ENVIRONMENTAL CONSIDERATIONS AND THE FINANCING OF HEALTHCARE: EVIDENCE FROM SIXTEEN EUROPEAN COUNTRIES

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Abstract

The results of empirical work on the relation between health expenditure and environmental quality invariably show that environmental degradation has a positive effect on health expenditure, in the sense that more resources are allocated to healthcare to combat the effect of environmental degradation on health. In this paper, the relation between environmental degradation and health expenditure is examined by using data on 16 European countries. The analysis is conducted by using simulation, mathematical derivation and empirical testing using ARDL, FMOLS and non-nested model selection tests. The results reveal that in all cases the relation between per capita health expenditure and CO2 emissions is significantly negative and that in some cases the addition of income per capita as an explanatory variable does not make much difference. Negative correlation between health expenditure and environmental degradation is explained in terms of the environmental Kuznets curve and expenditure on environmental protection.

Keywords: Environmental Degradation, Healthcare, Kuznets Curve, Europe

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1. INTRODUCTION

A large number of studies have been conducted to examine the determinants of health expenditure, with GDP per capita appearing as the most important explanatory variable. Yet very few studies have examined the effect of environmental degradation, although it is intuitive to envisage that environmental considerations are bound to affect expenditure on healthcare for two reasons. The first reason is that environmental pollution has adverse effects on health, thus requiring more spending on healthcare. Gerdtham and Jonsson (1991) suggest that "the costs of environmental contamination are indisputable, and put greater pressure on government budgets, potentially requiring an increase in health care expenditure". The second reason is that spending on environmental protection may reduce the need for more spending on healthcare as a clean environment is conducive to better health.

The objective of this paper is to examine empirically the effect of environmental degradation, measured in terms of CO2 emissions, on health expenditure using data on 16 European countries. While the relation between environmental degradation and health expenditure has been found to be positive (which is intuitively plausible), an examination of the data for European countries over a period going back to 1995 reveals a significant negative correlation between the two variables. Although this observation sounds counterintuitive, an explanation is presented in terms of the environmental Kuznets curve (EKC), which depicts rising then falling levels of degradation as income per capita rises. Whether the relation between health expenditure and degradation is positive or negative depends on whether the underlying country lies on the rising or falling sectors of the EKC.

The research question that is addressed in this paper is the following: how can we explain the observed negative correlation between health expenditure and environmental degradation? This research question is addressed by using simulation, mathematical derivation, and empirical testing. In the following section the literature review is presented, covering the general literature on the determinants of health expenditure and the more specific literature on the relation between environmental degradation and health expenditure. This is followed by a specification of the relation between environmental degradation and health expenditure using simulation, mathematical derivation, and diagrammatic derivation. The empirical results are presented next, followed by some concluding remarks.

2. LITERATURE REVIEW

The determinants of health expenditure have been examined extensively (for example, Di Matteo & Di Matteo, 1998; McCoskey & Selden, 1998; Gerdtham & Lothgren, 2000; Murthy & Okunade, 2000; Freeman, 2003; Jerrett et al., 2003; Di Matteo, 2005; Chou, 2007; Narayan & Narayan, 2008; Wang, 2009; Baltagi & Moscone, 2010; Moscone & Tosetti, 2010; Pan & Liu, 2012; Yavuz et al., 2013; Yu et al., 2013; Di Matteo, 2014; Khan & Mahumud, 2015; An et al., 2016). The important determinants of health expenditure as identified in the literature include income (as the primary factor), urbanisation, population ageing, number of practicing physicians, female labour force participation rate, the proportion of publicly funded healthcare, and foreign aid. Recent studies of the determinants of health expenditure that emphasise the role of income include Bose (2015), Da Silva et al. (2015), Khan et al. (2016), Sagarik (2016), Akca et al. (2017), Nghiem and Connelly (2017), Mahumud et al. (2017), Phi (2017), Di Matteo and Cantarero-Prieto (2018), Ashour (2018), and Moosa (2019).

An important determinant of health expenditure that has not received the attention it deserves is environmental quality or degradation, although it has been found that the environment-related health costs can add up to as much as $130 billion per year for OECD countries, which is equivalent to 0.5% of their GDP (OECD, 2001). Yu et al. (2016) attempt to answer the question if pollution drives up public spending on healthcare by testing for cointegration between health expenditure and environmental indicators in a panel cointegration framework. They specify health expenditure as a function of per capita income, waste gas emissions, dust and smog emissions, and waste water emissions. On the basis of their results, they conclude that health expenditure is positively affected not only by the level of income but also by environmental quality, both in the long run and short run. The positive association between health expenditure and per capita income corroborates the findings of Hansen and King (1996), Spix and Wichmann (1996), Narayan and Narayan (2008), and those of Baltagi and Moscone (2010).

Abdulla et al. (2016) examine the effect of environmental quality and socio-economic factors on health expenditure in Malaysia. The explanatory variables used in the model are GDP, fertility and mortality rates, and emissions of Carbon Dioxide (CO2), Nitrogen Dioxide (NO2) and Sulphur Dioxide (SO2). The ARDL approach is used to find out if the explanatory variables are related to health expenditure in the long run (that is, whether or not they form a cointegrating vector). In a study of the determinants of public health spending in Ghana, Boachie et al. (2014) find that CO2 emissions have a "positive but insignificant" impact on healthcare spending. Yet another study utilising the ARDL approach to cointegration is that of Yazdi et al. (2014) who find that health expenditure, income, sulphur oxide emissions and carbon monoxide emissions are cointegrated. Likewise, Kiymaz et al. (2006) find that pollution has a positive impact on public health spending in Turkey.

Assadzadeh (2014) examines the role of environmental pollution in determining per capita health expenditure in eight oil exporting countries over the period 2000–2010. The results show that income and CO2 emissions exert a statistically significant positive effect on health expenditure. In a recent study, Yazdi and Khanalizadeh (2017) explore the role of environmental quality and economic growth in the determination of health expenditure in the Middle East and North Africa (MENA) region over the period 1995-2014. By using the ARDL approach they find that health expenditure, income, CO2 emissions, and PM10 emissions form a cointegrated panel and that these explanatory variables have statistically significant positive effects on health expenditure.

Jerrett et al. (2003) explore the relation between health expenditure and environmental variables in the Canadian province of Ontario by using a sequential two-stage regression model to control for variables that may influence the dependent variable and to take care of endogeneity. They apply the methodology to cross sectional data on the 49 counties of Ontario and find, after controlling for other variables that may influence health expenditure, that both total toxic pollution output and per capita environmental expenditure have significant association with health expenditure. They find that counties with higher pollution output tend to have higher per capita health expenditure, while those that spend more on defending environmental quality allocate less funds to health on a per capita basis. Preker et al. (2016) attempt to estimate the portion of health expenditure that can be attributed to pollution and find that annual expenditure ranges from $630 billion (upper bound) to $240 billion (lower bound), or approximately 3-9% of the global spending on healthcare in 2013.

