile regression specifications of equation (3.1) at the 10th, 25th, 50th, 75th and 90th percentiles. Notice that the results in the last raw (where the wage effects are estimated at the mean of the wage distribution) are identical to column (1) of Table 3.3. Standard errors are reported in brackets.

*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.9: Differential Impact of the Legal Minimum Wage on Wages between Covered and Uncovered Employees

Percentile:	At Mean (1)	10^{th} (2)	25^{th} (3)	50^{th} (4)	75^{th} (5)	90^{th} (6)
MW * Uncovered	-0.110**	-0.217***	-0.235***	-0.094*	-0.065	0.009
	(0.049)	(0.077)	(0.061)	(0.049)	(0.054)	(0.086)
MW	0.323	-0.509	0.241	0.360	0.407	0.302
	(0.494)	(0.662)	(0.524)	(0.425)	(0.462)	(0.709)
R-squared	0.5734	0.3753	0.3617	0.3627	0.3755	0.3685

Notes: Table B.9 presents estimations from a specification of equation (3.1) that allows the assessment of the differential effect of the minimum wage between covered and uncovered employees. This specification includes a dummy variable for the workers in the occupations not covered by the minimum wage legislation (as defined in Table A.2 of the Data Appendix) and its interaction with the log real minimum wage. The first column presents the coefficient of the interaction term and the minimum wage variable, estimated at the mean of the wage distribution. In the rest of the columns the coefficients are estimated at different points of the wage distribution using quantile regressions. Standard errors are reported in brackets.

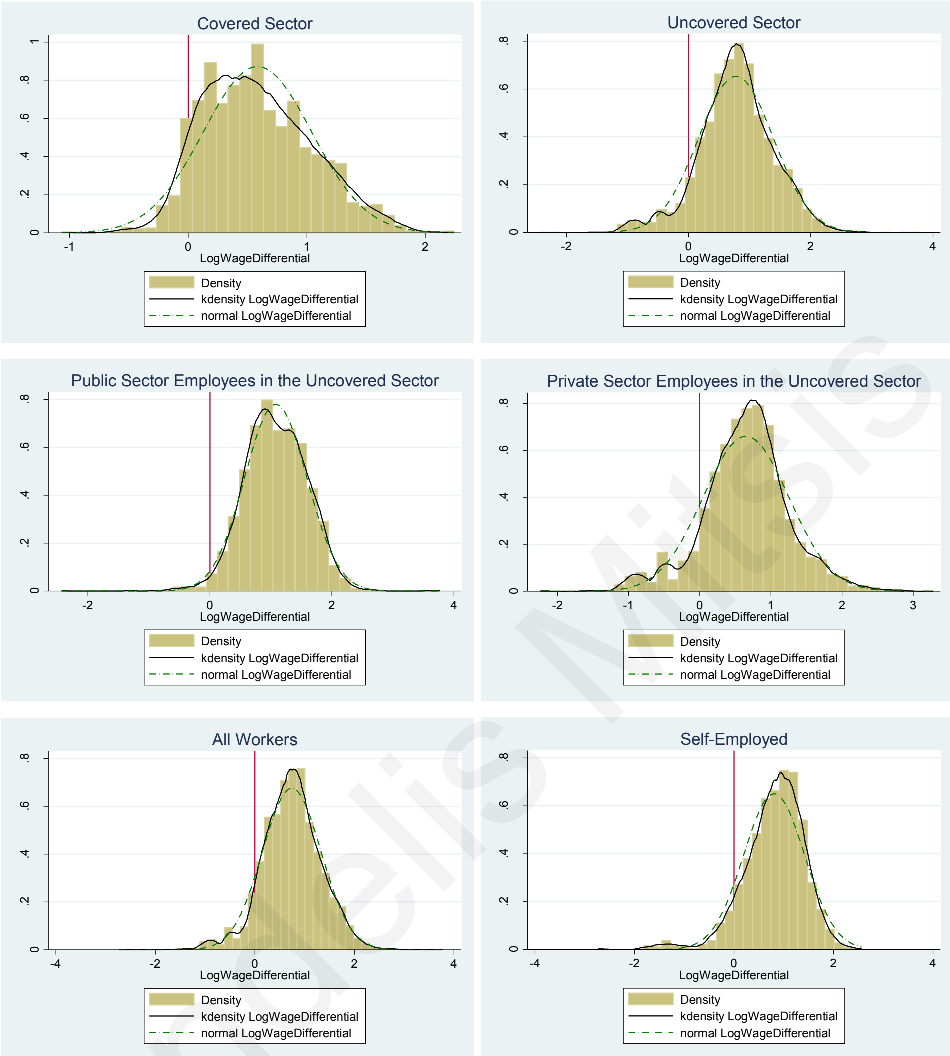
*** denotes significance at 1%, ** at 5%, and * at 10%.

Table B.10: Panel Data Unit Root Test Results

Variable	Test Statistic	P-Value
Real Wage	-56.762	(0.000)
Real Income from Self-Employment	-159.621	(0.000)
Real Non-Labour Income	-9.202	(0.000)
Real Minimum Wage	-87.726	(0.000)
Kaitz Index	-97.581	(0.000)
Growth of Real GDP	-122.123	(0.000)

Notes: All variables are in natural logarithms. The null hypothesis is that the series assumes a common unit root process (Levin, Lin and Chu, 2002). Probabilities for the tests are computed using an asymptotic Normal distribution. The p-values are reported in brackets.

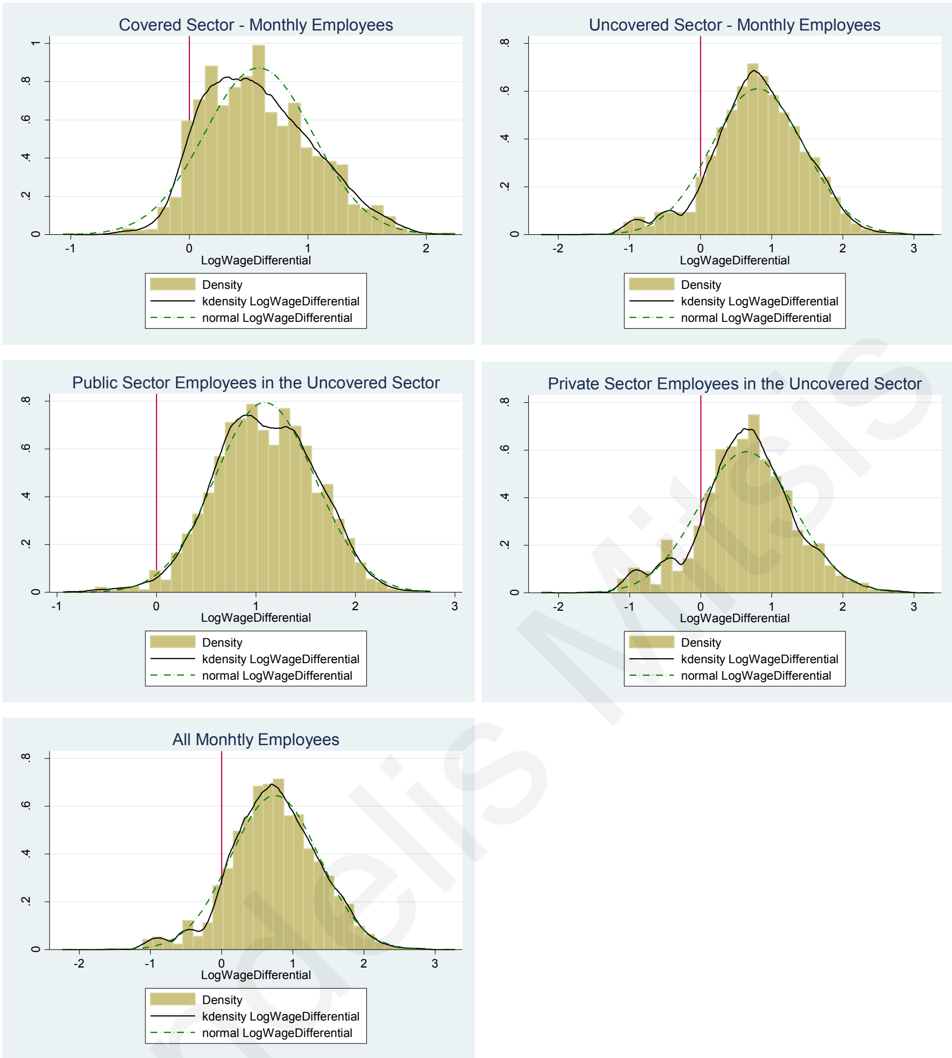
Figure 3.1: Graphs of Log Wage - Log Minimum Wage, All Workers



Note: The graphs in Figure 3.1 present the Kernel density estimates (continuous line) of the log wage minus the log minimum wage for each worker group described in Section 3.3.1. Normal distributions fitted to the data (dashed line) are also provided for comparison. A value equal to zero (vertical line) indicates the workers earning the legal minimum wage. Each of these graphs includes a histogram representing the frequency of the observations in discrete wage intervals.

Source: Author's calculations based on the Households Budget Surveys (HBS) 1990/91, 1996/97, 2002/03 and 2008/09.

Figure 3.2: Graphs of Log Wage - Log Minimum Wage, Monthly Workers Only



Note: Figure 3.2 presents the Kernel density estimates (continuous line) of the log wage minus the log minimum wage for each worker group described in Section 3.3.1, along with Normal distributions fitted to the data for comparison (dashed line). The difference from Figure 3.1 is that here only data for workers on monthly pay are used. As with Figure 3.1, the vertical line in zero indicates workers earning the legal minimum wage and histograms representing the frequency of the observations in discrete wage intervals are included. Notice that Figure 3.2 does not include a graph for the self-employed, since their earnings are only reported on an annual basis.

Source: Author's calculations based on the Households Budget Surveys (HBS) 1990/91, 1996/97, 2002/03 and 2008/09.

Chapter 4: Is there an Environmental Kuznets Curve in the Carbon Dioxide Emissions? A Bayesian Method Averaging Approach

4.1 Introduction

The Environmental Kuznets Curve (EKC) has been studied extensively in environmental economics. It is defined as an inverted U-shaped empirical relationship across countries between per capita GDP and the level of environmental degradation.[40] If the EKC holds universally, then economic growth will eventually lead to environmental improvement.

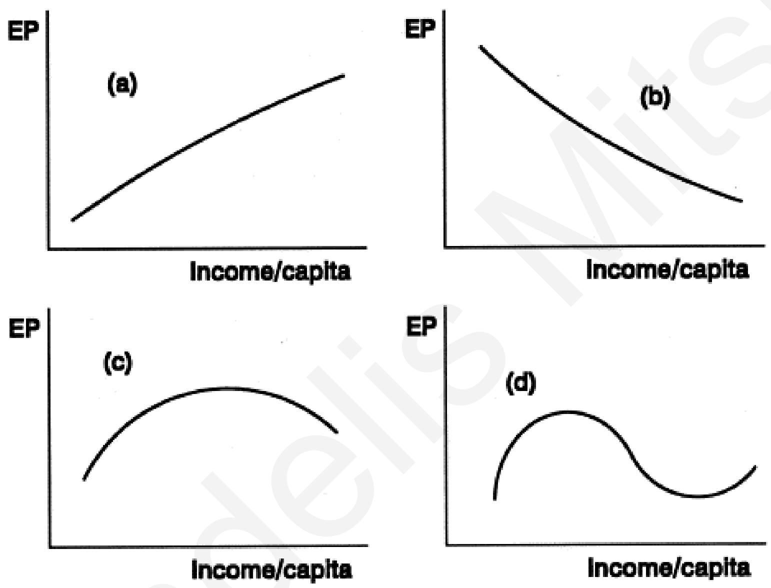
According to the EKC hypothesis, after a certain level of income per capita (turning point), the environmental quality should improve in accordance with economic growth, generating the pattern indicated in Figure 4.1(c). Based on economic theory, the dominant explanations that have been put forth to explain this relationship are: a) the high costs associated with pollution control and abatement make environmental concerns similar to a luxury good and the turning point marks the stage where countries can "afford" it; b) as countries become richer, desire for a cleaner environment increases in the population and so does the political pressure for stricter environmental regulations; and c) the EKC pattern reflects the transition of the countries from pollution-intensive industrialized economies to less-pollution intensive service-based economies.

