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Does gender matter for green behaviour: An empirical investigation with cross-country data from the Enterprise Surveys

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Does gender matter for green behaviour.

**An empirical investigation
with cross-country data from
the Enterprise Surveys**

Camilla Jensen

SECO WORKING PAPER 2023: 2

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ABSTRACT

Using firm-level data from the World Bank's Enterprise Surveys, the paper investigates, across 8 European and Central Asian countries, the hypothesis that female entrepreneurs are more likely to exhibit green behaviour, by adopting new and more environmentally friendly and/or energy efficient technologies (ecopreneurship). Across several dependent variables, it is shown that women demonstrate a higher propensity to act in such ecopreneurial ways. However, it is a paradox, that for the former socialist country part of the sample, gender has been mainstreamed, in terms of both ownership and management shares (approaching gender equality or neutrality in firms), but this does not have an overall positive impact on greening the technology adoption rates. The study shows that, as gender participation is mainstreamed, or by subjecting traditional female values to male institutions of professional management, so is behaviour.

AUTHOR

Camilla Jensen is an Associate Professor for the Department of Social Sciences and Business, at Roskilde University. She is an interdisciplinary economist and social science researcher trained originally in cultural studies and comparative economic history. Camilla has a strong background in quantitative methods, obtained over time through learning-by-doing, teaching, experience and by studying for diplomas in panel data analysis and data science more broadly. In her research she conducts policy evaluations using panel data-based research designs. The focus is on topics in international and sustainable trade, such as the impact of institutions and policies on long run economic outcomes (technological change). Most of Camilla's research to date has been concerned with the challenges of reincorporating the former socialist countries into the global trading system.

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Does gender matter for green behaviour.
An empirical investigation with cross-country data from the Enterprise Surveys
Camilla Jensen

1. Introduction

Does gender matter for green behaviour? A recent study, among more than 1,000 students in the Basque country, suggests that women are more likely to adopt pro-environmental strategies in different situations (Vicente-Molina et al., 2018). But knowledge about such ‘ecopreneurial’ behaviour (short for ecological entrepreneurship and defined as new initiatives to reduce the environmental impact of business activities), is scarce and scattered according to another recent article (Gunawan et al., 2020).

The paper seeks to investigate the role of gender in ecopreneurship, in a cross-country perspective, using the World Bank’s Enterprise Surveys. The background theory to the research is institutional theory (DiMaggio and Powell, 1983; Hall and Soskice, 2001; Gregory and Stuart, 1999). Both formal and informal institutions must be expected to exert influence on ecopreneurship or green behaviour, in relation to the adoption of new technologies. Also, pure economic factors, such as energy consumption, economies of scale of firms (or firm size), can influence the propensity of firms to adopt new and more sustainable technologies. But, besides these factors, that are treated as controls in the research, is there a systematic relationship between gender and technology adoption across different countries?

1.1 Summary of results

In a robust investigative framework (a.o. applying sampling weights supplied with the surveys and factor analysis as both a device of construct determination and as a data reduction technique), and thanks to the presence of rich data from the Green Module under the World Bank’s Enterprise Surveys, it is possible to generate data for the latent constructs (defined as a variable that is hidden in the mind of survey respondents) of formal and informal institutions. Across the eight country cases investigated in this paper (Azerbaijan, Italy, Kyrgyz Republic, Lithuania, Portugal, Slovenia, Tajikistan and Turkiye), the research shows that females exhibit a higher propensity to adopt more energy efficient and/or environmentally concerned technologies in firms across Europe and Central Asia.

The investigative framework is driven in-part by factor analysis as a data reduction tool, but there are advantages and disadvantages to this technique. When adopting the factor scores, both for dependent (measuring any and all environmentally concerned solutions) and independent variables, the exact effect size for gender cannot be ascertained.

Across the countries studied, women are more likely to adopt both new technologies, any energy efficiency improving technologies, and ‘any and all’ environmentally concerned solutions in firms

owned and/or governed by them. But the results also demonstrate that, in the former socialist countries, this type of gendered behaviour has been mainstreamed, but in a neutralising way, whereby the socialist system has not led to any additional ‘positive’ impact for the natural environment, due to such mainstreaming. The potential underlying causes of this result are numerous, as also discussed in the last section of the paper.