In a more recent study, Moosa (2019) presents empirical evidence on the relation between CO2 emissions, as a proxy for environmental degradation, and health expenditure. The underlying hypothesis is that if the environmental Kuznets curve exists then the relation between health expenditure (per capita) and emissions (per capita) will take a similar shape. In other words, the functional relations between income and emissions and between health expenditure and emissions take the same sign. This proposition is verified mathematically, diagrammatically, by using simulation and by empirical results obtained by using the fully modified ordinary least square (FMOLS) and variable addition tests.

In summary, empirical studies of the relation between health expenditure and environmental degradation have produced results invariably indicating that environmental degradation has a positive effect on health expenditure. This may or may not be the case, depending on the level of economic development (and hence the position on the environmental Kuznets curve). For the European countries examined in this paper, the stylised facts show that the relation between the two variables is consistently negative. The first step, therefore, is to examine the stylised facts in relation to what is predicted by a simulation exercise.

3. SIMULATION AND STYLISED FACTS

Consider the interrelationships among health expenditure per capita (*h*), income per capita (*y*) and environmental degradation (*d*). It is plausible to assume that health expenditure is a positive linear function of income per capita, given that highly supportive empirical evidence is available and because it makes sense to envisage that more is spent on healthcare as income rises. For the purpose of simulation it is assumed that income grows at the rate of 2% per period, such that:

$$y_t = 1.02y_{t-1} \quad (1)$$

and that health expenditure is related linearly to income, such that:

$$h_t = 2 + 0.7y_t \quad (2)$$

Both are shown to be growing over time in the top left-hand part of Figure 1 (see Appendix). Assume also the presence of EKC such that:

$$d_t = 7 + 1.8y_t - 0.066y_t^2 \quad (3)$$

which is depicted in the top right part of Figure 1. If this is the case, it follows that:

$$h_t = 945.46 - 101.86d_t + 2.77d_t^2 \quad (4)$$

for low values of h and y (bottom left-hand graph) and:

$$h_t = -1606.2 + 173.43d_t - 4.642d_t^2 \quad (5)$$

for high values of h and y (bottom right-hand graph). This means that health expenditure and environmental degradation are positively related when degradation rises with income and negatively correlated when degradation falls as income rises (that is, the upward-sloping and downward-sloping segments of the EKC, respectively).

This result can be derived mathematically. Assume that health expenditure is a linear function of income such that:

$$h = \alpha_0 + \alpha_1 y \quad (6)$$

where $\alpha_1 > 0$. Assume for simplicity that the upward and downward segments of the EKC can be represented by the equation:

$$d = \beta_0 + \beta_1 y \quad (7)$$

Equation 7 represents the upward-sloping segment of EKC when $\beta_1 > 0$ and the downward-sloping segment when $\beta_1 < 0$. By manipulating Equation 7 we obtain:

$$y = \frac{\beta_0}{\beta_1} + \left(\frac{1}{\beta_1}\right)d \quad (8)$$

which gives:

$$h = \left(\alpha_0 - \frac{\alpha_1\beta_0}{\beta_1}\right) + \left(\frac{\alpha_1}{\beta_1}\right)d \quad (9)$$

Since $\alpha_1 > 0$, it follows from Equation 9 that h is a positive function of d when $\beta_1 > 0$ and a negative function when $\beta_1 < 0$.

Let us see how the behaviour predicted by the simulation exercise compares with the actual behaviour of the three variables. For this purpose, annual time series data are used going back to 1995, as provided by the World Bank.[1] The data series cover 16 European countries: Belgium, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, and the UK. The variables are defined as follows: d is CO2 emissions (kg per PPP dollar of GDP), h is health expenditure per capita, (constant PPP dollar) and y is GDP per capita (constant PPP dollar).[2]

In Figure 2 (see Appendix), we observe scatter diagrams of degradation as a function of income (the environmental Kuznets curve), health expenditure per capita as a function of income per capita, and health expenditure per capita as a function of degradation. The patterns of behaviour are strikingly similar for all countries, although the strength of correlation varies from one country to another. The left-hand graph shows that all of the countries fall on the negatively-sloping segment of the EKC, as the relation between d and y is negative. The middle graph shows that h is a positive function of y, as assumed in the simulation exercise and supported by empirical evidence. In the right-hand graph, the relation between h and d is highly negative, indicating that health expenditure per capita declines as degradation rises.

A possible explanation for this phenomenon is as follows. The behaviour of h reflects its response to both y and d. As y grows, d increases initially but after a certain threshold it starts to decline, in which case the environmentally-driven health expenditure

[1] http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#.

[2] These particular 16 countries are chosen to ensure a wide range of income per capita, extending between $6647 for Romania and $84,212 for Norway.

per capita starts to decline as a result of increasing spending on environmental protection. Since healthcare is a normal good, with a positive income elasticity of demand, the portion of h triggered by income growth keeps on rising (except perhaps for cyclical downturns). The total value of h therefore rises with d at low levels and falls at high levels of y. Since European countries have high levels of income per capita, they fall on the downward-sloping sector of the EKC, which produces negative correlation between h and d, as shown clearly in Figure 2. This observation is consistent with the proposition put forward by Jerrett et al. (2003) who assert that counties with higher pollution output tend to have higher per capita health expenditure, while those that spend more on defending environmental quality allocate less funds to health on a per capita basis.

4. EMPIRICAL RESULTS

In this section we examine the relation between health expenditure and environmental degradation, using the annual data described earlier. The relation is specified as:

$$h_t = \alpha_0 + \alpha_1 d_t + \varepsilon_t \qquad (10)$$

where $\alpha_1 > 0$. Equation 10 is estimated by using the Phillips-Hansen (1990) fully-modified ordinary least squares (FMOLS) because OLS does not produce valid t-statistics, whereas FMOLS does. This is because with integrated variables, the OLS standard errors (and hence the t-statistics) do not follow an asymptotic normal distribution. Consequently, the conventional critical values of the t distribution cannot be used to derive inference on the significance of the estimated coefficients. The results reported in Table 1 (see Appendix) show that the association between health expenditure and environmental degradation is significantly negative for all countries.

A question is bound to arise as to what happens when income per capita is introduced as another explanatory variable, since the available evidence indicates the importance of income as a determinant of health expenditure. Instead of re-estimating the equation with two explanatory variables, a variable addition test is used to determine the significance of income per capita as an explanatory variable. Three test statistics are used to judge the significance of adding y to the equation, such that a significant test statistic implies the importance of y. The test statistics are: (i) a Langrage multiplier (LM) statistic, which is distributed as χ^2 (1); (ii) a likelihood ratio (LR) statistic, again distributed as χ^2 (1); and (iii) an F statistic with (1,18) degrees of freedom. The results show that income appears to be important in some cases but not in the other cases. The interpretation of this result is that for some countries, environmental considerations are more important than income, hence these countries spend so much on environmental protection that they can afford to spend less on healthcare as income rises. These countries include Finland, Germany, Hungary, Netherlands, Norway, Slovenia, Sweden, and the UK.

In order to find out whether environmental degradation is more or less important for the determination of health expenditure, non-nested model selection tests are used. For this purpose, M1 is taken to be Equation 6, whereas M2 is specified as:

$$h_t = \beta_0 + \beta_1 y_t + \xi_t \qquad (11)$$

Three non-nested model selection tests are used: N is the Cox test derived in Pesaran (1974); NT is the adjusted Cox test derived in Godfrey and Pesaran (1983); and W is the Wald-type test proposed by Godfrey and Pesaran (1983). All of the test statistics follow a t distribution. A description of these tests can be found in Pesaran and Pesaran (2009).