However, the encouraging initial EKC empirical findings have been followed by a vast literature with conflicting empirical results. The findings of some papers (e.g. Shafik, 1994; and Schmalensee et al, 1997) show environmental pressure (EP) as a linear function of income per capita, indicated in Figures 4.1(a) and

[40] The first use of the term, Environmental Kuznets Curve, in an academic journal was by Selden and Song (1994). The original Kuznets 'inverted U-shape' hypothesis refers to the relationship between income inequality and per capita income - that in early stages of economic growth the distribution of income worsens, while at later stages it improves (Kuznets, 1955).

4.1(b), while authors such as de Bruyn et al. (1998), believe that EKC does not hold in its classical form. The inverted U shape is only an initial stage of the relationship between economic growth and environmental pressure, since at a certain income level there would be a new turning point, leading to the N-shaped EKC shape indicated in Figure 4.1(d).

Figure 4.1: Various relationships between environmental pressure (EP) and per capita income



Source: de Bruyn et al. (1998), Fig.1, p.164.

This diversity of findings necessitated further research to explain the income/pollution relationship, either by creating more formal models than emissions-income regressions, or by adding control variables in the model - resulting from different lines of research. Despite the vast amount of empirical research generated by these approaches, there is remarkably little consensus on which of the additional determinants is the most salient in explaining environmental degradation. The EKC is thus an area of research with model (theory) uncertainty: the true model is unknown and several competing approaches exist that attempt to quantify the exact relationship between environmental quality and income.

The goal of this chapter is to re-examine whether the relationship between carbon dioxide emissions and income per capita exhibits an EKC and also to identify for which of the range of possible candidate regressors the data provide the most favourable evidence, using model averaging techniques. The model averaging solution to model uncertainty is to base inferences on all competing models (i.e. sets of regressors), each model weighted by the posterior probability that it is indeed the true model. In EKC studies prominent examples of method averaging applications include the computing the EKC parameters under switching regimes of environmental degradation (Halkos and Tsionas, 2001), as well as examining the existence of EKC in local air pollution (Begun and Eicher, 2008). To the author's knowledge, this is the first study to apply model averaging to resolve the model uncertainty surrounding the existence of EKC in global air pollution.

The empirical analysis finds very strong support for the EKC. The income measures are the most robust variables affecting carbon dioxide emissions, whereas I find little evidence in favour of political economy proxies, international trade and other regressors proposed in the literature. The Gini coefficient and the regional dummy variables are the only additional repressors which remain significant in explaining carbon dioxide emissions once the model uncertainty has been incorporated in the estimation method and the robustness of the findings examined. This result suggests that a significant portion of the regressors proposed in the literature may appear empirically significant only because the empirical strategy does not account for model uncertainty. The results also indicate that social policy may influence environmental degradation and that the numerous alternative specifications in the EKC modeling cannot be adequate to account for the unexplained regional variation in the levels of CO2.

The organization of this study is as follows: Section 4.2 provides the econometric framework in the EKC approaches, and Section 4.3 details the strategy for addressing model uncertainty using Bayesian method averaging. Section 4.4

describes the data used, Section 5 presents the estimation results and Section 4.6 concludes.

4.2 Basic Econometric Framework

The literature on Environmental Kuznets curves (EKCs) begins in 1992 with the paper by Grossman and Krueger and has exploded since with: i) papers estimating "traditional" EKCs (e.g. Grossman and Krueger, 1995; Shafik and Bandyopadhyay, 1992; Holtz-Eakin and Selden, 1995), ii) EKC critiques (e.g. Arrow et al, 1995; Stern et al, 1996; Stern, 1998) and iii) studies of the theoretical and empirical determinants of EKC (Selden and Song, 1994; Stokey, 1998; Suri and Chapman, 1998; and others).[41]

The 'traditional' papers focus on estimating a quadratic or cubic relationship between some measure of environmental degradation and per capita income, to test the inverted U-shape of the EKC. The literature that follows indicates a diversity of empirical results that some authors (e.g. List and Gallet, 1999; Spangenberg, 2001; Harbaugh et al, 2002; Millimet et al, 2003) consider as evidence against the mere existence of the EKC. However, the expressed criticisms have not put a stop to the continuing growth of the literature, motivating the inclusion of a variety of additional regressors in estimating EKC.[42]

This chapter attempts to assess whether an EKC exists and to weight the evidence of the different determinants of environmental degradation proposed in the EKC literature, using the Bayesian Method Averaging. It focuses on air pollution and, more specifically, on the level of carbon dioxide emissions in the atmosphere.[43]

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[41] The interested reader may consider the extensive reviews of the EKC literature in the following papers: Panayotou (2000), Dasgupta et al (2002) and Nahman and Antrobus (2005).

[42] See Dasgupta et al (2002) for a survey.

[43] The majority of EKC studies use air pollution indicators to measure environmental degradation, of which carbon dioxide emissions are amongst the most frequently used (see, for example, Shafik and Bandyopadhyay, 1992; Holtz-Eakin and Selden, 1995; and Managi, 2004). Other papers use sulphur dioxide emissions or concentrations, for which data are available in varying levels of aggregation from various sources (see, for example, Grossman and Krueger, 1995; Antweiler et al, 2001; and Cole, 2004). Other air pollution indices used in EKC studies are: nitrogen oxides (List and Gallet, 1999; Hill and Magnani, 2002; Cole, 2004; Managi et al, 2009), suspended particulate matter (Dinda et al, 2000) and carbon monoxide (Cole

This is investigated by examining two approaches used to test EKC: a) reduced-form models and b) theory-based models. In the reduced-form approach many possible determinants of pollution are tried and, even in the carbon dioxide EKC related papers, this strand of literature is vast and open-ended.[44] Following a similar approach with Begun and Eicher (2006), this chapter uses the theory-based model of Antweiler, Copeland and Taylor (2001) as a logical alternative to the reduced-form approach, since it examines specific theories proposed as the underlying determinants of an EKC.[45]

4.2.1 Reduced-Form Approach and Econometric Concerns

Many economic theories are expressed, deductively, as a system of equations, i.e. structural form models. The reduced form of any theory is the result of solving the system for the endogenous variables and this gives the latter as a function of the exogenous variables. Grossman and Krueger in their 1995 paper estimate several reduced-form equations that relate the level of pollution in a location to a flexible function of the current and lagged income in the country and to other covariates. An alternative to this reduced-form approach would be to model the structural equations relating environmental regulations, technology, and industrial composition to GDP, and then to link the level of pollution to the regulations, technology and industrial composition. The reason they choose a reduced-form

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et al, 1997). One of the main aspects of Stern's (1998) critique of the EKC literature is the emphasis on particular EKCs for specific environmental problems (i.e. air pollution), ignoring the rest.

[44] The topic of theory open-endedness in the EKC area of research is addressed in Section 4.3.

[45] Begun and Eicher (2006) introduce Bayesian model averaging (BMA) to the EKC analysis using sulphur dioxide concentrations data obtained from Antweiler et al (2001). Though I use a similar approach, my study sheds a different light on the literature, since there is no reason to expect a priori the results of Begun and Eicher to apply also to the carbon dioxide emissions. As indicated in Shafik and Bandyopadhyay (1992), sulphur dioxide concentrations are local air pollutants, costly to abate and their costs are not easy to externalize, i.e. it is difficult to identify and charge the responsible parties for the harm caused. In contrast, carbon dioxide emissions are global air pollutants and their costs are relatively easy to externalize, e.g. via cap-and-trade policies (where a central authority sets a limit or *cap* on the amount of a pollutant that each firm has the right to emit). Thus they are expected to respond in quite a different manner to proposed regressors, such as the ones referring to the pollution heaven hypothesis, explained further-on. Even more importantly, the approach of Begun and Eicher does not account for the potential endogeneity issues, while this chapter does.

approach is to have a direct estimate of the net effect of a nation's income on pollution and also due to data restrictions.[46]

Grossman and Krueger's (1995) approach has become the norm and since then, the relationship between pollution and growth has been estimated using reduced-form equations that usually take the following panel data form:[47]

$$E_{i,t} = a_o + a_1 y_{i,t} + a_2 y_{i,t}^2 + a_e y_{i,t}^3 + \sum_{p=1}^{P} \beta_p G_{p,i,t} + \sum_{t=1}^{T} \gamma_t F_{i,t} + \varepsilon_{i,t} \ , \qquad (4.1)$$

where $E_{i,t}$, is the natural logarithm of a measure of environmental degradation in country i at time t , $y_{i,t}$ is the natural logarithm of real per capita income, the term $\sum_{t-1}^{T} \gamma_t F_{i,t}$ captures the year-specific or country-specific fixed effects, $G_{p,t,i}$ is a subset of the additional covariates described in the previous section and $\varepsilon_{i,t}$ is a stochastic error term. The inverted U-shaped pattern suggested by EKC requires a_1 being positive, a_2 negative and a_3 positive.[48]

One of the major econometric concerns emphasized in the EKC literature regarding the reduced-form approach (e.g. Stern, 2004; Costantini and Martini, 2010) is the proper identification of the econometric model. Estimations of EKC using only a subset of the alternative regressors ignore other covariates that may affect environment degradation or even be the real reason behind the observed inverse U-shaped patterns in environmental indicators. Another econometric concern in the literature is potential heteroscedasticity. The data used are usually sparse and/or poor in quality and that leads to estimations using simplified

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[46] If the structural equations were estimated, they would need to solve back to find the net effect of income changes on pollution, and confidence in the implied estimates would depend upon the precision and potential biases of the estimates at every stage.

[47] Papers by Shafik (1994) and Stern et al (1996) use cross-country regressions, instead. There are also papers that perform time series analyses for specific countries (e.g. Lindmark, 2002, for Sweden, and Egli, 2004, for Germany).

[48] As noted in Costantini and Martini (2010), the cubic term derives from the empirical evidence found initially by Grossman and Krueger (1995), and later by de Bruyn et al (1998), that the relationship between income and some pollutants (e.g. sulphur oxides) becomes positive again for higher income levels. Thus, it actually suggests an N-shaped pattern.

assumptions. When the data used in cross-section studies are aggregations of varying number of subunits, heteroscedasticity may result and their estimates may be inefficient. However, as reported by Stern et al (1996) and Stern (2004), in most of the EKC studies heteroscedasticity tests are not reported.