1.2 Structure of the paper

Section 2 introduces institutional theory and provides for a simple conceptual framework. Section 3 offers a review of the studies, investigating the role of gender in situations of technology adoption decision-making, whether in households or organisations, and when related with the natural environment and/or energy efficiency. Section 4 accounts for the research design and methodology, starting with the selection of country cases to be studied with the Enterprise Surveys, and then moving to discuss the data and the variables selected from the Surveys in this research. Section 5 explains the derivation of factor variables (latent constructs), used in the subsequent econometric models. Section 6 briefly introduces the model-driven parts of the methodology. Section 7 summarises the results country-by-country. Section 8 combines all the datasets in one overall empirical model, towards investigating the possible cross-country aspect to gender and ecopreneurship, and through adoption of various robustness checks. Finally, section 9 discusses the results and offers theoretical and practical perspectives, derived from the research.

2. Theory

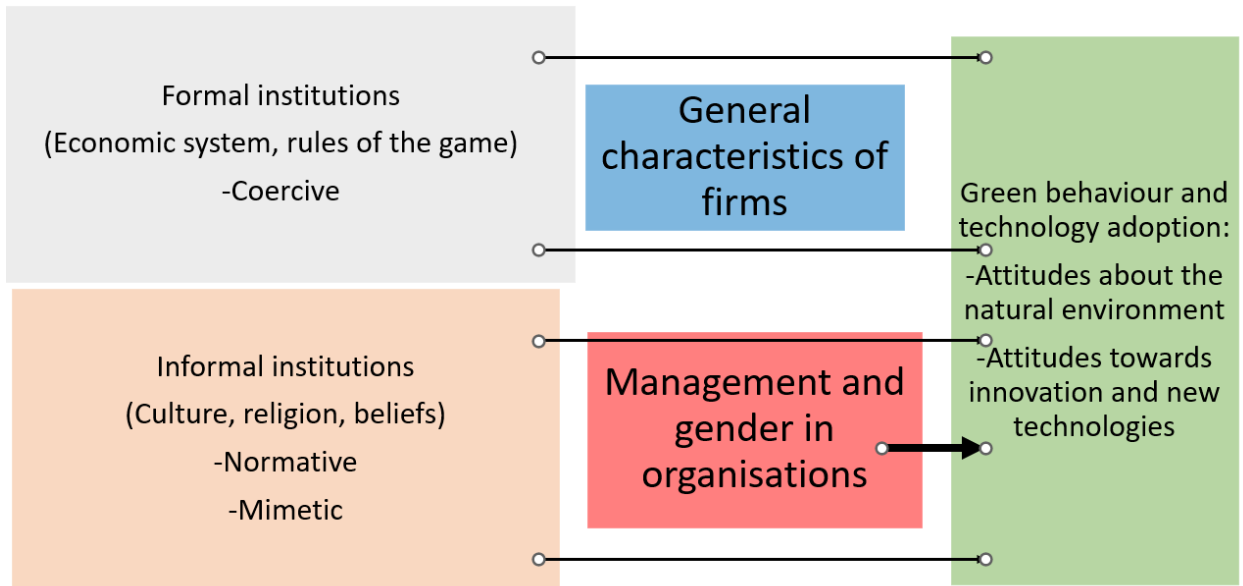
The specific methodology adopted concerns deriving three factors in a confirmatory (theory-driven) factor analysis. The factors can account for the latent constructs, that we, in institutional theory, associate with the informal and formal institutions (rules of the game) in a firm’s operating environment. Theory on decision-making in organisations, advances that each of these forces of institutions, what is also termed coercive, mimetic and normative (DiMaggio and Powell, 1983), will place a pressure on firms to conform with their operating environment.

DiMaggio and Powell (1983; 2000) termed, in their work, the effect that the operating environment exerts on firms to conform, ‘isomorphism’. In combination with the reinforcement through the mimetic pressure (or pressure for sameness through imitation across firms), it means, that the tendency for firms to become more similar over time is greatly intensified, leading to less and less organisational diversity. This could result then in a race to the bottom, where economic factors or the pure drive for competition and efficiency, without concerns for external and indirect effects, take over and drive industries towards unsustainable positions (both geographically and in their innovatory trajectories), driving them, eventually, to a developmental standstill. But DiMaggio and Powell (1983) suggested that the pressure for conformity, generally, will overshadow other concerns of firms that mainstream economic theory emphasise, such as the drives for competition and efficiency.