The tests are run both ways by testing M1 versus M2 and M2 versus M1. When M1 is tested versus M2, the null hypothesis is that M1 is a better model (in terms of specification) than M2. A significant test statistic indicates that M1 is not a better model than M2. When M2 is tested against M1, the null is that M2 is a better a model than M1. A significant test statistic indicates that M2 is not a better model than M1. Significant test statistics both ways imply that both models are misspecified. Obtaining insignificant test statistics by testing M1 versus M2 and significant statistics by testing M2 versus M1 means that M1 is preferred to M2, and vice versa.

The results presented in Table 3 (see Appendix) show that in 9 cases, environmental degradation is more important than income per capita as M1 cannot be rejected against M2 while M2 is rejected against M1. In the other seven cases, M1 is rejected against M2 while M2 is rejected against M1, implying that a correctly specified model should contain both variables because they are independently important for determining health expenditure. The results of the variable addition test are consistent with the results of the non-nested model selection tests in the seven cases of France, Greece, Italy, Poland, Portugal, Romania and Spain, because they show that income per capita is a significant variable to be added to the model and that a model that does not contain income is misspecified. Still this leaves a large number of cases where environmental degradation on its own can explain health expenditure adequately.

As in the previous literature, the ARDL approach is used to test for cointegration between health expenditure and the two determining variables. The static cointegrating regression is specified as:

$$h_t = \alpha_0 + \alpha_1 d_t + \alpha_2 y_t + \varepsilon_t \qquad (12)$$

The corresponding error correction model can be extracted from the long-run static equation that can be derived from an autoregressive distributed lag equation relating h to d and y (Pesaran & Pesaran, 2009; Pesaran & Shin, 1995, 1996; Pesaran et al., 2001). This model can be written as:

$$\Delta h_t = \beta + \sum_{j=1}^{p} \delta_j \Delta h_{t-j} + \sum_{j=0}^{q} k_j \Delta d_{t-j} + \sum_{j=0}^{s} \lambda_j \Delta y_{t-j} + \phi \varepsilon_{t-1} + \xi_t \qquad (13)$$

where ϕ is a measure of the speed of adjustment to deviations from (8). Kremers et al. (1992) contend that a cointegration test involving the application of the DF unit root test (or similar tests) to the residuals of the cointegrating regression may not reject the null hypothesis of no cointegration when the coefficient on the error correction term in the corresponding dynamic model may be statistically significant. They suggest that this conflict arises because of the implied common factor restriction that is imposed when the DF statistic is used to test for cointegration. If this restriction is invalid, the DF test remains consistent but loses power relative to cointegration tests that do not impose a common factor restriction. Testing for cointegration is therefore based on the sign and significance of the coefficient on the error correction term such that the null of no cointegartion is rejected when ϕ is significantly negative. For the purpose of comparison, the same test statistic is reported for the equation where d is the only explanatory variable.

The results of cointegration testing are reported in Table 4 (see Appendix) where $t(\phi)$ (h, d) is the t-statistic on the error correction term of the equation where d is the only explanatory variable and $t(\phi)$ (h, d, y) is the same for the equation with two explanatory variables, d and y. In most cases cointegration is found in the equations with one and two explanatory variables. In four cases, however, cointegration is found only in the equation with d as the only explanatory variable. Caution is required when these results are interpreted. To start with, it is a myth that if cointegration is not found, then the regression is spurious, because only common sense tells us whether a regression is spurious or genuine. In this case, common sense, intuition and economic theory tell us that both explanatory variables matter for the determination of health expenditure. Furthermore, failure to find cointegration does not mean the absence of a causal link. With reference to the EKC literature, Moosa (2017a) argues that the importance of cointegration is often exaggerated. In another paper, Moosa (2017b) warns of the hazard of using cointegration testing to detect spurious correlation, arguing that this procedure may lead us to believe that NASA is responsible for suicide and that the consumption of margarine leads to divorce. We should not forget that different cointegration tests produce inconsistent results more often than never.

5. CONCLUSION

The literature on the determinants of health expenditure is extensive but very few studies identify environmental quality or degradation as an important determining factor. The importance of environmental degradation stems from the fact that it has an adverse effect on public health, leading to the need for a higher level of health expenditure. The level of per capita income, which has been identified as a major determinant of health expenditure, is associated with environmental degradation as represented by the environmental Kuznets curve.

In this paper, the relation between environmental degradation and health expenditure is examined by using data on 16 European countries. The results reveal that in all cases the relation between per capita health expenditure and CO_2 emissions is significantly negative and that in some cases the addition of income per capita as an explanatory variable does not make much difference. The significance of the bivariate relation between health expenditure and environmental degradation should not be taken to mean that income does not matter for the determination of health expenditure as its role is implicit. Income growth has an impact on environmental quality, depending on the position on the EKC. Response to deteriorating environmental quality triggers public expenditure on environmental protection, which offsets some of the expenditure on healthcare. Thus income growth shapes the response of health expenditure to environmental degradation, while exerting a direct effect because healthcare is a normal good.

The end result is that the relation between health expenditure and environmental degradation may be positive or negative, depending on the position of the EKC. Given that European countries have such high levels of income per capita that put them on the downward-sloping sector of the EKC, the relation between health expenditure and environmental degradation is significantly negative across the 16 European countries considered in this study.

A possible limitation of this study is that the sample period is not that long, going back to 1995 where the countries examined fall on the declining sector of the environmental Kuznets curve. Going back to the 1960s, for example, would allow us to see how the relation changes when countries fall on the rising compared with the declining sector of the environmental Kuznets curve. Under those conditions we would expect, as the simulation results show that the relation between degradation and health expenditure was positive in earlier years then turned negative. This would be a useful extension of this paper when data are available.

REFERENCES

1. Abdullah, H., Azam, M., & Zakariya, S. K. (2016). The impact of environmental quality on public health expenditure in Malaysia. *Asia Pacific Journal of Advanced Business and Social Studies*, *2*(2), 365-379.
2. Akca, N., Sonmez, S., & Yilmaz, A. (2017). Determinants of health expenditure in OECD countries: A decision tree model. *Pakistan Journal of Medical Science*, *33*(6), 1490-1494. https://doi.org/10.12669/pjms.336.13300
3. An, Y., Zhao, K., & Zhou, R. (2016). Health spending and public pension: Evidence from panel data. *Applied Economics*, *48*(11), 987-1004. https://doi.org/10.1080/00036846.2015.1090556
4. Ashour, M. (2018). Determinants of and changes in catastrophic health expenditure in the occupied Palestinian territory: An analysis of ten rounds of the Palestinian Households Expenditure and Consumptions Survey (1996–2011). *Lancet*, *391*(1), S18. https://doi.org/10.1016/S0140-6736(18)30343-X
5. Assadzadeh, A., Bastan, F., & Shahverdi, A. (2014). The impact of environmental quality and pollution on health expenditures: A case study of petroleum exporting countries, *Proceedings of 29th International Business Research Conference*, Sydney, Australia, 24-25 November.