A third major econometric concern is potential endogeneity: As suggested by many papers (e.g. Arrow et al, 1995; Stern et al, 1996; Stern; 2004), estimating the reduced-form model expressed by equation (1) may suffer from simultaneity bias, since it is inappropriate to assume unidirectional causality from economy to environment and thus the previous estimates of EKC may be biased and inconsistent. Frankel and Rose (2002) consider both the income and trade variables to be endogenous in respect to the environmental degradation. They address the potential simultaneity of trade, environmental quality, and income by applying instrumental variable estimation, using a gravity model of bilateral trade and endogenous growth from neoclassical growth equations.

4.2.2 Theory-Based Approach

Another concern in the EKC literature is that the reduced-form specification of Grossman and Krueger cannot be used to examine separately the direct and the indirect effects of any variable (e.g. trade) to environmental degradation. Studies seeking to isolate the independent effect of trade openness to pollution include Antweiler, Copeland and Taylor (2001), which is cited as *"one of the most careful existing study explicitly focusing on the effects of trade on the environment"*. They estimate a different type of econometric decomposition model that derives a reduced-form equation from a theoretical structural model of the demand and supply of pollution, in an attempt to determine the effects of trade on scale, composition, and technique effects that yields precise, testable EKC implications and relationships. The Antweiler et al (2001) model, (ACT), is usually applied on data at the city/station level. Therefore, this chapter uses a specification similar to the one used in Cole and Elliot (2003), who estimate the ACT model using country-level data:

$$E_{i,t} = \lambda_0 + \lambda_1 I_{i,t} + \lambda_2 I_{i,t}^2 + \lambda_3 KL_{i,t} + \lambda_4 (KL_{i,t})^2 + \lambda_5 I_{i,t} * KL_{i,t} + \lambda_6 O_{i,t}$$
$$+ \lambda_7 O_{i,t} * RI_{i,t} + \lambda_8 O_{i,t} * (RI)_{i,t}^2 + \lambda_9 O_{i,t} * KL_{i,t} + \lambda_{10} O_{i,t} * (RKL)_{i,t}^2 \quad (4.2)$$
$$+ \lambda_{11} O_{i,t} * RI_{i,t} * RKL_{i,t} + \lambda_{12} Polity_{i,t} + \lambda_{13} Site_{i,t} + \lambda_{14} t + \sum_{t=1}^{N} \gamma_t F_{i,t} + \varepsilon_{i,t}$$

$E_{i,t}$, as in equation (4.1), is a logged index of environmental degradation in country i at time t, $I_{i,t}$ is the three-year average of lagged GDP per capita in constant prices, $KL_{i,t}$ denotes a country's capital–labour ratio, $O_{i,t}$ is the ratio of aggregate exports and imports to GDP (trade intensity), $RI_{i,t}$ is the relative lagged per capita income, $RKL_{i,t}$ denotes a country's relative capital–labour ratio and ε_{it} is an error term.

The terms $I_{i,t}$ and $I_{i,t}^2$ are used to capture the technique effect, i.e. the lowering of carbon dioxide emissions due to technological process. The technique effect is proxied by lagged per capita income, since countries with higher incomes in the past should be able to afford better technology today.[49] The use of per capita income and per capita income squared to capture scale and technique effects is consistent with the reduced-form approach in testing the environmental Kuznets curve. The terms $KL_{i,t}$ and $(KL_{i,t})^2$ are used to represent the composition effect, i.e. development and human capital accumulation generating shifts toward less pollution-intensive industries. The squared term is included to allow capital accumulation to have a diminishing effect on the pollution, whilst the interaction term $I_{i,t} * KL_{i,t}$ captures the fact that the effect of income on pollution is likely to depend on the existing level of the capital-labour ratio, and vice versa.

The interactions with the trade intensity term ($O_{i,t}$) are included to test for the trade-induced composition effect. This is defined as: compositional changes in pollution arising from trade liberalization due to differences in capital–labour endowments and/or differences in environmental regulations proxied by the

[49] ACT also allow for the estimation of the scale effect, i.e. increased aggregate production causing increased pollution, using GDP per squared kilometer (GDP/km2) as a proxy. Since I use national pollution emissions, the use of GDP/km2 is no longer meaningful as a measure of scale, so the obvious measure of the scale effect is now the same as that for the technique effect. As a result, lagged per capita income in equation (2) captures both scale and technique effects.

lagged income per capita. Since comparative advantage is a relative concept, a country's capital–labour ratio and per capita income levels are here expressed relative to the world average. For both of these interacted variables a quadratic term is also included. It is expected that an increase in trade intensity would be associated with rising pollution for a country with low per capita income and with falling pollution for those with high incomes, i.e. $\lambda_7 > 0$ and $\lambda_8 < 0$. Similarly, trade liberalization is expected to increase pollution for countries with high capital–labour ratio and reduce pollution for those with lower capital–labour ratios, i.e. $\lambda_9 < 0$ and $\lambda_{10} > 0$. ACT predicts that $\lambda_6 = 0$ since trade liberalization per se should not affect pollution, while the sign of λ_{11} could be positive or negative.

$Polity_{i,t}$ is a variable (or a set of variables) incorporating effects on environmental policy induced by political systems, while $Site_{i,t}$ controls for *observable* site-specific factors (e.g., temperature and precipitation variation). Climate variables may reflect nature's ability to cleanse the air pollution from the atmosphere. They may also account for the greater cooling or heating requirements in countries with more extreme climatic conditions, since the energy use associated with these requirements may result in higher levels of carbon dioxide emissions.[50] Unmeasured topographical features (*unobservable* country heterogeneity) are captured through the site or country-specific fixed effect terms: $\sum_{i-1}^{N} \gamma_i F_{i,t}$.[51] The linear trend (t) is included to control for effects that are common-to-all-countries but nevertheless time varying. The data used for both reduced-form and theory-based models are described in detail in Section 4.4 and the Data Appendix.

[50] ACT use city-specific weather data. Since this study uses country-specific data (and since aggregating city-specific weather data to produce country-specific values is not a sensible exercise), the climate variable used is the percentage of land area in each country classified as tropical and subtropical. As described in Section 4.4, the country specific variables used in this study also include population growth, in order to capture growth of emissions arising via the demand for public goods that are pollution-intensive such as infrastructure and defense.

[51] As noted by ACT, since the model is viewed as a random draw of countries or observation sites from a larger population, it may be more appropriate to use a random-effects estimator to capture the level effect. However, because this estimator treats the level effects as uncorrelated with the other regressors, it may suffer from inconsistency due to omitted variables. By comparison, the fixed-effects estimator does not suffer from this inconsistency problem, but it focuses exclusively on the variation over time in the data. An additional advantage of the fixed-effects approach is that it controls for many time-invariant, site-specific and country-specific factors.

4.3 Model Uncertainty

Despite their differences, both EKC modelling approaches described in the previous sections may be consistently expressed in matrix notation as:

$$E_{i,t} = X'_{i,t}\beta + \varepsilon_{i,t}, \tag{4.3}$$

where i = 1,2,…, N, t = 1,2,…, T, $X_{i,t}$ is a $k \times 1$ vector encompassing all possible determinants of environmental degradation and $\varepsilon_{i,t}$ the error term.[52] The diverse range of the different approaches in empirically examining EKC (where different models employ different subsets of $X_{i,t}$ in order to examine EKC) represents the level of model uncertainty that surrounds empirical research on this topic.

The existence of this uncertainty creates a substantive problem in the analysis of the EKC papers: the lack of evaluation of each of the proposed regressors against the regressors found by other authors to be empirically important. In other words, the theoretical background of the existing empirical literature is limited to the one implied by a single model and not on a model space whose elements span an appropriate range of environmental degradation determinants. Therefore this chapter employs a model averaging method to account for the broad theoretical background that both EKC itself and each additional regressor (line of research) must be assessed. This section provides a brief overview of the BMA procedure used and identifies how it addresses the model uncertainty in the case of examining EKC.

4.3.1 Model Averaging

The basic Bayesian model averaging (BMA) idea originates with Jeffreys (1961) and Leamer (1978), whose insights are developed and operationalized by Draper (1995) and Raftery (1995). BMA was first introduced to economics by Fernandez et al (2001), with an application to economic growth, where *"despite the vast amount of empirical research generated by new growth theories, there is little*

[52] In that manner, equation (4.3) nests the reduced-form and the theory-based models in one model.

consensus on which mechanisms are most salient in explaining cross-country differences" (Durlauf, Kourtellos and Tan, 2008). As with the growth area of research, empirical work on the EKC is especially challenging, because of the nature of the proposed theories: these theories are open-ended. By theory open-endedness, Brock and Durlauf (2001) refer to the idea that, in general, the statement that a particular theory (regressor or regressors) is relevant does not logically preclude other theories (regressors) being relevant. That means that an evaluation of the statistical relationship between environmental degradation and any regressor needs to account for the plethora of pollution determinants that exist in the empirical literature.

The above argument asserts that each subset of plausible regressors included in $X_{i,t}$ represents a legitimate statistical model for empirical analysis. The true model, which in the context of this chapter is the correct combination of regressors included in $X_{i,t}$, is treated as an unknown. Thus, different combinations of EKC regressors constitute distinct models and the set of all possible combinations constitute the model space, with a size (S) equal to 2^k. Let $M = (M_1, M_2, ..., M_S)$ denote the set of all models considered and let $\hat{\beta}_m$ denote the estimate of the vector of parameters of each model M_m. Then, given the model space, one can determine the evidentiary support of a given model by "integrating out" the uncertainty with respect to the identity of the true model by taking a weighted average of model-specific estimates.

The model's weight in the averaging process, $\mu(M_m | D)$, is the posterior probability of model M_m, i.e. the probability that M_m is the true model given the data D and the model space M. Letting $\mu(M_m)$ denote the prior model probability and $\mu(D | M_m)$ denote the likelihood of the data given the model, then by Bayes' rule:

$$\mu(M_m | D) \propto \mu(D | M_m)\mu(M_m), \tag{4.4}$$

where $\propto$ means "is proportional to". Then the model averaging estimator is given by the posterior mean, derived by Raftery (1993):

$$\hat{\beta}_{D,M}^{MA} = \sum_{m=1}^{S} \hat{\beta}_m \hat{\mu}(M_m \mid D) \tag{4.5}$$

The methodology surrounding Bayesian model averaging is specifically developed for linear models in Raftery, Madigan and Hoeting (1997). For an introduction to model averaging techniques, see the survey of Hoeting, Madigan, Raftery and Volinsky (1999).

4.3.2 Addressing the potential endogeneity in the EKC models

As described in previous sections, one concern in the EKC literature is that 'key' regressors, such as the income and trade variables, may be determined endogenously in respect to the environmental degradation. In that manner equation (4.3) is more precisely specified as:

$$E_{i,t} = X'_{1,i,t}\beta_1 + X_{2,i,t}\beta_2 + \varepsilon_{i,t}, \tag{4.6}$$

where $X_{1,i,t}$ a $k_1 \times 1$ vector of endogenous pollution determinants and $X_{2,i,t}$ a $l_2 \times 1$ vector of exogenous/predetermined variables. In order to account for the endogeneity of $X_{1,i,t}$, equation (4.6) may be augmented with:

$$X_{1,i,t} = \Pi'_1 Z_{1,i,t} + \Pi'_2 X_{2,i,t} + V_{i,t} = \Pi' Z_{i,t} + V_{i,t}, \tag{4.7}$$

where $Z_{1,i,t}$ is a $l_1 \times 1$ vector of exogenous/predetermined (instrumental) variables excluded from the equation (4.6), such that $l_1 \geq k_1$ and $V_{i,t}$ is the vector of errors. Let this system be exactly identified, so that $l_1 = k_1$. Then, assuming also that $(\varepsilon_{i,t}, V_{i,t})$ is i.i.d. and that $E(Z'_{i,t}V_{i,t}) = 0$ and $E(Z'_{i,t}\varepsilon_{i,t}) = 0$, equation (4.6) may be estimated using 2SLS.