Nevertheless, institutional theory has many different traditions and strands in economics that are both overlapping and competing with the institutional theory proposed by DiMaggio and Powell. For example, neoclassical economic theory operates with other classifications of institutions, as pointed out by North (1989), who also has emphasised the difference between the formal and informal institutions. Arrow's work on institutions, derived from the law and economics perspective of Coase (Arrow et al., 1996), has focused on property rights and rent-seeking behaviour. Acemoglu and Robinson (2012), in *Why nations fail*, emphasise inclusive (political) and extractive (rent-seeking) institutions. Hall and Soskice's work (limited also to the Western context of institutional setting), has focused on varieties of capitalism across the continent, the UK and the US, with concepts such as co-ordinated and liberal market economic systems. The comparative economic system tradition is also distinct in this respect and offers a more universal, helicopter perspective on institutions, but it is still often confined to be developed for the specific dichotomy of socialism versus capitalism (Gregory and Stuart, 1999). Here, the tradition has been to label institutions on four dimensions (co-ordination, ownership, information and incentive structure), but failed for example to integrate the influence of political institutions until very recently and did not pay much attention to gender.

Regarding pro-environmental behaviour and the decision-making surrounding these concerns, the research makes the case for the isomorphic hypothesis advanced by DiMaggio and Powell (1983), to be the most relevant in terms of underlying the modelling framework in this research (see Figure 1a below for a conceptual framework). The theoretical perspective adopted here is, therefore, that gender is to be treated separately from the model set-up, i.e. the existing economic institutions and the influence of ecofeminism (whether grounded in evolutionary theories of selection, biology, sociology, culture or behavioural psychology), are external to the way we normally think of the influence formal and informal economic institutions exert on behaviour in economic theory. Perhaps, that is also because the theory has been entirely developed by men. All the above-mentioned theories are silent on such aspects of diversity (Ely and Meyerson, 2000; Johnson et al., 2020).

Figure 1a: Conceptual Framework



See also the conceptual framework re-represented under methodology in Section 4 referring to this discussion about separating the influences of the different variables in relation to institutional theory.

3. Literature review

Many studies on technology adoption take a focus on agriculture in developing countries (including gender issues), but it is beyond this short review to relate to that specific literature. The focus here is on recent studies concerning technology adoption of energy saving and/or environmentally concerned technologies (green behaviour broadly conceived) where gender was a primary or secondary (control) variable. Given the limited research available in organisational studies, it was decided also to include research of a similar nature at the level of individuals and households.

Lee et al. (2013) studied the role of gender in suburban household consumption of energy-efficient lighting in the United States. Women in their research demonstrated higher willingness to pay and engagement in energy-saving practices. Yet no gendered difference emerged in actual consumption decisions according to Lee et al. (2013). The research suggested that it was more the underlying beliefs and attitudes of women rather than psychological traits (such as egoistic values), that was the reason for their pro-environmental concerns and green behaviour. In a very large and gender balanced sample of 1,089 university students in the Basque country, Vicente-Molina et al. (2018) find that women are more strongly inclined to exhibit, what they term, pro-environmental behaviour. However, their models (all based on intent rather than de facto behaviour), also suggest, that men are more likely to be impacted by policies and interventions designed to change or impact individual values, beliefs and behaviour.

Gunawan et al. (2020), in their literature and meta-study of ecopreneurship and gender, confirm that many studies treat gender not as a main variable, but more as a casual control variable. This can be a hindering factor for drawing strong conclusions from available empirical literature on gender biases in green technology adoption. Their meta-study concludes that male and female ecopreneurs are driven by different motivations. Women are more likely to exhibit pro-environmental behaviour that reflects their personal, ecological, social, and family values. Oppositely, men are more likely to be driven by rational economic factors when making decisions about ecopreneurship.

A study on adoption of solar energy among private households in Ethiopia, by Guta (2018), showed that male headed households were less likely to adopt renewable-based technologies, such as solar, in comparison to the female headed households (of which there were only 12% in Guta's random sample). Nabaweesi et al. (2023) found the opposite (male headed households more likely to adopt) in a research of household adoption of solar energy technology in Uganda, using a Heckman model, that considers both the willingness and urgency to adopt renewable technologies. For heat-pumps, a similar question of technology adoption was investigated across Chinese households by Jingchao et al. (2018). The authors' general finding is that in hill and mountain areas in China, closer to nature (than in the plains), the propensity of households to adopt green technologies, such as heat-pump technology, is higher. Female-led households were also more likely to install heat-pumps, but there is a strong correlation between living close to nature and being a female-led household, as well in the research conducted by Jingchao et al. (2018).

The organisational literature has mainly approached research questions related to green innovation and technology adoption, in the top-down perspective of gender diversity on boards (Khan et al., 2021). For example, a recent, but highly cited study by Konadu et al. (2022), find that gender diversity on boards of directors can be an important driver towards improving the carbon footprint of organisations and that innovation plays an intervening role. Other similar studies according to Khan et al. (2021) reflect quite similar findings or impacts of board of directors' diversity on green management practices.