6. Baltagi, B., & Moscone, F. (2010). Health care expenditure and income in the OECD reconsidered: Evidence from panel data. *Economic Modelling, 27*(4), 804-811. https://doi.org/10.1016/j.econmod.2009.12.001
7. Boachie, M. F., Mensah, I. O., Sobiesuo, P., Immurana, M., Iddrisu, A., & Kyei-Brobbey, I. (2014). Determinants of public expenditure in Ghana: A cointegration analysis. *Journal of Behavioral Economics, Finance, Entrepreneurship, Accounting and Transport, 2*(2), 35-40.
8. Bose, S. (2015). Determinants of per capita state-level health expenditures in the United States: A spatial panel analysis. *Journal of Regional Analysis and Policy*, *45*(1), 93-107.
9. Chou, W. (2007). Explaining China's regional health expenditures using LM-type unit root tests. *Journal of Health Economics, 26*(4), 682-698. https://doi.org/10.1016/j.jhealeco.2006.12.002
10. Da Silva, M. S., Barros, A. J. D., Bertoldi, A. D., Jacinto, P., Matijasevich, A., Santos, I. S., & Tejada, C. A. O. (2015). Determinants of out-of-pocket health expenditure on children: An analysis of the 2004 Pelotas Birth Cohort. *International Journal for Equity in Health*, 14, 53. https://doi.org/10.1186/s12939-015-0180-0
11. Di Matteo, L. (2005). The macro determinants of health expenditure in the United States and Canada: Assessing the impact of income, age distribution and time. *Health Policy, 71*(1), 23-42. https://doi.org/10.1016/ j.healthpol.2004.05.007
12. Di Matteo, L. (2014). Physician numbers as a driver of provincial government health spending in Canadian health policy. *Health Policy, 115*(1), 18-35. https://doi.org/10.1016/j.healthpol.2013.07.003
13. Di Matteo, L., & Cantarero-Prieto, D. (2018). *The determinants of public health expenditures: Comparing Canada and Spain* (MPRA Papers, No. 87800). Retrieved from https://mpra.ub.uni-muenchen.de/87800/.
14. Di Matteo, L., & Di Matteo, R. (1998). Evidence on the determinants of Canadian provincial government health expenditures: 1965–1991. *Journal of Health Economics*, *17*(2), 211-228. https://doi.org/10.1016/S0167-6296(97)00020-9
15. Freeman, D. (2003). Is health care a necessity or a luxury? Pooled estimates of income elasticity from US state-level data, *Applied Economics, 35*(5), 495-502. https://doi.org/10.1080/00036840210138374
16. Gerdtham, U. G., & Jonsson, B. (1991). Conversion factor instability in international comparisons of health care expenditure. *Journal of Health Economics, 10*(2), 227-234. https://doi.org/10.1016/0167-6296(91)90005-8
17. Gerdtham, U. G., & Lothgren, M. (2000). On Stationarity and cointegration of international health expenditure and GDP. *Journal of Health Economics, 19*(4), 461-475. https://doi.org/10.1016/S0167-6296(99)00036-3
18. Godfrey, L. G., & Pesaran, M. H. (1983). Tests of non-nested regression models: small sample adjustments and Monte Carlo evidence. *Journal of Econometrics, 21*(1), 133-154. https://doi.org/10.1016/0304-4076(83)90123-9
19. Hansen, P., & King, A. (1996). The determinants of health care expenditure: A cointegration approach. *Journal of Health Economics, 15*(1), 127-137. https://doi.org/10.1016/0167-6296(95)00017-8
20. Jerrett, M., Eyles, J., Dufournaud, C., & Birch, S. (2003). Environmental influences on healthcare expenditures: An exploratory analysis from Ontario, Canada. *Journal of Epidemiol Community Health, 57*(5), 334-338. https://doi.org/10.1136/jech.57.5.334
21. Khan, H. B., Razaliand, R. B., & Shafie, A. (2016). Modeling determinants of health expenditures in Malaysia: Evidence from time series analysis. *Frontiers in Pharmacology, 7*, 69. https://doi.org/10.3389/fphar.2016.00069
22. Khan, J., & Mahumud, R. (2015). Is healthcare a 'Necessity' or 'Luxury'? An empirical evidence from public and private sector analyses of South-East Asian countries. *Health Economics Review, 5*, 3-9. https://doi.org/ 10.1186/s13561-014-0038-y
23. Kiymaz, H., Akbulut, Y., & Demir, A. (2006). Test of stationarity and cointegration of healthcare expenditure and gross domestic product: An application to Turkey. *European Journal of Health Economics, 7*(4), 285-310. https://doi.org/10.1007/s10198-006-0375-9
24. Kremers, J. J. M., Ericsson, N. R., & Dolado, J. J. (1992). The Power of cointegration tests. *Oxford Bulletin of Economics and Statistics, 54(3)*, 325-348. https://doi.org/10.1111/j.1468-0084.1992.tb00005.x
25. Mahumud, R. A., Sarker, A. R., Sultana, M., Islam, Z., Khan, J., & Morton, A. (2017). Distribution and determinants of out-of-pocket healthcare expenditures in Bangladesh. *Journal of Preventive Medicine and Public Health, 50*(2), 91-99. https://doi.org/10.3961/jpmph.16.089
26. McCoskey, S., & Selden, T. (1998). Health care expenditure and GDP: Panel data unit roots test results. *Journal of Health Economics, 17*(3), 369-376. https://doi.org/10.1016/S0167-6296(97)00040-4
27. Moosa, I. A. (2017a). The econometrics of the environmental Kuznets Curve: An illustration using Australian CO2 emissions. *Applied Economics, 49*(49), 4927-4945. https://doi.org/10.1080/00036846.2017.1296552
28. Moosa, I. A. (2017b). Blaming suicide on NASA and divorce on margarine: The hazard of using cointegration to derive inference on spurious correlation. *Applied Economics*, *49*(15), 1483-1490. https://doi.org/ 10.1080/00036846.2016.1218434
29. Moosa, N. (2019). *The financing of healthcare: Theoretical, empirical and practical considerations* (PhD Thesis, University of South Australia).
30. Moscone, F., & Tosetti, E. (2010). Health expenditure and income in the United States. *Health Economics, 19*(12), 1385-1403. https://doi.org/10.1002/hec.1552
31. Murthy, V., & Okunade, A. (2000). Managed care, deficit financing, and aggregate health care expenditure in the United States: A cointegration analysis. *Health Care Management Science, 3*(4), 279-285. https://doi.org/ 10.1023/A:1019066012984
32. Narayan, P. K., & Narayan, S. (2008). Does Environmental quality influence health expenditures? Empirical evidence from a panel of selected OECD countries. *Ecological Economics, 65*(2), 367-374. https://doi.org/ 10.1016/j.ecolecon.2007.07.005
33. Nghiem, S. H., & Connelly, B. (2017). Convergence and determinants of health expenditures in OECD countries. *Health Economics Review, 7*, 29. https://doi.org/10.1186/s13561-017-0164-4
34. OECD (2001). *Environmental Outlook.* Paris, France: Organisation for Economic Co-operation and Development.
35. Pan, J., & Liu, G. (2012). The determinants of Chinese provincial government health expenditures: Evidence from 2002-2006 data. *Health Economics, 21*(7), 757-777. https://doi.org/10.1002/hec.1742
36. Pesaran, B., & Pesaran, M. H. (2009). *Time Series Econometrics: Using Microfit 5.0.* Oxford, UK: Oxford University Press.
37. Pesaran, M. H. (1974). On the general problem of model selection. *Review of Economic Studies, 41*(2), 153-171. https://doi.org/10.2307/2296710