I incorporate the potential endogeneity of the EKC models in my estimations by employing a variant of the 2SLS model averaging (2SLS-MA) estimator proposed in Durlauf, Kourtellos and Tan (2012).[53] The authors of this paper employ a "hybrid" approach to model averaging by "integrating out" the uncertainty over models by taking the average of model specific 2SLS ("frequentist") estimates, weighted by Bayesian model weights constructed to be analogous to the posterior model probabilities defined in the previous subsection. As in the model averaging (MA) estimator, the set of all possible combinations of the regressors in equation (4.6) sets the model space. More precisely, given the fairly large model space, I use the determinist algorithm of "leaps and bounds", which provides a number of best models of each model size to approximate the model space (see Raftery, 1995).[54]

Then, for each model M_m, I obtain an associated first stage model given by a model-specific version of equation (4.7).[55] Then, if X_m is defined as the vector of model-specific regressors, Z_m as the vector of model specific exogenous/predetermined variables (including the instruments) and $P_m = Z_m(Z'_m Z_m)^{-1} Z'_m$ as the projection matrix, the 2SLS model averaging (2SLS-MA) estimator is given by the posterior mean:

$$\hat{\beta}_{D,M}^{2SLS-MA} = \sum_{M_m \in M} \hat{\mu}(M_m \mid D)(X'_m P_m X'_m)^{-1} X'_m P_m E \,, \tag{4.8}$$

where $\mu(M_m \mid D)$ are the model-specific (second-stage) weights constructed to be analogous to the posterior model probabilities and depend on the fitted values $P_m X_m$ rather than data X_m. The latter is an important difference between (4.8) and the standard LS model averaging estimator defined in equation (4.5). Similarly, the posterior variance of the parameter vector, $\hat{V}_{D,M}^{\beta}$, is obtained by:

[53] Their 2SLS-MA estimator is a set of S-PLUS functions that are available online at: https://sites.google.com/site/kourtellos/resear/research/Programanddatafiles.zip?attredirects=0.

[54] To ensure that enough models are included in the approximation of the model space, I set the leaps and bounds mechanism is set to return the 1000 best models for each size.

[55] Note that for each model M_m: $k_m = k_{1,m} + l_{2,m}$ and $l_m = l_{1,m} + l_{2,m}$ such that under exact-identification: $k_m = l_m$.

$$\hat{V}^{\beta}_{D,M} = \sum_{M_m \in M} \hat{V}^{\beta}_{D,m} \hat{\mu}(M_m \mid D) + \sum_{M_m \in M} (\hat{\beta}^{2SLS}_{D,m} - \hat{\beta}^{2SLS-MA}_{D,M})^2 \, \hat{\mu}(M_m \mid D), \tag{4.9}$$

where the model-specific posterior variance of the 2SLS estimator, under homoskedasticity, is given by $\hat{V}^{\beta}_{D,m} = (X'_m P_m X_m)^{-1} \hat{\sigma}^2_{\varepsilon|D,m}$ and $\hat{\sigma}^2_{\varepsilon|D,m}$ is the variance estimate for each model M_m. The posterior variance is then used to compute standard errors for the model averaged estimates.

4.3.3 Model weights

The model weights $\hat{\mu}(M_m \mid D)$ are constructed using Bayes' rule in equation (4.4), so that each weight is the product of the integrated likelihood of the data given the model, $\hat{\mu}(D \mid M_m)$, and the prior probability of the model, $\mu(M_m)$. Following Raftery (1995) and Eicher, Lenkoski and Raftery (2009), the integrated likelihood of the data given the model is approximated using the Bayesian Information criterion (BIC), so that:

$$\log \hat{\mu}(D \mid M_m) = -\frac{N}{2} \log \hat{\sigma}^2_{e|D,m} - \frac{1}{2} l_m \log(N) + O(N^{-1}) \tag{4.10}$$

I use the standard practice in the model averaging literature, which is to assign a uniform prior over the model space. This approach is equivalent to assuming that the prior probability that a given variable is present in the "true" model is 0.5 independent of the presence or absence of any of the other included regressors.

4.3.4 Posterior Inclusion Probabilities

In addition to the posterior means and standard deviations, BMA provides the posterior inclusion probability of a candidate regressor, $pr(\beta_k \neq 0 \mid D, M)$. The posterior inclusion probability is a probability statement of a primal concern: what is the probability that each regressor has a non-zero effect on the dependent variable.

4.4 Data

An unbalanced panel data set of 35 countries over four periods, 1971-75 ($N_1 = 31$), 1976-1980 ($N_2 = 33$), 1981-85 ($N_3 = 35$), and 1986-90 ($N_4 = 35$) is used.[56] This is actually an extension/update of the data set created by Antweiler, Copeland and Taylor. The dependent variable is average carbon dioxide emissions per capita (CO_2) in these periods, collected from the Carbon Dioxide Information Analysis Center, Environmental Sciences Division at the Oak Ridge National Laboratory. The choice of alternative regressors is determined by both data restrictions and the existing literature, which is followed as closely as possible. Note that some regressors are motivated by several alternative theories and also that some are included in both the reduced-form and the theory-based specifications.

As described previously, the common thread that runs through all the EKC models is the estimation of a non-linear relationship between per capita income and the chosen measure(s) of environmental degradation. Following Begun and Eicher (2008), I use two alternative measures of income: the three-year average of lagged GDP per capita in constant prices, $I_{i.t} = (Y^R_{i.t-1} + Y^R_{i.t-2} + Y^R_{i.t-3})/3$, suggested in Antweiler et al (2001), and the average value of the natural logarithm of GDP per capita in current prices ($y^N_{i.t}$).[57] The data source for both measures is the World Penn Tables (Heston, Summers and Aten; 1995, 2011). In order to account for the possible endogeneity of income in the EKC regressions suggested by Stern et al (1996), both measures of income are instrumented using lagged values, i.e. the average values of $I_{i.t}$ and $y^N_{i.t}$ in the intervals: 1966-70, 1971-75, 1976-1980 and 1981-85.

Before BMA is employed, each proposed additional regressor must be motivated by a well-established theory or line of research to justify its inclusion alongside the 'traditional' income variables. Operationally, and for an easier analysis of the

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[56] Selden and Song (1994) and Begun and Eicher (2008) also use five-year averages. This is also common in the economic growth literature; since it allows addressing the error associated with business cycle fluctuations that are inherent in income data (see Barro, 1990). I opted to use the original sources for all the variables in the Antweiler, Copeland and Taylor data set, even if it restricts the sample from being expanded beyond 1990: updates of the physical capital per worker beyond that year have not been included in the newest versions of the Penn World Tables.

[57] Using both current and lagged values of income per capita is also consistent with the literature where authors estimate the EKC using a dynamic specification (see Grossman and Krueger, 1995; Agras and Chapman, 1999; Coondoo and Dinda, 2002; and Perman and Stern, 2003).

empirical findings in the subsequent section, I organize the proposed additional control variables (possible determinants of environmental degradation) into 7 groups, focusing on the EKC studies that include carbon dioxide emissions as an environmental indicator: 1) Trade measures (e.g. Agras and Chapman, 1999; Frankel and Rose, 2002; Cole and Elliott, 2003), 2) Production structure (e.g. Panayotou, 1993; Halkos and Tsionas, 2001), 3) Political economy proxies (e.g. Antweiler et al, 2001; Hill and Magnani, 2002; Costantini and Martini, 2010), 4) Macroeconomic Policy (e.g. Shafik, 1994; Torras and Boyce, 1998; Heerink et al, 2001), 5) Country-specific controls (e.g. Ravallion et al, 2000; Antweiler et al, 2001; Neumayer, 2002), 6) Common-to-world factors (e.g. Antweiler et al, 2001), 7) Unexplained regional heterogeneity.

1. The impact of *Trade* on the environment is being approached in many ways in the empirical literature, one of them by examining whether differences in environmental regulations may explain the relocation of pollution-intensive industries (Jaffe et al, 1997). International trade is measured as the sum of exports and imports expressed as a percentage of GDP from the Penn World Tables 7.0. As Frankel and Rose (2002) point out, the observed positive correlation between openness to trade and some measures of environmental quality could be due to the endogeneity of trade, rather than causality. Therefore, I instrument trade openness using lagged values, i.e. the average sum of exports and imports expressed as a percentage of GDP in the intervals: 1966-70, 1971-75, 1976-1980 and 1981-85. As an additional proxy for the effect of international trade of environment degradation, I use the ratio of investment to GDP for the periods: 1971-75, 1976-80, 1981-1985 and 1986-1990, since, as argued in Harbaugh et al (2002), increased openness may lead to increased competition, which could cause more investment in efficient and cleaner technologies to meet the environmental standards of developed nations.[58]

[58] Investment is one of the variables motivated by more than one line of research in the area of EKC. Shafik and Bandyopadhyay (1992) use it to account for the intensity of environmental regulations, arguing that economies that experience rapid economic growth and investment may have worse environmental quality relative to the average for their income level if regulations are slow to respond to the changing circumstances.

2. As indicated previously, the *Composition of GDP* may also explain the observed EKC patterns. Panayotou (1993) indicates that when development and human capital accumulation generates a shift towards cleaner industries (services or information technology), the ensuing change in the composition of output may reduce the environmental degradation. Thus, structural changes in the economy lead to different environmental pressures.[59] The production structure is measured in the reduced-form model using the physical capital stock per worker, available in the Penn World Tables, for the periods: 1971-75, 1976-80, 1981-1985 and 1986-1990. This variable is also included in the theory-based approach, as suggested in Section 4.3.2. The relative capital-labour ratio (used in the interactions terms employed to examine the trade-induced composition effect) is calculated by dividing the absolute term by the corresponding world average. The same approach is followed in the calculation of the relative income variable.

3. *Political Economy* may also play a role in environmental betterment. Barrett and Graddy (2000) find that an increase in civil and political freedoms significantly reduces some measures of pollution. One reason for this result may be that high incomes are not enough to spark a popular desire to clean up the environment. There must also be effective government regulation, which usually requires a democratic system to translate the popular will into action, as well as the rule of law and reasonably intelligent mechanisms of regulation. Political economy is measured in both approaches using three variables: following Managi (2004) and Begun and Eicher (2008), the Polity IV 'Constraint on Executive' index (Marshall and Jaggers, 2003), the average years of total schooling from Barro and Lee (2010) and a country-specific dummy for communist regimes suggested in Antweiler et al (2001).[60] Since it takes some time for educational

[59] Copeland and Taylor (2003) develop a model that shows that the reliance on capital accumulation in the first stages of development, as opposed to human capital accumulation in later stages, may generate an EKC.

[60] Educational achievement may increase environmental awareness of the people, hence exert pressure on politicians to introduce environmental regulations. Note that in the theory-based approach the intensity of environmental regulations is also examined by the income variables.

achievement to translate into environmental activism, for each country in the sample I use the average years of total schooling over the prior five years.