One problem in these organisational studies can be that both factors (i.e., diversity on boards of directors and more green management practices such as adoption of energy preserving technologies) may be co-determined by third factors, such as the propensity of firms to adopt voluntary environmental standards (i.e., Environmental, Social and Governance (ESG) standards or other similar corporate social responsibility practices). It is therefore questionable whether many of the findings in the management literature with respect to gender issues, are robust towards understanding agency or decision-making with respect to technology adoption. Here, the more economic grounded literature has prevailed, and has been focused on cost perspectives in the investigative framework. There is, for example, a relatively large available literature in economics on the energy-efficiency paradox (referring to the empirical fact that the diffusion of energy conserving technologies is much slower than what pure economic rationality concerns or relative costs would seem to dictate) (see i.e. Jaffe and Stavins, 1994a; 1994b; Popp et al., 2010), related to this type of decision-making households and, to some extent, also in firms. Yet, the technology

adoption problem has not been studied widely in this tradition either, and not in a broader lens of institutional theory or gender biases in decision-making from within organisations.

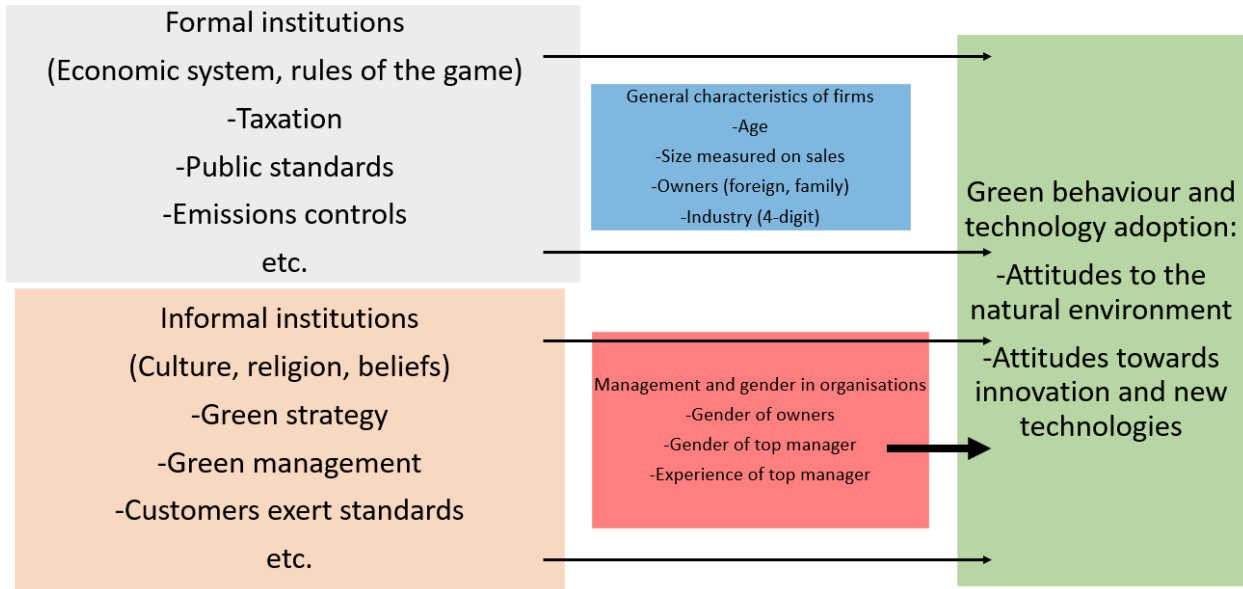
Across a variety of studies on technology adoption and gender, the review, therefore, finds resonance in the review by Gunawan et al. (2020). It suggests that there is only weak evidence as to whether gender, more generally, plays an important role for decision-making, and when it comes to adopting new and more climate friendly and/or environmentally concerned technologies. Most of the available studies, that have singled out agency or decision-making by gender, focus on individual contexts and specific situations, often household or non-professional situations, and where results may also be impacted by skewed samples or the problem of general under-representation of women in the actual decision-making process. Few studies, at the level of organisations, have singled-out decision-making or agency by gender and are, therefore, only of weak relevance towards contextualising the present research results.