38. Pesaran, M. H., & Shin, Y. (1995). *Long-run structural modelling* (Cambridge Working Paper in Economics 9419, University of Cambridge). Retrieved from http://www.tandfonline.com/doi/abs/10.1081/ETC-120008724
39. Pesaran, M. H., & Shin, Y. (1996). Cointegration and the speed of convergence to equilibrium. *Journal of Econometrics, 71*(1-2), 117-143. https://doi.org/10.1016/0304-4076(94)01697-6
40. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289-326. https://doi.org/10.1002/jae.616
41. Phi, G. (2017). *Determinants of health expenditures in OECD countries.* Retrieved from http://digitalcommons.bryant.edu/cgi/viewcontent.cgi?article=1025&context=honors_economics
42. Phillips, P. C. B., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. *Review of Economic Studies, 57*(1), 99-125. https://doi.org/10.2307/2297545
43. Preker, A. S., Adeyi, O., Lapetra, M. G., Simon, D., & Mawr, B. (2016). Health care expenditures associated with pollution: Exploratory methods and findings. *Annals of Global Health, 82*(5), 711-721. https://doi.org/10.1016/j.aogh.2016.12.003
44. Sagarik, D. (2016). Determinants of health expenditures in ASEAN region: Theory and evidence. *Millennial Asia, 7*(1), 1-19. https://doi.org/10.1177/0976399615624054
45. Spix, C., & Wichmann, H. E. (1996). Daily mortality and air pollutants: Findings from Koln, Germany. *Journal of Epidemiology and Community Health, 50*(1), S52-S58. https://doi.org/10.1136/jech.50.Suppl_1.s52
46. Wang, Z. (2009). The determinants of health expenditures: Evidence from US state-level data. *Applied Economics, 41*(4), 429-435. https://doi.org/10.1080/00036840701704527
47. Yavuz, N., Yilanci, V., & Ozturk, Z. (2013). Is health care a luxury or a necessity or both? Evidence from Turkey. *European Journal of Health, 14*(1), 5-10. https://doi.org/10.1007/s10198-011-0339-6
48. Yazdi, S. K., & Khanalizadeh, B. (2017). Air Pollution, economic growth and health care expenditure. *Economic Research-Ekonomska Istraživanja, 30*(1), 1181–1190. https://doi.org/10.1080/1331677X.2017.1314823
49. Yazdi, S. K., Tahmasebi, Z., & Mastorakis, N. (2014). Public healthcare expenditure and environmental quality in Iran. *Recent Advances in Applied Economics*, 126-134. Retrieved from http://www.wseas.us/e-library/conferences/2014/Lisbon/AEBD/AEBD-17.pdf
50. Yu, Y., Zhang, L., & Zheng, X. (2016). On the Nexus of environmental quality and public spending on health care in China: A panel cointegration analysis. *Economic and Political Studies, 4*(3), 319-331. https://doi.org/10.1080/20954816.2016.1218670
51. Yu, Y., Zhang, L., Li, F., & Zheng, X. (2013). Strategic interaction and the determinants of public health expenditures in China: A spatial panel perspective. *Annals of Regional Science, 50*(1), 203-221. https://doi.org/10.1007/s00168-011-0488-7

APPENDIX

Figure 1. The simulation exercise

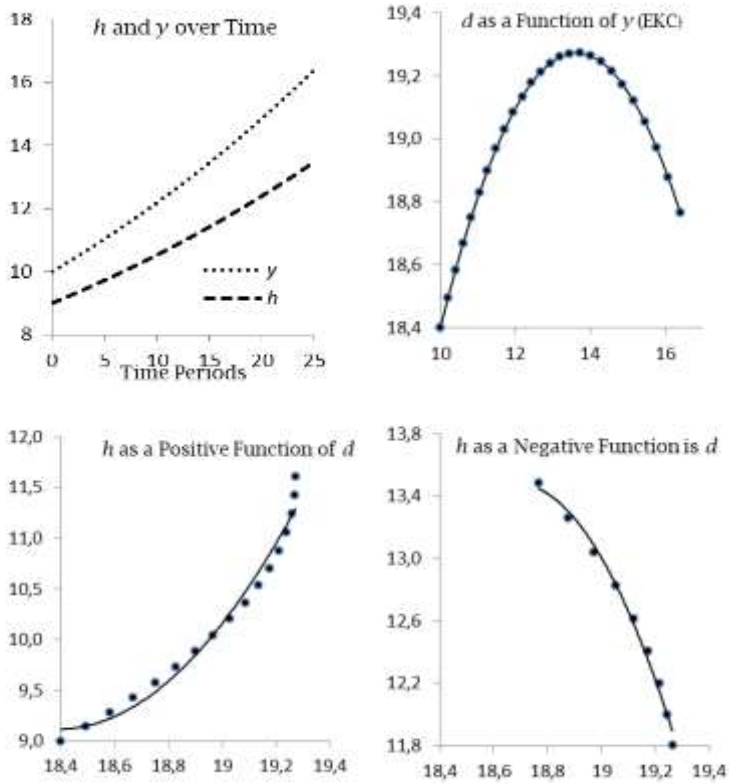

Figure 2. The stylised facts (Part 1)