4. The *Macroeconomic Policy* on issues such as income inequality and the national debt may also have an impact on environmental degradation. Boyce (1994) hypothesizes that greater equality of income results in lower levels of environmental degradation, since redistributing income will affect society's demand for environmental quality and thus induce a policy response in that direction. On the other hand, Heerink et al (2001) argue that when a non-linear relation between income and degradation can be found at the micro (household) level, redistributing income from rich to poor households may actually deteriorate environmental quality. Policy is measured using two proxies: the Gini coefficient from the Deininger and Squire (1996) data set, following Heerink et al (2001), and the gross general government debt expressed as a percentage of GDP, following Shafik and Bandyopadhyay (1992) and Shafik (1994). In the latter papers it is argued that the burden of debt servicing may force poor countries to excessively degrade their natural resources, eventually harming the environment, instead of making social decisions about the provision of environmental public goods.

5. Climatic conditions and other *Country-Specific Variables*, such as population growth, can also explain cross-country and time differences in the levels of pollution, even after controlling for the effect of income. As argued by Neumayer (2002), one would expect cold countries to have greater heating requirements and hot countries to have greater cooling requirements, all other things equal and thus have higher emissions than countries with less extreme climatic conditions. Population growth may have a result in growth of emissions (independently of the growth in per capita income) via the demand for public goods that are pollution-intensive, such as infrastructure and defense, as argued, for example, by Ravallion et al (1997). Country-specific factors are measured in both approaches with the percentage of a country's land area classified as tropical or sub-tropical via the

Koeppen-Geiger system.[61] I also use total population from the Penn World Tables 7.0 to capture other country-specific determinants.

6. Common-to-all-countries factors are proxied in both approaches with period-specific dummies. In the country-specific fixed effects specifications a linear trend is used, instead. As suggested in Antweiler et al (2001), such factors reflect secular changes in global awareness of environmental problems, innovations, diffusion of technology and the evolution of world energy prices.

7. In addition to the six groups of proposed additional control variables, I also consider the possibility that environmental degradation is determined by *Unexplained Regional Heterogeneity*, as captured via a dummy variable for South American countries, one for East Asian countries and one for South-East Asian countries. This heterogeneity is not so much a theory as an argument that countries in different continents may not represent draws from a common EKC model. Coondoo and Dinda (2002) discuss this problem in the context of per capita income–CO2 emission causality and their results indicate three different types of causality relationship holding for different country groups. I refer the reader to the Data Appendix for a detailed description of the variables and data.

4.5 Empirical Findings

I present my main findings in Tables 4.1 and 4.2 that show BMA two-stage least squares (2SLS; Columns 1 and 2), BMA least squares (LS; Columns 3 and 4), as well as Classical two-stage least squares (2SLS; Column 5) and least squares (LS; Column 6), estimations. I retain time period dummies in all specifications to capture the time fixed effects.[62] All estimates are modelled using robust (White) standard errors in order to correct heteroscedasticity of the error term indicated by Stern (2004), inter alia. The classical estimation exercises are referred to in the

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[61] Antweiler et al (2001) use city-level data on average temperature and precipitation. Since there is no such thing as national weather or national rainfall, I use this variable in order to capture the climate effect on a country-level.

[62] To maintain as much consistency as possible with other studies on EKC the following estimations and exercises are also performed allowing for country-specific fixed effects. The results from the country fixed effects specifications can be seen to be very similar in terms of sign and significance to those estimated using time fixed effects. Note, however, that the regional heterogeneity dummies are absorbed into the coefficients of the country-specific fixed effects. The results from the country fixed effects specifications are available in an earlier version of this chapter available online at: http://papers.econ.ucy.ac.cy/RePEc/papers/16-12.pdf.

literature as “kitchen sink exercises”, i.e. they refer to the largest possible model in each model space (all variables included) and are reported for comparison. The empirical findings in Table 4.1 refer to the reduced-form approach, described in Section 4.3.1, while the estimations in Table 4.2 refer to the theory-based approach described in Section 4.3.2.

4.5.1 Findings from the Reduced-Form Approach

The key finding from the BMA results is that the regressors that appear to matter most for carbon dioxide emissions are the income variables. The posterior probabilities of inclusion of all the “standard” EKC variables are equal or near to 1, while the values of the coefficients continue to suggest an inverse U-pattern.[63] In terms of probability of being included in the “true” model, for the additional regressors I find posterior probabilities of inclusion greater than the 0.5 prior for Macroeconomic Policy (0.997; because of the Gini Coefficient), Unexplained Regional Heterogeneity (1.000; because of the East Asia dummy), Production Structure (0.909) and International Trade (0.884; because of the trade intensity variable).

The key finding from the “kitchen sink” results is the additional support for income being a key driver of carbon dioxide emissions. The income variables ($I_{i.t}$, $I_{i.t}^2$ and $I_{i.t}^3$) are significant at the 1% level and their coefficients have values suggesting the inverted U-shaped pattern suggested by the Environmental Kuznets curve. However, there is only weak evidence in favour of the alternative income variables used ($y_{i.t}^N$). Note that $I_{i.t}$ is composed from lagged values of GDP, while $y_{i.t}^N$ is a measure of current output. In that manner, this is evidence in favour of contemporaneous economic activity being less important in determining carbon dioxide emissions than the indirect effects of rising income over time.

In the 2SLS “kitchen sink” results, there is also evidence for international trade having a positive effect on the environment, something which is consistent with the hypothesis that trade allows countries to attain more than they want, which includes environmental goods in addition to market-measured output. This is contrary to the predictions of the pollution heaven hypothesis, i.e. trade allowing

[63] More precisely, the coefficients indicate an N-shaped EKC. The issue of the empirical shape of EKC is addressed in section 4.5.4.

rich countries to move their pollution-intensive industries to poorer nations with less restrictive environmental regulations (Antweiler et al, 2001). However, the trade coefficient is not significant in the 2SLS “kitchen sink” (and BMA) results, which is evidence in favour of the argument of Frankel and Rose (2002) that trade is determined endogenously in respect to the environmental degradation.

I also find that policy proxies are significant on the level of environmental degradation. There is very strong evidence that income inequality positively affects the environment. This is consistent with the argument of Boyce (1994) that redistributing income will affect society’s demand for environmental quality and thus induces a policy response in that direction, contrary to the predictions of Scruggs (1998) and the empirical findings of Heerink et al (2001). Nevertheless, the coefficient of debt ratio is found to be negative, contrary to the findings of Shafik and Bandyopadhyay (1992). Production Structure is also indicated to affect environmental degradation. I find the coefficient of the capital-labour ratio to be highly significant at the 1% level and negative, contrary to what the composition of output explanation of EKC predicts; I do not see a natural explanation for this. Of the political economy proxies engaged, only the level of education is found to have a significant effect on the environment in the “kitchen sink” results.

The “kitchen sink” results are encouraging in the sense that they strongly suggest the existence of an EKC pattern in the carbon dioxide emissions, and also in that additional variables suggested by different lines of research in the related literature appear to be significant in explaining differences in the levels of environmental degradation across time and countries. However, these results are contingent on the use of a very specific EKC model, i.e. these claims are based on very specific choices of which pollution determinants are included in the analysis (all of them in this case). As discussed in Section 4.4, there is no reason to come down so heavily on the side of any particular model, no matter how many regressors it includes, since that approach ignores the intrinsic model uncertainty.

In contrast, the BMA results do account for the model uncertainty in the area of EKC, and they indicate that among the only regressors that matter for carbon dioxide emissions are the income variables. It appears therefore that the main outcome of accounting for model uncertainty is in fact to re-confirm the existence of the EKC and that the national income remains a crucial driver of carbon dioxide emissions. In addition, I find strong evidence for macroeconomic policy effects and that (unexplained) regional heterogeneity plays a major role in explaining the variation of carbon dioxide emissions.

The 2SLS-BMA results do not differ a lot from the results obtained from the 2SLS "kitchen sink" model. Therefore, it may appear that the main outcome of accounting for model uncertainty is, in fact, to confirm the robustness of results of the classical methodology, whose results are contingent on the use of a very specific EKC model, which includes all the possible pollution determinants (the largest model). Table 4.3 provides clues as to why this might not be the case. Columns 1 to 5 present the five models that correspond to the largest posterior probabilities for all the models used in the Bayesian Model Averaging exercises reported in Table 4.1. As described in Section 4.3.3, those model-specific weights are constructed to be analogous to the posterior model probabilities, each weight being the product of the integrated likelihood (approximated using the Bayesian Information criterion in equation 4.10) and the prior probability of each model.

Columns 2-5 of Table 4.3 present the variables included in each model, while for the model with the highest posterior weight (Column 1) classical 2SLS coefficients and robust standard errors are provided. Column 6 reproduces the baseline 2SLS results of the largest model (Column 5 of Table 4.1). The posterior weight assigned to the posterior modal model turns out to be more than 0.5, while for the "kitchen sink" model rings close to zero. Despite the proximity of the BMA results with the ones obtained from the classical methodology, the comparison of the posterior weights suggests that the Bayesian Model Averaging Methodology provides empirical results with a higher degree of confidence in areas of research with model (theory) uncertainty, such as the EKC.

4.5.2 Findings from the Theory-Based Approach

The results for the regressors motivated by the theory-based approach of Antweiler, Copeland and Taylor (ACT) are presented in Table 4.2. Antweiler et al (2001) develop this model to examine the scale, technique composition effects in the environment and also to divide the impact of trade on environment by each of these channels (i.e. the trade-induced composition effect).

The results are similar to the ones from the reduced-form approach, in the sense that income, trade and regional heterogeneity variables appear to matter for carbon dioxide emissions. The posterior probabilities of inclusion in the true model are equal to 1.000 for $I_{i,t}$ and its interaction with the capital-labour ratio, 0.989 for the interaction of trade with the capital-labour ratio and 1.000 for the East Asia dummy. I also find posterior probability of inclusion greater than the 0.5 prior for the tropical climate variable, a country-specific factor, and some weak evidence in favour of two trade interaction terms. The major difference from the reduced-form model results is that they indicate the squared income variable ($I_{i,t}^2$) to have a posterior probability of inclusion of less than 0.5.

In "kitchen sink" results the coefficients of $I_{i.t}$ and $I_{i.t}^2$ are both found to be positive. As indicated in Section 4.3.2, in the theory-based approach the absolute income variables capture the joint scale and technique effect. Thus these results imply that the scale effect dominates the technique effect. Cole and Elliott (2003) attribute this result to the fact that carbon dioxide emissions have not been subjected to the same degree of regulation as other air pollutants, such as the sulphur dioxide concentrations. As a result, carbon emissions have been increasing steadily with economic growth.

There is no strong evidence for composition effect from the "kitchen sink" results, since (contrary to the results of Cole and Elliott, 2003) there is no statistically significant relationship between emissions and the capital-labour ratio terms. The notable exception is the income interaction term which captures the fact that the effect of income on pollution is likely to depend on the existing level of capital abundance. There is no robust evidence for a trade-induced composition effect either, since only one out of the six related variables (trade and interactions) is found statistically significant in the LS "kitchen sink" results, while in the 2SLS "kitchen sink" results this limited evidence vanishes altogether. The significance of the interaction of trade with the capital-labour ratio suggests the existence of compositional changes in pollution arising from trade liberalization due to differences in capital–labour endowments. In other words, this result does suggest that trade plays an important indirect role in determining pollution since it is revealed that trade moderates the composition effect.

The coefficient of the tropical climate proxy is indicated to be significant and negative, contrary to the evidence in the literature that hot countries have greater cooling requirements, higher energy consumption and thus higher carbon dioxide emissions (Neumayer, 2002). The educational level and the debt ratio now are indicated as having no explanatory power over the carbon dioxide emissions. The coefficients of the period dummies (not reported for parsimony) are found to be insignificant, a result that points against the existence of factors that help in reducing (or increasing) environmental degradation that are common in all the periods.