4. Methodology

4.1 Operationalisation

In the perspective of the present paper, institutions translate into observed variables with the Enterprise Surveys, such as regulations, taxation and standards (formal institutions). Whereas the normative and mimetic, or informal, is more difficult to observe directly with the Enterprise Survey data. For these aspects of institutions, it is therefore necessary to rely on variables measuring these indirectly through management, strategy, and pressure from customers. The informal institutions or normative coercion is best measured with the variable about the perceived exertion, that managers express customers place on them in terms of what are the acceptable environmental standards. Oppositely is the energy consumption of the firm, considered to be a 'pure' economic factor, but also co-determined by the general economic environment or economic system including energy system, that the firm operates within. Other firm-specific variables, such as firm size and industry belonging (simple control variables) are not used towards creating the latent constructs. See also the final (applied) conceptual framework informed by institutional theory in Figure 1b.

Figure 1b: Conceptual Framework



4.2 Selection of country cases

The country cases are selected from the Enterprise Survey pools of data. The Green Module was implemented during the period 2018 - 2020 but was dropped and possibly overshadowed by issues related to the recent pandemic since 2021. The Green Module is available for approximately 40 countries in the Middle East, Central Asia, Europe and North Africa regions during this period (Kalantzis et al., 2022). This research focuses on European and Central Asian countries. A follow up study could later be conducted to broaden the perspective towards other world regions (such as Latin America, Africa and South-East Asia). All the surveys used in this research were conducted in 2019.

Figure 2 shows the plotted share in renewables against GDP per capita (in 2019) for some of the European and Central Asian countries (subject to the availability of information about the share of renewables in total energy consumption from the World Development Indicators dataset). The idea with a comparative case study (here conducted at the country level through selection of the most relevant Enterprise Survey samples, see also Blatter and Haverland, 2012), is to choose cases that exhibit maximum variance on these underlying macro-institutional differences. In the context of the present research such differences are identified to be income level (GDP per capita), and energy system (captured in Figure 2 with renewables, even though other aspects of the energy system such as self-sufficiency and export capacity in fossil fuels, are important as well). Other relevant aspects of institutions that can be ‘controlled’, through conducting a study of comparative cases, include religion and economic system.

Figure 2 demonstrates, on the first two macro-institutional dimensions (energy system and income level), how cases are selected in the pool of availability. The selection of cases seeks to maximise, as much as possible, the size of the red circle on these two dimensions. Other important sources of

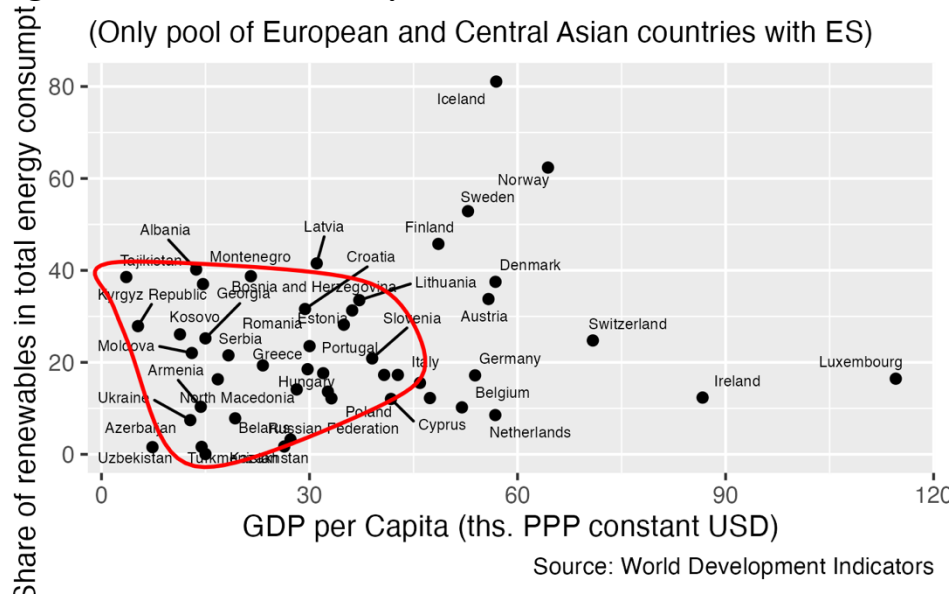
macro-institutional variation include religion. Here Italy, Lithuania and Portugal predominantly adhere to the Catholic faith, whereas the Kyrgyz, Tajik and Turkish populations are predominantly of Muslim faith. Finally, in the Azari and Slovene populations the modern or institutionalised religions play a limited role in society.