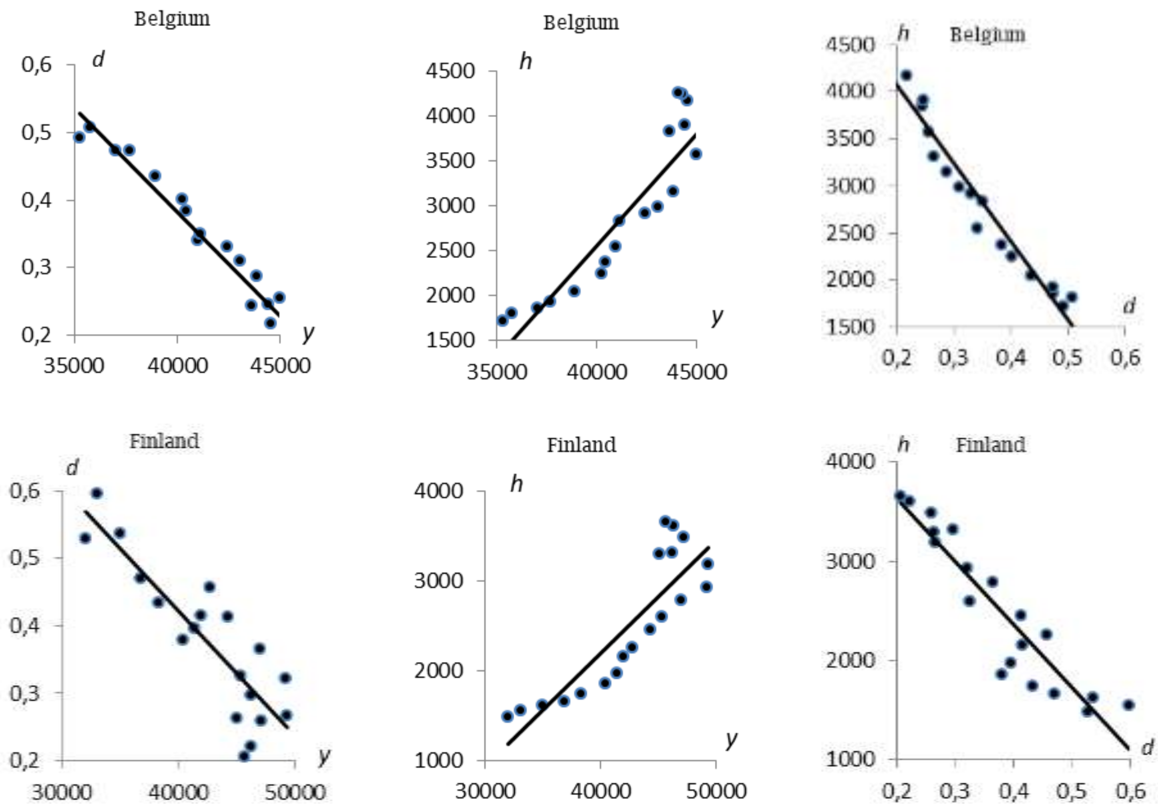

Figure 2. The stylised facts (Part 2)

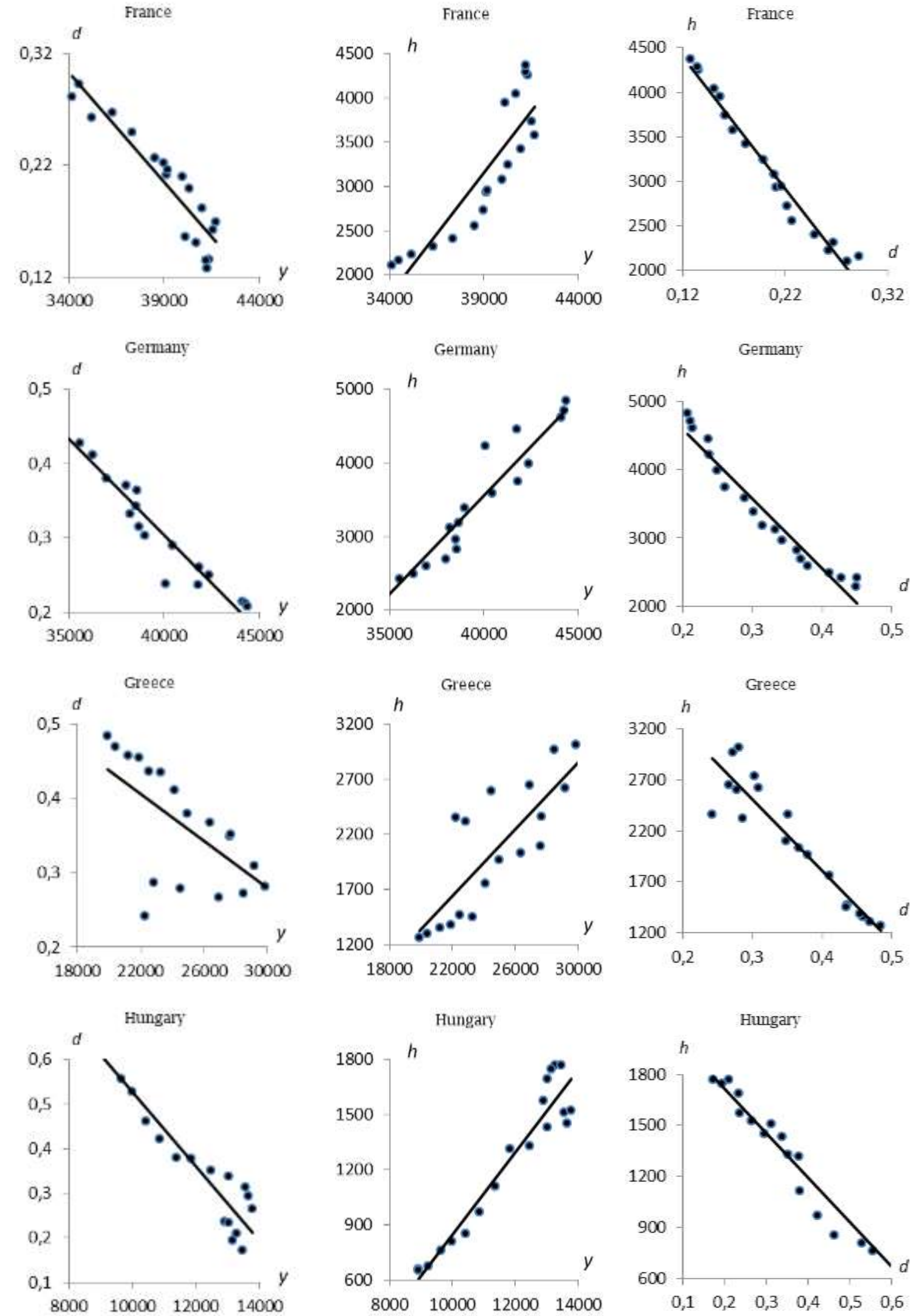

Figure 2. The stylised facts (Part 3)