The results from the theory-based approach suggest that a significant portion of the regressors proposed by Antweiler et al (2001) to explain environmental degradation are not significant in explaining carbon dioxide emissions. This finding is consistent with the empirical results of Cole and Elliott (2003), which attribute this to the fact that the ACT model is designed with local, rather than global, pollutants in mind and hence it could be argued that this is what ACT predicts for carbon dioxide emissions. This also provides evidence that a complex theory with a large number of proposed regressors may not be necessary in explaining EKC. In that manner, alternative theories, such as the Green Solow model (Brock and Taylor, 2004; 2005), should not be discarded simply because they do not suggest additional EKC regressors.

4.5.3 Robustness

In Tables 4.4 and 4.5, I report results assessing the robustness of the MA results to alternative model prior specifications as well as approximations to the integrated likelihood. Column 1 of Tables 4.3 and 4.4 reproduces the baseline MA results (Column 2 of Tables 4.1 and 4.2).

Table 4.4 reports the robustness estimations for the reduced-form approach results. Columns 2 to 5 contain results for cases where particular subsets of variables are assumed a priori to always be included in the "true" model. For instance, the MA exercises for which results are reported in column 2 assume that the (lagged) income variables ($I_{i,t}$, $I_{i.t}^2$ and $I_{i.t}^3$) are included in all models in the model space. Similarly, column 3 reports results for MA exercises where the canonical EKC variables (lagged *and* current income) are always included in all models. Columns 4 and 5 report results for exercises where, respectively, all Policy and all Regional Heterogeneity variables are retained in all models in the model space. Finally, column 6 reports results for exercises where instead of using the BIC approximation for the integrated likelihood, I use the AIC instead. The effect of using the AIC instead of the BIC is to allow for a smaller penalty on larger models.

The baseline reduced-form results are largely robust to those perturbations. When model uncertainty is accounted for, the results support the existence of an N-shaped EKC in the carbon dioxide emissions, i.e. a positive coefficient for I, a negative coefficient for I^2 and a positive coefficient for I^3 - all of them significant at the 1% level. It turns out that of the additional regressors, only the Gini coefficient and the East Asia dummy appear robustly significant in explaining the carbon dioxide emissions. Trade intensity, which also has posterior probability of inclusion greater than the 0.5 prior, appears insignificant in all the exercises. Thus, the estimates accounting for the model uncertainty in the area of EKC indicate that the only regressors that robustly matter for carbon dioxide emissions are income and the regional dummy variables. This finding is not inconsistent with the existing literature, in the sense that no matter how many regressors are added to the EKC equation, in the end, many studies conclude that income has the most significant explanatory power on the environmental quality of all the explanatory variables tested (Agras and Chapman, 1999).

Table 4.5 reports the robustness estimations for the theory-based approach results. As in Table 4.4, Columns 2 and 3 contain results for cases where particular subsets of variables are assumed a priori to always be included in the "true" model. For instance, the MA exercises for which results are reported in column 2 assume that the income variables ($I_{i.t}$ and $I_{i.t}^2$) are included in all models in the model space. Similarly, column 3 reports results for MA exercises where the trade interaction terms (which in the ACT model express the trade-induced composition effect) are always included in all models. Columns 4 and 5 report results for exercise where model space includes particular variables not suggested by the ACT theory. In that manner, the results in columns 4 and 5 nest the ACT model within a larger model space which includes variables deemed significant by other EKC approaches. Columns 4 and 5 report results for exercises where, respectively, $I_{i.t}^3$ and the Gini coefficient plus $I_{i.t}^3$ are included in all models in the model space. As in Table 4.4, column 6 reports results for exercises using the AIC instead of the BIC approximation for the integrated likelihood.

Contrary to the baseline reduced-form results, the theory-based ones are not largely robust to those perturbations. When model uncertainty is accounted for, the variables appearing robustly significant are income, interaction of trade with the capital-labour ratio and the East Asia dummy. The income-capital interaction term and tropical climate variable, which in Table 4.2 have posterior probability of inclusion greater than the 0.5 prior appear insignificant in exercises where the ACT model is nested within a larger model space. The key result from columns 4 and 5 is that when model uncertainty is accounted for the $I_{i.t}^{2}$ variable appears significant and negative, thus re-confirming the existence of an EKC in the carbon dioxide emissions evidence from the empirical findings of Section 4.5.1.

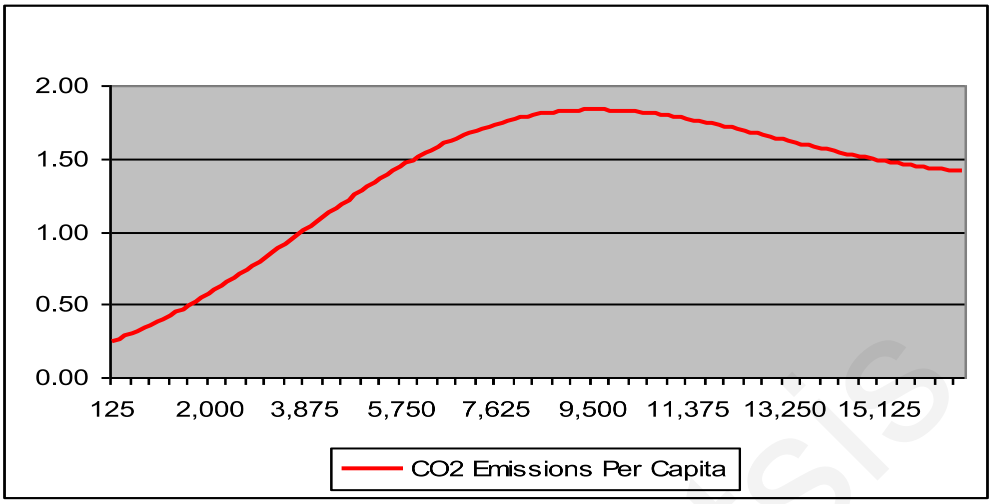
Another striking result is that the regional variables appear robustly significant in both the reduced-form and the theory-based approaches, while the trade variables do not. Obviously, variation in carbon dioxide levels across regions is not robustly explained by differences in trade intensities (i.e. pollution heaven hypothesis) or any other EKC-related theory, as a matter of fact. Therefore, more work needs to be done in systematically uncovering the unexplained regional heterogeneity.

4.5.4 The Shape of the Environmental Kuznets Curve

The empirical findings of this study indicate an N-shaped EKC, implying that the level of carbon dioxide emissions in the atmosphere initially improves and then deteriorates again at very high income levels, as indicated in Figure 4.1(d). This income turning point is $17,600 and this eventual increase in the carbon dioxide emissions in high income levels (outside the sample of this study) is more difficult to explain.

An explanation of why countries should suddenly experience increasing CO2 emissions beyond a given income level was first recognized as a problem by Sengupta (1996) who attributed it to the presence of Canada and the USA in the data set. These were the only countries that exceeded his income turning point level of $15,300 income level and Sengupta attributed their increasing emissions components to their endowments of natural resources and the sectoral product-composition of their economies. Moomaw and Unruh (1997) also hypothesize that their N-shaped EKC findings are more the result of polynomial curve fitting to countries such the USA and Canada in the data set, than a reflection of any underlying structural relation between per capita income and air pollution.

Figure 4.2: Environmental Kuznets Curve for Carbon Dioxide Emissions



Note: Figure 4.2 is created by first sorting the sample data for the three-year average of lagged GDP per capita in constant prices and then using the related estimates in Table 4.1 to produce for each level of lagged GDP per capita the corresponding levels of average carbon dioxide emissions per capita as predicted by the EKC.

Source: World Penn Tables 7.0 and author's calculations.

On the other hand, the analysis of Costantini and Martini (2010) indicates that the cubic form of the EKC is valid and robust for the CO_2 emissions. They indicate that for carbon dioxide emissions the cubic form is associated to the increasing environmental efficiency in the productive sector – the technological effect – and the shift from heavy industries to services – the structural effect – which determine the descending part of the curve. The second ascending part of the curve is associated to the increasing demand for energy products as income rises further.

In the light of Sengupta (1996) and Moomaw and Unruh (1997), and since USA and Canada are not captured in this study via a dummy variable when examining the regional heterogeneity argument, it may be argued that the choice of the omitted country group categories (e.g. the North America countries) may affect the estimated shape of the curve. However, the estimates from country fixed effects specifications (where the regional heterogeneity dummies are absorbed into the coefficients of the country-specific fixed effects) are very similar in terms of sign and significance to those estimated using time fixed effects.[64] This is evidence that an N-shaped EKC may not be necessarily due to the presence of

[64] For space considerations only results from the time fixed effects specifications are included. However, the results from the country fixed effects specifications are available in an earlier version of this chapter available online at: http://papers.econ.ucy.ac.cy/RePEc/papers/16-12.pdf.

Canada and the USA in the data set, even if this topic should be further examined via a specification allowing for the cubic term to vary across countries or regions.

4.6 Conclusion

This study re-examines the evidence for an Environmental Kuznets Curve using the updated Oak Ridge National Laboratory data in the carbon dioxide emissions. The literature on the income-pollution relationship is characterized by model uncertainty as both the number of proposed theories and the range of candidate regressors are large. I apply Bayesian model averaging methods to address model uncertainty using both reduced-form and theory-based approaches as an econometric framework.

Overall I find strong and robust evidence for an EKC, which is generally consistent with the related empirical literature. There are many reasons why EKC holds, one of the most dominant being that as countries become richer they have a higher demand for environmental quality, thus inducing a policy response in that direction. This argument is also supported by the fact that amongst the only regressors other than the "standard" EKC variables supported by the BMA results is the Gini coefficient for income inequality – since greater equality of income may also affect society's demand for environmental quality.

Two other major findings are also made: a) the significance of many of the remaining potential pollution determinants (including the ones derived from elaborated theories) is not supported by the BMA results, indicating that the particular regressors may be significant in the related literature only because the empirical strategy does not account for model uncertainty, and b) the variation in carbon dioxide levels across regions is not robustly explained by differences in trade intensities (i.e. pollution heaven hypothesis) or any EKC-related theory and thus more work needs to be done in systematically uncovering the unexplained regional heterogeneity.