In terms of economic system, Portugal, Turkiye and Italy are more similar (with predominantly market-economic systems), whereas Azerbaijan, Lithuania, the Kyrgyz Republic and Tajikistan were part of the Former Soviet Union (and therefore followed a quite radical form of socialist planning system - see Kornai, 1992). Slovenia was part of Yugoslavia, which also belonged to the Eastern Bloc, but was never contained by the Soviet Union. Upon transition, Slovenia quickly fell back to its institutional roots in the Julian Alps between Austria, Hungary and Northern Italy.

There is a stark contrast between the rest of the countries and Azerbaijan and Tajikistan in several aspects of their energy systems. According to data published in the World Development Indicators datasets, fuel pump prices are less than half those of Europe in both countries. But, while Azerbaijan relies on oil rents and is self-sufficient, including relying on oil-based electricity, Tajikistan has a very clean system and uses mostly hydropower to produce electricity. Overall, this also means that due to the ‘behind the scenes’ green transition in Tajikistan (thanks to a conversion of the energy system as a whole), it places less urgency on individual decision-makers. The opposite is true in the case of Azerbaijan. In many respects these two cases must be considered as outliers in the sample.

Ideally, at least two protestant countries from Northern Europe should have been included in the research as well (such as Norway, Iceland, Sweden, United Kingdom or Denmark). However, Enterprise Surveys are only very rarely available for the high-income countries (such as is the case for Italy and Portugal), no additional cases were found in the pool of Enterprise Surveys from the relevant period (2018 - 2020) and with inclusion of the Green Module.

Figure 2: Selection of country cases



4.3 Introducing factor analysis as a data reduction tool

Several strategies for strengthening the validity of using the survey data are available. The research uses factor analysis to combine survey items into latent variable constructs, but there are multiple reasons why factor analysis can be ideal to use with the survey data (see the section on the generation of factor variables). In addition, limits of sampling sizes, and the challenges it poses for validity, can be alleviated by pooling the country cases into a larger research design. The research is built around such comparisons as well. Without factor analysis it would be difficult to implement the theory or conceptual model when pooling the data across countries with very different institutions and energy systems. In the reporting and due to the bottom-up nature of the research design, it is, therefore, considered important to report the results, both on a country-by-country basis and for the pooled data or combined results of the 8 cases (controlling then directly for country differences with a simple country dummy, but indirectly also because the factor analysis has generated scores that are specific enough and, therefore, flexible to handle institutional difference in a cross-country study).

The next sections now turn to selecting the relevant variables out of the surveys.

4.4 Data

All the data used in the research comes from the World Bank's Enterprise Surveys (see also section on selection of country cases). A full explanation of each variable (including the survey wordings) is given in the Appendix. Even though many relevant survey items are not selected due to limited availability (missing observations) and/or relevance, most of the potential explanatory variables, capturing formal and informal institutions, are overlapping. Therefore, factor analysis is used as a data reduction technique.

Depending on the country, missing observations lead to a reduction in the datasets, between 25-50% in most of the cases, but more severe in the case of Tajikistan (reducing the number of observations by 75%) and Azerbaijan (reducing the number of observations by 63%). (See also Table 3). The statistical results reported in this research, are after the deletion of rows with missing observations for any of the included variables.

4.5 Selected descriptive statistics for the country cases

This section briefly introduces several variables by country cases. Descriptive statistics are provided for the most important explanatory or independent variables in Table 1 and for the dependent variables in Table 2. A correlogram (Figure 3) is also drawn in combination for the variables presented in Table 1 and the dependent variables (Table 2). Table 3 reports Cronbach Alpha (capturing data reliability) for the survey items underlying all the dependent and independent variables used in the research, respectively, and includes information about the original size of each dataset, before removing rows with missing information.

Table 1: Descriptive statistics, gender variables

Country	Number of obs.	Mean (SD)				
		Family owned	Female owned	Female majority	Top Manager experience	Top Manager female
Azerbaijan	84	0.52 (0.50)	0.11 (0.31)	0.10 (0.30)	17.05 (9.38)	0.14 (0.35)
Italy	484	0.62 (0.49)	0.19 (0.39)	0.07 (0.25)	28.41 (13.20)	0.10 (0.31)
Kyrgyz Rep.	201	0.24 (0.43)	0.45 (0.50)	0.22 (0.42)	19.25 (13.43)	0.25 (0.44)
Lithuania	264	0.72 (0.45)	0.42 (0.50)	0.18 (0.38)	18.68 (9.55)	0.28 (0.45)
Portugal	743	0.75 (0.43)	0.42 (0.49)	0.10 (0.30)	30.24 (12.02)	0.13 (0.34)
Slovenia	230	0.70 (0.46)	0.45 (0.50)	0.12 (0.33)	21.21 (10.51)	0.20 (0.40)
Tajikistan	89	0.30 (0.46)	0.19 (0.40)	0.07 (0.25)	17.15 (12.11)	0.08 (0.27)
Turkiye	802	0.57 (0.50)	0.14 (0.35)	0.06 (0.24)	23.87 (11.94)	0.06 (0.24)
Overall	2,897					