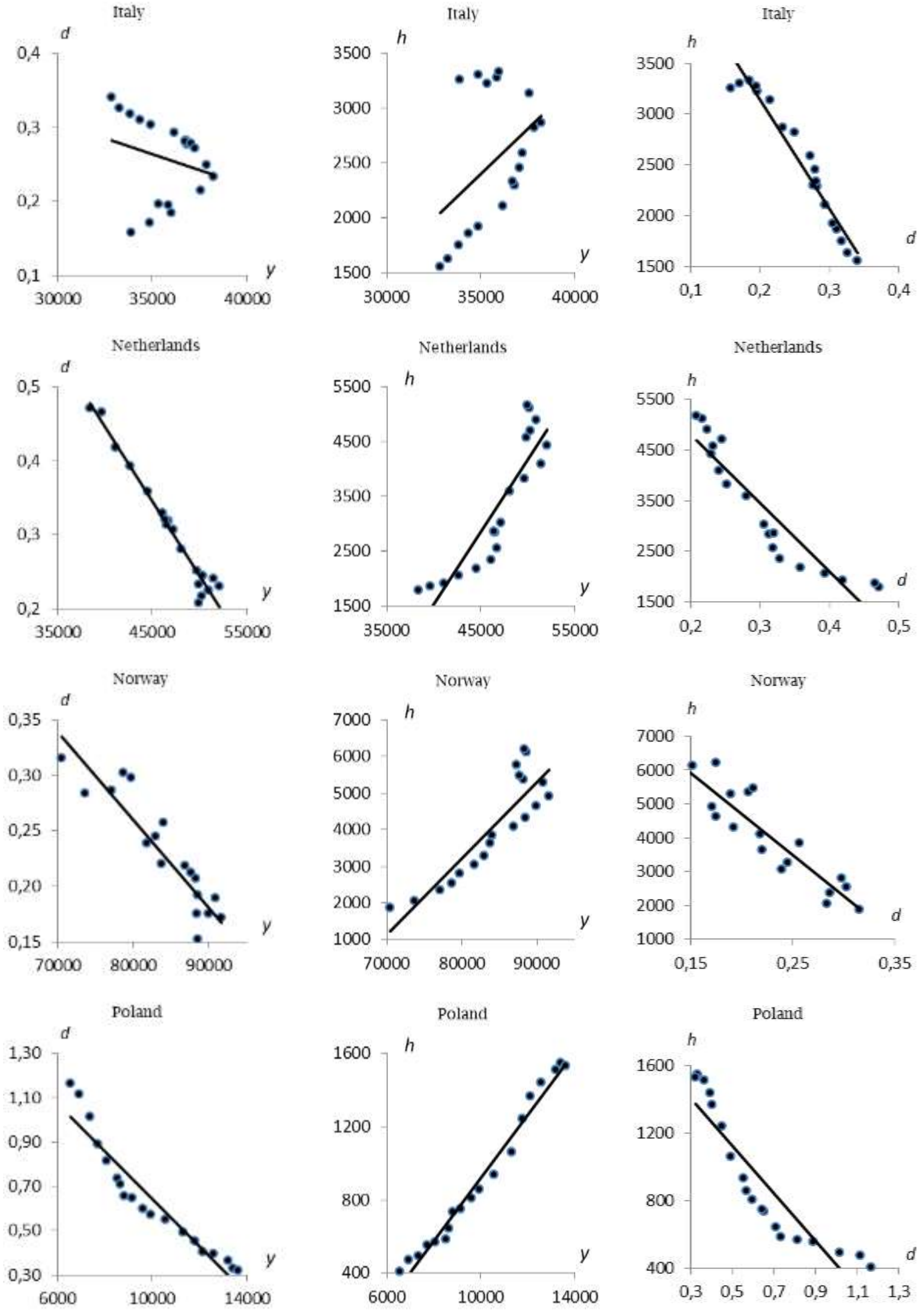

Figure 2. The stylised facts (Part 4)

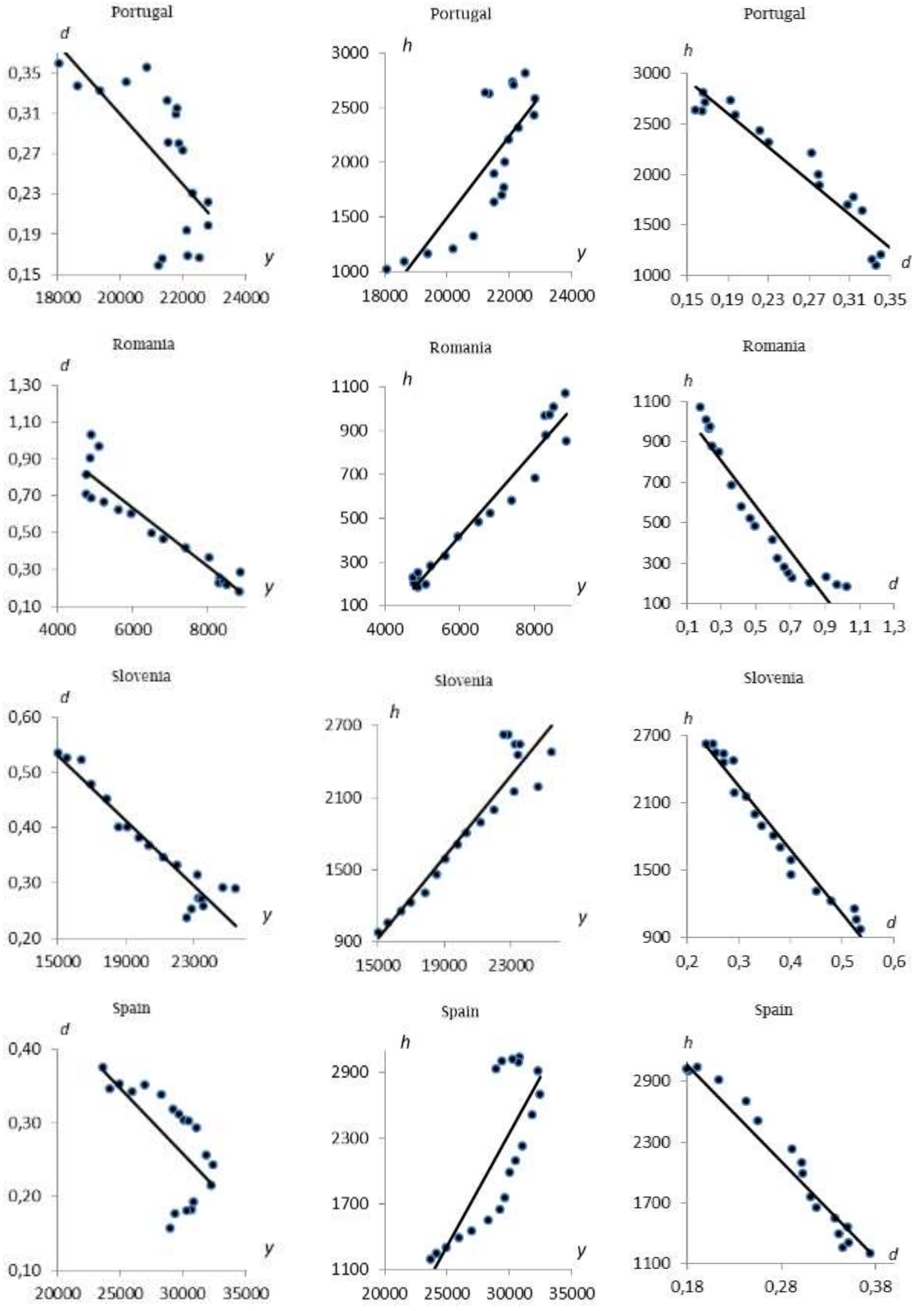

Figure 2. The stylised facts (Part 5)