Data Appendix

Table A.1: Variable Description

Variable	Description	Source
Average Carbon Dioxide Emissions Per Capita (CO2)	Average values of the natural logarithm of CO2 emissions per capita for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990.	Boden, Marland and Andres (2011)
Income (I)	Average values of the three-year average of lagged GDP per capita in constant prices for the periods 1971-75,1976-80, 1981-1985 and 1986-1990. The instruments for income include the average values of 1966-70, 1971-75, 1976-1980 and 1981-1985.	Penn World Tables 7.0
Relative Income (RI)	Income divided by the corresponding world average for the given year, where “world average” is defined by the countries in the Penn World Tables. Average values for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990. The instruments for relative income include the average values of 1966-70, 1971-75, 1976-1980 and 1981-1985.	Penn World Tables 7.0
Alternative Measure of Income (Y)	Average values of the natural logarithm of GDP per capita in current prices for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990.	Penn World Tables 7.0
Trade Intensity (O)	Average values of the sum of exports and imports expressed as a percentage of GDP. The instruments for trade intensity include the average values for 1966-70, 1971-75, 1976-1980 and 1981-1985.	Penn World Tables 7.0
Investment (INV)	Average values of the ratio of investment to GDP for the periods 1971-75,1976-80, 1981-1985 and 1986-1990.	Penn World Tables 7.0
Capital-Labour Ratio (KL)	The average physical capital stock per worker for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990.	Penn World Tables 5.6
Relative Capital-Labour Ratio (RKL)	Average values of the capital-labour ratio divided by the corresponding world average for the given year, for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990. The "world average" data were kindly provided by Professor Werner Antweiler.	Penn World Tables 5.6, Antweiler et al (2001)

Table A.1(Cont'd): Variable Description

Variable	Description	Source
Executives Constraint (EXEC)	Average values of a measure of the extent of institutionalized constraints on the decision making powers of chief executives, whether individuals or collectivities, for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990. Cases in "transition", i.e. = -88, were prorated across the span of the transition, in the manner suggested in the Polity IV dataset User's Manual.	Polity IV, Marshall and Jaggers (2010)
Education (EDUC)	The average years of total schooling in 1975, 1980, 1985 and 1990.	Barro and Lee (2010)
Communist (CC)	Dummy variable: Country was/is communist. In the Antweiler, Copeland and Taylor (2001) dataset this variable is equal to one if the country is China, Czechoslovakia, Poland, or Yugoslavia. All these countries, but China, are excluded from this dataset, due to lack of other data.	
Income Inequality (GINI)	Average values of the Gini coefficient (divided by the number ten) for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990.	Deininger and Squire (1996)
Debt Ratio (DEBT)	Average values of the gross general government debt expressed as a percentage of GDP for 1971-75, 1976-80, 1981-1985 and 1986-1990. For Brazil and China the data are from the Reinhart and Rogoff (2010) working paper.	Abbas, Belhocine, El Ganainy and Horton (2010), Reinhart and Rogoff (2010)
Tropical Climate (CLIM)	The percentage of land area classified as tropical and subtropical in the Koeppen-Geiger system.	The Center for International Development (CID) at Harvard University
Population Growth Rates (POP)	Average total population growth rates for the periods 1971-75, 1976-80, 1981-1985 and 1986-1990.	Penn World Tables 7.0
Regional Dummy Variables	Dummy variables for South America, for East Asia (China, Japan and Korea) and South-East Asia (Indonesia, Philippines and Thailand).	
Dum19XX	Four dummy variables for 1971-75, 1976-80, 1981-1985 and 1986-1990.	
Linear Trend (T)	Takes the value 1 for 1971-75, 2 for 1976-80, 3 for 1981-1985 and 4 for 1986-1990.	

Table A.2: List of Countries

Code	Country	Code	Country
	Europe		*South America*
AUT	Austria	ARG	Argentina
BEL	Belgium	BRA	Brazil
CHE	Switzerland	CHL	Chile
DEU	Germany	COL	Colombia
DNK	Denmark	PER	Peru
ESP	Spain	VEN	Venezuela
FIN	Finland		
FRA	France		*North America*
GBR	United Kingdom	CAN	Canada
GRC	Greece	USA	United States
IRL	Ireland		
ITA	Italy		*Asia and Africa*
NLD	Netherlands	CHN	China
PRT	Portugal	IDN	Indonesia
SWE	Sweden	IND	India
		IRN	Iran
	Oceania	ISR	Israel
AUS	Australia	JPN	Japan
NZL	New Zealand	KEN	Kenya
		KOR	Korea, Rep.
		PHL	Philippines
		THA	Thailand

Table A.3: Descriptive Statistics

Variable	Mean	St. Dev.	Min.	Max.
Carbon Dioxide Emissions (CO2)	0.174	1.069	-2.751	1.739
Income (I)	0.747	0.428	0.073	1.687
Relative Income (RI)	1.089	0.613	0.108	2.260
Alternative Measure of Income (Y)	1.557	1.041	-1.359	3.099
Trade Intensity (O)	1.983	1.254	0.098	6.883
Investment (INV)	5.507	6.676	0.009	47.490
Capital-Labour Ratio (KL)	0.501	0.244	0.087	1.357
Relative Capital-Labour Ratio (RKL)	0.238	0.057	0.136	0.398
Executives Constraint (EXEC)	5.513	2.108	1.000	7.000
Education (EDUC)	7.381	2.392	1.972	11.924
Communist (CC)	0.014	0.121	0.000	1.000
Income Inequality (GINI)	3.598	0.225	3.072	4.241
Debt Ratio (DEBT)	0.427	0.312	0.029	2.478
Tropical Climate (CLIM)	0.213	0.346	0.000	1.000
Population Growth Rates (POP)	0.012	0.010	-0.001	0.040
South America (SA)	0.171	0.378	0.000	1.000
East Asia (EA)	0.074	0.263	0.000	1.000
South-East Asia (SEA)	0.074	0.263	0.000	1.000

Table 4.1: Reduced-Form EKC Models: BMA and Classical Estimation Results

Estimation Method	Model Averaging Estimation				Classical Estimation	
	2SLS-MA		LS-MA		2SLS	LS
	Posterior Inclusion Probability (1)	Posterior Mean and Std. Error (2)	Posterior Inclusion Probability (3)	Posterior Mean and Std. Error (4)	Coefficient Estimate and Std. Error (5)	Coefficient Estimate and Std. Error (6)
EKC:						
Income (I)	1.000	8.371*** (0.771)	1.000	8.316*** (0.804)	8.318*** (1.565)	6.996*** (1.464)
I^2	0.999	-6.554*** (0.973)	0.999	-6.589*** (0.979)	-6.499*** (1.665)	-5.345*** (1.539)
I^3	0.999	2.015*** (0.378)	0.999	2.081*** (0.371)	2.002*** (0.547)	1.720*** (0.495)
Alternative EKC Specification:						
Alternative Measure of Income (y^N)	0.070	0.001 (0.046)	0.092	0.012 (0.061)	-0.032 (0.170)	0.153 (0.153)
$(y^N)^2$	0.436	-0.025 (0.040)	0.488	-0.039 (0.048)	-0.005 (0.096)	-0.068 (0.066)
$(y^N)^3$	0.430	-0.011 (0.015)	0.437	-0.012 (0.016)	-0.020 (0.030)	-0.012 (0.023)
International Trade:						
Trade Intensity (O)	0.884	0.186 (0.144)	0.943	0.320** (0.143)	0.191 (0.160)	0.379*** (0.116)
Investment (INV)	0.069	0.001 (0.173)	0.077	-0.008 (0.187)	0.443 (0.704)	0.210 (0.660)
Production Structure:						
Capital-Labour Ratio (KL)	0.909	-0.115** (0.059)	0.899	-0.114** (0.059)	-0.137*** (0.051)	-0.145*** (0.055)

Table 4.1 (Cont'd): Reduced-Form EKC Models: BMA and Classical Estimation Results

	Model Averaging Estimation				Classical Estimation	
Estimation Method	**2SLS-MA**		**LS-MA**		**2SLS**	**LS**
	Posterior Inclusion Probability (1)	Posterior Mean and Std. Error (2)	Posterior Inclusion Probability (3)	Posterior Mean and Std. Error (4)	Coefficient Estimate and Std. Error (5)	Coefficient Estimate and Std. Error (6)
Political Economy:						
Executives Constraint (EXEC)	0.132	0.002	0.148	0.003	0.008	0.022
		(0.009)		(0.010)	(0.020)	(0.018)
Education (EDUC)	0.082	0.002	0.103	0.002	0.022**	0.007*
		(0.008)		(0.007)	(0.022)	(0.022)
Policy:						
Income Inequality (GINI)	0.997	-0.526***	0.997	-0.540***	-0.448***	-0.481***
		(0.153)		(0.152)	(0.140)	(0.130)
Debt Ratio (DEBT)	0.361	-0.050	0.385	-0.064	-0.127	-0.183**
		(0.087)		(0.099)	(0.083)	(0.162)
Country-Specific Factors:						
Tropical Climate (CLIM)	0.399	-0.092	0.447	-0.108	-0.115	0.194
		(0.135)		(0.144)	(0.173)	(0.084)
Population Growth Rates (POP)	0.080	-0.158	0.081	-0.150	-1.692	-0.207
		(1.259)		(1.155)	(4.799)	(3.487)
Regional Heterogeneity:						
East Asia (EA)	1.000	0.511***	1.000	0.520***	0.399***	0.466***
		(0.099)		(0.099)	(0.153)	(0.143)

Note 1: Columns (1)-(4) present the results using BMA (discussed in Section 4.3) while columns (5)-(6) present the results using Classical estimation. The description of the variables and the instruments used is given in Section 4.4 and in the Data Appendix. Period dummies are included in each specification, but coefficients are not shown. The complete set of results is available upon request.

Note 2: Posterior robust (White) standard errors are in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

Table 4.2: Theory-Based EKC Models: BMA and Classical Estimation Results

	Model Averaging Estimation				Classical Estimation	
Estimation Method	**2SLS-MA**		**LS-MA**		**2SLS**	**LS**
	Posterior Inclusion Probability (1)	Posterior Mean and Std. Error (2)	Posterior Inclusion Probability (3)	Posterior Mean and Std. Error (4)	Coefficient Estimate and Std. Error (5)	Coefficient Estimate and Std. Error (6)
Scale and Technique Effect:						
Income (I)	1.000	3.928*** (0.689)	1.000	3.784*** (0.631)	3.259*** (0.833)	3.062*** (1.108)
I^2	0.118	0.003 (0.203)	0.133	0.032 (0.248)	0.764 (0.666)	0.671 (0.941)
Composition Effect:						
Capital-Labour Ratio (KL)	0.417	0.128 (0.192)	0.448	0.143 (0.188)	0.333 (0.240)	0.185 (0.279)
$(KL)^2$	0.631	0.049 (0.045)	0.650	0.046 (0.042)	0.059 (0.047)	0.089** (0.040)
$I * KL$	1.000	-0.622*** (0.245)	1.000	-0.628*** (0.235)	-1.745* (0.355)	-1.024*** (0.355)
Trade-Induced Composition Effect:						
Trade Intensity (O)	0.091	-0.027 (0.988)	0.107	-0.012 (0.901)	0.167 (0.581)	-1.004 (0.674)
$O * RI$	0.693	-0.847 (0.696)	0.186	-0.717 (0.658)	-0.832 (1.421)	1.542 (1.961)
$O * (RI)^2$	0.079	-0.035 (0.186)	0.672	-0.007 (0.150)	-0.003 (0.860)	-0.058 (0.861)
$O * RKL$	0.989	2.981*** (0.176)	0.995	2.754*** (0.239)	2.225 (1.165)	2.561** (1.168)
$O * (RKL)^2$	0.274	-0.181 (0.397)	0.300	-0.150 (0.350)	-0.276 (0.521)	0.058 (0.861)
$O * RI * RKL$	0.751	-0.929 (0.625)	0.788	-0.865 (0.566)	-0.626 (1.334)	-0.689 (2.194)

Table 4.2 (Cont'd): Theory-Based EKC Models: BMA and Classical Estimation Results

	Model Averaging Estimation				Classical Estimation	
Estimation Method	**2SLS-MA**		**LS-MA**		**2SLS**	**LS**
	Posterior Inclusion Probability (1)	Posterior Mean and Std. Error (2)	Posterior Inclusion Probability (3)	Posterior Mean and Std. Error (4)	Coefficient Estimate and Std. Error (5)	Coefficient Estimate and Std. Error (6)
Political Economy:						
Executives Constraint (EXEC)	0.076	-0.001 (0.005)	0.075	-0.001 (0.005)	0.003 (0.018)	-0.015 (0.020)
Education (EDUC)	0.062	0.001 (0.005)	0.071	0.001 (0.005)	-0.001 (0.022)	0.015 (0.021)
Country-Specific Factors:						
Tropical Climate (CLIM)	0.995	-0.345*** (0.114)	0.996	-0.349*** (0.111)	-0.350 (0.214)	-0.512** (0.205)
Population Growth Rates (POP)	0.072	-0.138 (1.330)	0.068	-0.074 (1.051)	-0.907 (3.780)	-1.808 (4.861)
Regional Heterogeneity:						
South America (SA)	0.231	0.022 (0.052)	0.253	0.030 (0.061)	0.153 (0.116)	0.080 (0.111)
East Asia (EA)	1.000	0.439*** (0.135)	1.000	0.462*** (0.125)	0.491*** (0.155)	0.460*** (0.174)
Southeast Asia (SEA)	0.085	0.003 (0.045)	0.083	0.003 (0.045)	0.146 (0.235)	0.131 (0.230)

Note 1: Columns (1)-(4) present the results using BMA (discussed in Section 4.3) while columns (5)-(6) present the results using Classical estimation. The definition of each variable is given at Section 4.2.2, while the data and instruments used are described in detail in Section 4.4 and the Data Appendix. Period dummies are included in each specification, but coefficients are not shown. The complete set of results is available upon request.