Source: World Bank Enterprise Surveys

Table 1 shows the variation in levels of female entrepreneurship/ownership/top management of firms in the 8 country cases. The share of female owners *Female* is lowest in the Tajik and Turkish samples, and highest in the samples from most of the other former socialist countries (Kyrgyz Republic, Lithuania and Slovenia). But inheritance laws may also play a role, for example, both Portugal and Lithuania have high shares of family held firms in combination with high female ownership shares.

According to the Correlogram in Figure 3, all the gender variables directly capturing female participation in firms are moderately to highly correlated (with coefficients around 0.4 - 0.6). The preferred variable in the research, capturing gender in organisations, is the simple *Female* dummy, but robustness checks are made also by using the other variables. However, introducing several of these variables in the same equation is avoided, due to the high degree of correlation among them (causing multicollinearity).

Table 2: Descriptive statistics, dependent variables (technology adoption)

Country	Number of obs.	Adopt_tech_mach, Mean (SD)	Adopt_any_EE, Mean (SD)	Adopt_all_EC, Med. (Range)
Azerbaijan	84	0.33 (0.47)	0.13 (0.40)	-0.38 (4.38)
Italy	484	0.37 (0.48)	0.37 (0.48)	-0.52 (2.85)
Kyrgyz Rep.	201	0.45 (0.50)	0.34 (0.47)	0.08 (3.41)
Lithuania	264	0.37 (0.48)	0.40 (0.49)	-0.43 (4.22)
Portugal	743	0.54 (0.50)	0.47 (0.50)	-0.33 (3.96)
Slovenia	230	0.53 (0.50)	0.43 (0.50)	-0.36 (4.24)
Tajikistan	89	0.39 (0.49)	0.52 (0.50)	-0.48 (3.59)
Turkiye	802	0.25 (0.44)	0.23 (0.42)	-0.49 (4.44)
Overall	2,897	0.40 (0.49)	0.36 (0.48)	-0.46 (5.10)

Source: World Bank Enterprise Surveys

Table 2 shows descriptive statistics for the dependent variables. Note that the variable *Adopt_all_EC* is generated using factor scores (more details below), why it is rendered as a standardised variable with mean 0 and variance 1. Hence, it follows a slightly different distribution than the other dependent variables but captures in essence the same yes/no (y/n) dimension of whether the firm has decided to adopt a certain type of technology. All the dependent variables are moderately to highly correlated (with a coefficient around 0.4 - 0.6) - see the Correlogram in Figure 3.

One of these dependent variables *Adopt_tech_mach* serves as a ‘control’ or background dependent variable - to investigate whether there is any difference in behaviour, when it comes to the adoption of new technologies, more generally, and the adoption of green technologies (see also a screenshot of these survey items in the Appendix). Since there are many and internally consistent dependent variables available, factor analysis is used as a data reduction technique to generate a single dependent variable from all these items (as shown in Figure A1.1 in the Appendix). The only exception being the last item on technology adoption in the questionnaire *Adopt_any_EE*, which is a rephrasing of the previous questions using the wording (see Figure A2): ‘Over the last three years, did this establishment adopt any measures to enhance energy efficiency?’ The variable *Adopt_all_EC* has been generated by applying factor analysis with a single factor for all the survey items listed in Figure A1.2. The shown statistic is for the factor score (which is a composite variable obtained through the factor analysis and the factor loadings) generated using Bartlett’s method. The specific factor loadings for each country are also rendered in the Appendix.

For each of the country cases studied, the internal validity (checking the internal consistency in terms of reliability of the data) of the survey data was ascertained calculating Cronbach's Alpha¹. These results are shown in Table 3. Here, it is important to conduct the test separately for different groups in the data, such as the binary y/n variables, that go towards the dependent or independent variables. The data validity score varies from around 0.60 for the Kyrgyz Republic to 0.76 for Italy. Differing country and sample sizes may also affect these numbers. The validity score (Cronbach's Alpha) is typically lower for the independent variables relative to the dependent variables, but this is to be expected, as different scales are used for the explanatory variables (which also measure a variety of things and not only on Likert type of scales) relative to the ones the research seeks to explain (the latter are solely binary variables measuring whether a firm has adopted a certain type of technology). The dependent variables are found to be measured consistently across all the country cases with the least reliable being still close to 0.8.