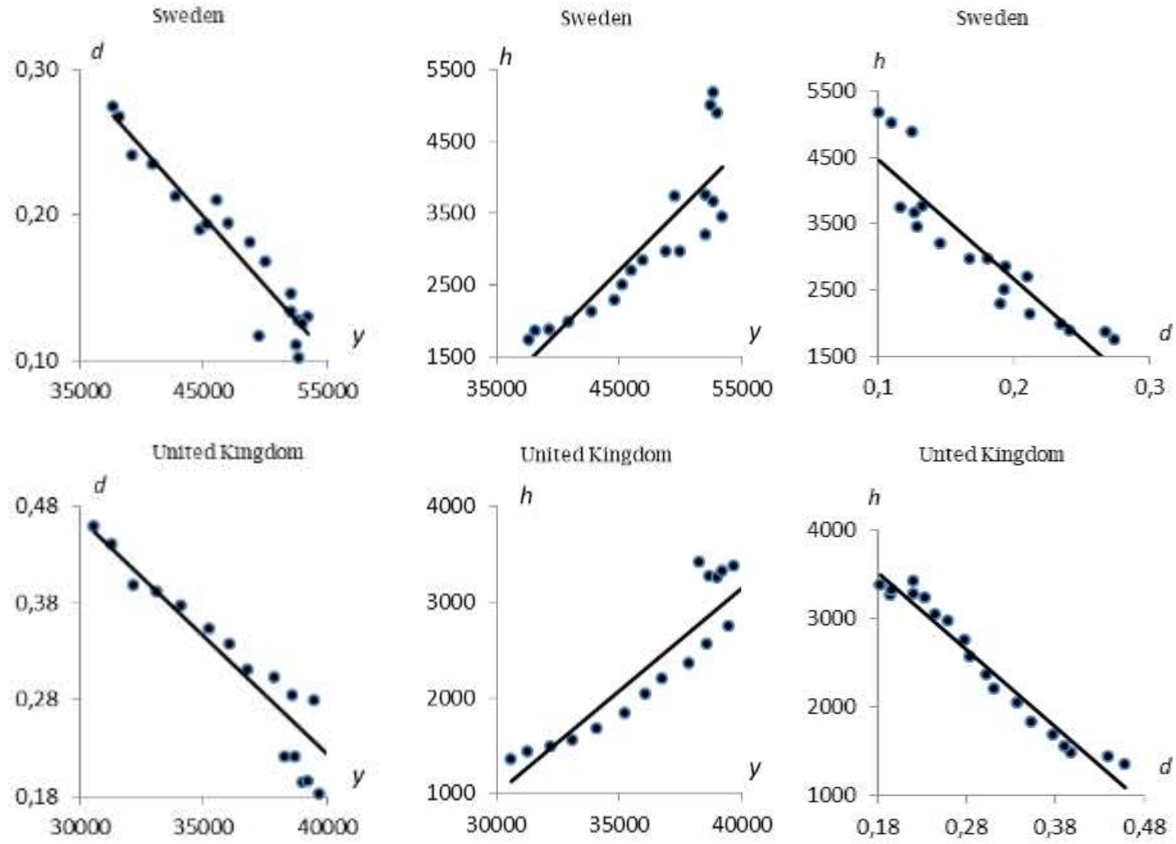

Table 1. Phillips-Hansen FMOLS estimates of Equation 10

Country	α_0	α_1	R^2
Belgium	5768.2 (34.56)	-8435.0 (-17.30)	0.96
Finland	5224.0 (17.12)	-7236.8 (-9.06)	0.87
France	6294.3 (49.20)	-15140 (-24.39)	0.97
Germany	665.8 (29.07)	-999.4 (-14.16)	0.95
Greece	4519.6 (3.89)	-6759.6 (-7.48)	0.87
Hungary	2222.5 (76.58)	-2590.4 (-34.97)	0.96
Italy	5265.9 (20.19)	-10629.9 (-10.51)	0.95
Netherlands	7783.0 (12.62)	-14587.9 (-7.23)	0.86
Norway	9934.2 (19.66)	-25943.6 (-11.60)	0.84
Poland	1936.4 (10.94)	-1607.9 (-5.94)	0.84
Portugal	4142.7 (25.28)	-8112.9 (-13.23)	0.93
Romania	1148.3 (14.90)	-1159.9 (-8.45)	0.89
Slovenia	3907.3 (37.43)	-55.68 (-19.55)	0.97
Spain	4686.2 (24.20)	-9185.7 (-13.19)	0.95
Sweden	6603.1 (14.63)	-20056.3 (-7.82)	0.83
UK	5082.6 (33.41)	-8747.5 (-17.26)	0.96

T-statistics are placed in parentheses.

Table 2. Variable addition test results (income per capita)

Country	*LM χ^2 (1)*	*LR χ^2 (1)*	*F(1,18)*
Belgium	5.86	7.01	7.14
Finland	2.04	2.16	1.93
France	5.85	7.00	7.132
Germany	1.69	1.78	1.57
Greece	13.31	22.91	34.44
Hungary	2.92	3.18	2.91
Italy	13.42	23.29	38.52
Netherlands	2.71	2.92	2.65
Norway	2.59	2.79	2.53
Poland	17.63	50.04	206.79
Portugal	14.79	28.66	56.32
Romania	11.35	17.30	23.77
Slovenia	0.66	0.67	0.58
Spain	12.63	20.79	31.79
Sweden	0.07	0.07	0.06
UK	0.36	0.36	0.31

The 5% critical value for the LM, LR and F statistics are 3.84, 3.84 and 4.49, respectively.

Table 3. Non-nested model selection tests

Country	*M1 vs M2*			*M2 vs M1*			*Preferred Model*
	N	*NT*	*W*	*N*	*NT*	*W*	
Belgium	1.93	1.83	2.25	-9.03	-8.44	-3.96	M1
Finland	-1.75	-1.61	-1.37	-5.89	-5.42	-3.22	M1
France	2.01	1.90	2.25	-12.50	-11.63	-4.28	*
Germany	-1.55	-1.45	-1.23	-4.65	-4.37	-2.74	M1
Greece	-6.05	-5.60	-4.01	-11.78	-10.65	-5.08	*
Hungary	-2.14	-2.01	-1.62	-6.21	-5.83	-3.19	M1
Italy	-5.44	-4.95	-4.62	-68.19	-34.16	-11.15	*
Netherlands	1.43	1.35	1.53	-3.88	-3.63	-2.79	M1
Norway	-2.06	-1.89	-1.55	-4.06	-3.75	-2.56	M1
Poland	-12.16	-11.37	-4.20	2.27	2.15	2.62	*
Portugal	-5.74	-5.35	-4.11	-15.39	-13.86	-5.46	*
Romania	-6.66	-6.24	-3.31	-2.06	-1.93	-1.58	*
Slovenia	-0.88	-0.83	-0.76	-8.12	-7.62	-3.58	M1
Spain	-4.83	-4.51	-3.69	-17.42	-15.62	-5.54	*
Sweden	0.26	0.26	0.27	-3.53	-3.27	-2.45	M1
UK	-0.64	-0.59	-0.56	-9.20	-8.59	-3.80	M1

** Both models are rejected, which means that the preferred model should contain both variables. In M1 health expenditure is a function of environmental degradation whereas in M2 it is a function of income.*

Table 4. Results of cointegration test

Country	*t(ϕ) (h, d)*	*t(ϕ) (h, d, y)*
Belgium	-2.35	-1.84
Finland	-0.79	-1.86
France	-3.48	-2.81
Germany	-2.73	-2.09
Greece	0.10	0.05
Hungary	-4.64	-4.64
Italy	1.21	-1.04
Netherlands	-2.39	-1.90
Norway	-3.40	-3.30
Poland	-3.03	-1.02
Portugal	1.30	-2.55
Romania	-2.03	-4.53
Slovenia	-2.94	-3.68
Spain	2.89	-0.16
Sweden	-0.44	-0.30
UK	-2.02	-5.69