Note 2: Posterior robust (White) standard errors are in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

Table 4.3: Posterior Mode Models

Models	**Best Model (1)**	**2nd Best Model (2)**	**3rd Best Model (3)**	**4th Best Model (4)**	**5th Best Model (5)**	**Largest Model (6)**
Posterior Model Weights	0.054	0.051	0.044	0.035	0.034	2.150e-012
EKC:						
Income (I)	8.149*** (0.640)	Included	Included	Included	Included	8.318*** (1.565)
I^2	-6.292*** (0.881)	Included	Included	Included	Included	-6.499*** (1.665)
I^3	1.951*** (0.360)	Included	Included	Included	Included	2.002*** (0.547)
Alternative EKC:						
Alternative Income (y^N)						-0.032 (0.170)
$(y^N)^2$		Included			Included	-0.005 (0.096)
$(y^N)^3$	- 0.261** (0.105)		Included	Included		-0.020 (0.030)
International Trade:						
Trade Intensity (O)	0.187 (0.129)	Included	Included	Included	Included	0.191 (0.160)
Investment (INV)						0.443 (0.704)
Production Structure						
Capital-Labour Ratio (KL)	-0.105** (0.048)	Included	Included	Included	Included	-0.137*** (0.051)
Political Economy:						
Education (EDUC)						0.022** (0.022)
Policy:						
Income Inequality (GINI)	-0.495*** (0.148)	Included	Included	Included	Included	-0.448*** (0.140)
Debt Ratio (DEBT)				Included		-0.127 (0.083)
Country-Specific Factors:						
Tropical Climate (CLIM)	-0.224** (0.112)			Included		-0.115 (0.173)
Population Growth (POP)						-1.692 (4.799)
Regional Heterogeneity:						
East Asia (EA)	0.521*** (0.098)	Included	Included	Included	Included	0.399*** (0.153)

Note: Table 4.3 presents the five models that correspond to the largest posterior probabilities for all the models used in the Bayesian Model Averaging Exercises and reported in Table 4.1. For the model with the highest posterior probability (Column 1) classical 2SLS coefficients and robust standard errors are also provided. The last column reproduces the 2SLS "Kitchen-Sink" model results (Column 5 of Table 4.1). *** denotes significance at 1%, ** at 5%, and * at 10%.

Table 4.4: Robustness of Reduced-Form EKC Models Estimation Results

Information Criterion	**BIC**	**BIC**	**BIC**	**BIC**	**BIC**	**AIC**
Always Kept:	**None (1)**	**EKC (2)**	**All Income (3)**	**Policy (4)**	**Regional (5)**	**None (6)**
EKC:						
Income (I)	8.371***	8.410***	8.302***	8.418***	8.629***	8.305***
	(0.771)	(0.758)	(1.423)	(0.800)	(0.807)	(0.985)
I^2	-6.554***	-6.600***	-6.545***	-6.604***	-6.870***	-6.486***
	(0.973)	(0.975)	(1.569)	(1.006)	(1.027)	(1.171)
I^3	2.015***	2.028***	2.027***	2.035***	2.109***	2.007***
	(0.378)	(0.364)	(0.535)	(0.372)	(0.380)	(0.417)
Alternative EKC:						
Alternative Income (y^N)	0.001	-0.000	-0.005	-0.000	-0.002	0.000
	(0.046)	(0.042)	(0.159)	(0.048)	(0.048)	(0.083)
$(y^N)^2$	-0.025	-0.020	0.012	-0.018	-0.047	-0.024
	(0.040)	(0.040)	(0.089)	(0.040)	(0.051)	(0.055)
$(y^N)^3$	-0.011	-0.012	-0.027	-0.013	-0.008	-0.015
	(0.015)	(0.015)	(0.028)	(0.016)	(0.014)	(0.019)
International Trade:						
Trade Intensity (O)	0.186	0.173	0.140	0.228	0.104	0.226
	(0.144)	(0.153)	(0.157)	(0.154)	(0.142)	(0.148)
Investment (INV)	0.001	-0.002	-0.012	-0.019	-0.002	0.035
	(0.173)	(0.161)	(0.224)	(0.196)	(0.179)	(0.351)
Production Structure						
Capital-Labour Ratio (KL)	-0.115**	-0.113*	-0.080	-0.120**	-0.090	-0.125**
	(0.059)	(0.060)	(0.069)	(0.061)	(0.067)	(0.051)
Political Economy:						
Executives Const. (EXEC)	0.002	0.002	0.002	0.003	0.001	0.007
	(0.008)	(0.008)	(0.008)	(0.010)	(0.005)	(0.014)
Education (EDUC)	0.002	0.002	0.003	0.002	0.006	0.005
	(0.008)	(0.008)	(0.010)	(0.008)	(0.014)	(0.013)
Policy:						
Income Inequality (GINI)	-0.525***	-0.532***	-0.125***	-0.511***	-0.497***	-0.490***
	(0.153)	(0.145)	(0.150)	(0.140)	(0.162)	(0.144)
Debt Ratio (DEBT)	-0.050	-0.041	-0.002	-0.136*	-0.022	-0.108
	(0.087)	(0.074)	(0.170)	(0.072)	(0.054)	(0.092)
Country-Specific Factors:						
Tropical Climate (CLIM)	-0.092	-0.079	-0.521	-0.118	-0.013	-0.139
	(0.136)	(0.130)	(0.149)	(0.148)	(0.058)	(0.148)
Population Growth (POP)	-0.158	-0.028	-0.029	-0.095	-0.258	-0.420
	(1.259)	(0.561)	(0.065)	(1.253)	(1.523)	(2.468)
Regional Heterogeneity:						
East Asia (EA)	0.511***	0.515***	0.515***	0.506***	0.464***	0.491***
	(0.099)	(0.124)	(0.125)	(0.118)	(0.126)	(0.123)

Note: Table 4.4 presents the posterior means and std. errors for six different model averaging exercises for the EKC regression described in equation (1) of the text. Period dummies are included in each specification. Notice that column (1) is identical to column (2) of Table 4.1. Posterior robust (White) standard errors are in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

Table 4.5: Robustness of Theory-Based EKC Models Estimation Results

Information Criterion	**BIC**	**BIC**	**BIC**	**BIC**	**BIC**	**AIC**
Always Kept / Added	**None (1)**	**Income Variables (2)**	**Trade Inte/tions (3)**	**Add *Inc. Cubed* (4)**	**Add *Gini Coef.* (5)**	**None (6)**
Scale and Tech. Effect:						
Income (I)	3.928***	3.980***	3.849***	6.162***	6.885***	4.045***
	(0.689	(0.680)	(0.495)	(0.943)	(0.829)	(0.616)
I^2	0.003	-0.015	-0.034	-3.876***	-4.757***	0.096
	(0.203	(0.590)	(0.230)	(1.158)	(1.134)	(0.363)
Composition Effect:						
(KL)	0.128	0.134	0.004	0.114	0.003	0.095
	(0.192	(0.221)	(0.064)	(0.200)	(0.099)	(0.163)
$(KL)^2$	0.049	0.053	0.033	-0.004	-0.005	0.066
	(0.045	(0.055)	(0.036)	(0.022)	(0.019)	(0.041)
$I * KL$	-0.622**	-0.641**	-0.459**	-0.263	-0.175**	-0.706**
	(0.245	(0.404)	(0.227)	(0.205)	(0.149)	(0.280)
Trade-Induced Effect:						
Trade Intensity (O)	-0.027	-0.028	-0.677	-0.062	0.008	-0.042
	(0.988)	(0.212)	(0.524)	(0.231)	(0.160)	(0.275)
$O * RI$	-0.847	-0.751	0.265	-0.759	-1.090*	-0.856
	(0.696)	(0.675)	(1.263)	(0.711	(0.565)	(0.742)
$O*(RI)^2$	-0.035	-0.050	-0.350	-0.008	-0.005	-0.097
	(0.186)	(0.202)	(0.857)	(0.090	(0.064)	(0.319)
$O * RKL$	2.981***	2.843***	3.270***	2.192**	2.534***	3.102***
	(0.176)	(1.060)	(0.941)	(1.081	(0.716)	(0.829)
$O*(RKL)^2$	-0.181	-0.137	0.345	-0.409	-0.535*	-0.206
	(0.397)	(0.361)	(0.733)	(0.355	(0.306)	(0.449)
$O * RI * RKL$	-0.929	-0.945	-1.702	-0.288	-0.195	-0.887
	(0.625)	(0.618)	(1.610)	(0.486	(0.415)	(0.772)
Political Economy:						
Executives Cons. (EXEC)	-0.001	-0.001	-0.002	0.001	-0.001	-0.003
	(0.005)	(0.005)	(0.007)	(0.005)	(0.004)	(0.009)
Education (EDUC)	0.001	0.001	0.001	0.000	0.000	0.002
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.009)
Country-Specific:						
Tropical Climate (CLIM)	-0.345***	-0.332***	-0.258**	-0.288**	-0.148	-0.348***
	(0.114)	(0.118)	(0.132)	(0.140)	(0.143)	(0.128)
Population Growth (POP)	-0.138	-0.139	-0.187	-0.559	0.006	-0.621
	(1.330)	(1.358)	(1.485)	(2.098)	(1.035)	(2.695)
Region. Heterogeneity:						
South America (SA)	0.023	0.012	0.007	-0.002	0.002	0.050
	(0.052)	(0.038)	(0.029)	(0.017)	(0.025)	(0.072)
East Asia (EA)	0.439***	0.439***	0.457***	0.486***	0.449***	0.442***
	(0.135)	(0.136)	(0.148)	(0.133)	(0.126)	(0.140)
Southeast Asia (SEA)	0.004	0.003	0.004	0.004	-0.013	0.022
	(0.045)	(0.042)	(0.045)	(0.037)	(0.052)	(0.095)

Note: Table 4.5 presents the posterior means and std. errors for six different model averaging exercises for the ACT regression described in equation (2) of the text. Period dummies are included in each specification. Notice that column (1) is identical to column (2) of Table 4.2. Posterior robust (White) standard errors are in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

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