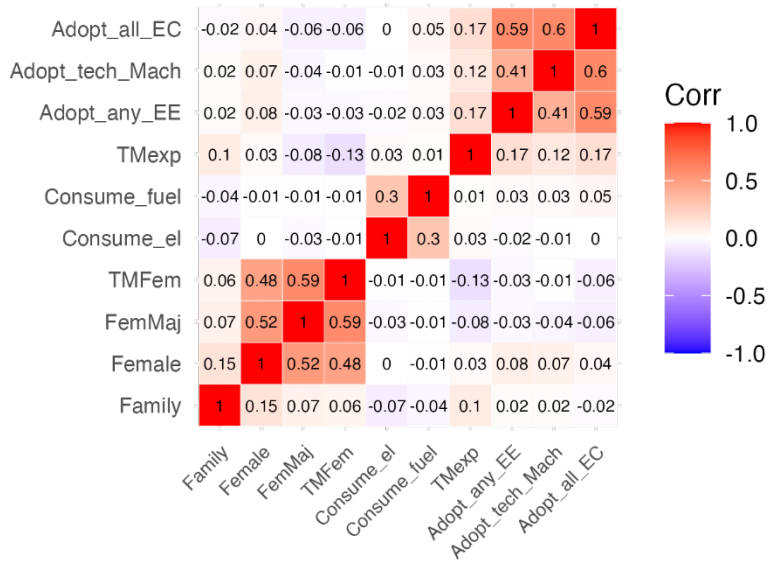
Table 3: Data validity assessment statistics

Country	Cronbach's Alpha, Indep.Vars.	Cronbach's Alpha, Dep.Vars.	Full dataset	Missing obs. %
Azerbaijan	0.47	0.80	225	63
Italy	0.75	0.93	760	36
Kyrgyz Rep.	0.60	0.84	360	44
Lithuania	0.64	0.83	358	26
Portugal	0.72	0.79	1,062	30
Slovenia	0.60	0.81	409	44
Tajikistan	0.58	0.85	352	75
Turkiye	0.63	0.84	1,663	52

Source: World Bank Enterprise Surveys

Figure 3: Correlogram to Tables 1 and 2

¹ Cronbach's alpha is a test developed to check if multiple questions on Likert scales, typically used in surveys, are reliable. It takes a value between 0 and 1, where a higher value reflects a higher degree of internal validity in the survey scores. Typically, a Cronbach alpha more than 0.5 - 0.6 is considered acceptable. Cronbach's alpha will tell you how closely related a set of test items are as a group. It is an assumption underlying the test that the scores are unidimensional (answers all refer to the same latent construct and go in the same direction positive or negative on the scale in usage). If this assumption is violated, the test must be interpreted with care and it may be necessary to subdivide the survey items into smaller groups to make a sensible test (Tavakol et al., 2011).



Other important caveats, pertaining to data and methodology of the research concerns, omitted variable biases and the time order of the different variables.

The study seeks to control for as many relevant variables as possible, given the availability of data. For example, control is made both for family ownership and experience of top managers. Therefore, ensuring that these factors could not be wrongly ascribed to the effect-size for the gender variable (i.e. if women have more experience or education relative to men in their roles, see for example Blau and Kahn, 2007). Omitted variable biases is a common problem in cross-sectional research on gender pay differences in economics (for an extensive review see Alkadry and Tower, 2011). However, it is also important to note that there is a difference between the dependent variable in this study, which refers to the agency of the person or manager of the firm him- or herself, whereas in studies of, for example gender pay differences, the agency effect is that of ‘others’.

Owing also to the cross-sectional nature of the dataset (with a time frame between 2016 - 2019), the time order is relatively weak to argue for strong causality in the research. All the dependent variables in the research were collected using questions that refer to the last three years, whereas many of the explanatory variables refer to the latest financial year (which in the time perspective of the present research could be 2017, 2018 or 2019, depending on the individual firm respondent and, even though all the Enterprise Surveys used here were conducted during 2019). However, with respect to the main variable (gender), it can safely be argued that gender could cause decisions about technology adoption, but the reverse could never be true.

As mentioned in the introduction to this part, many of the explanatory factors capturing institutions are better represented using factor analysis. Because individually many of the relevant survey items, while highly relevant to the research, cover only partial aspects of the research constructs we have in mind, such as formal institutions (laws, regulations, taxes), informal institutions (culture, beliefs and mimetic behaviour) and pure economic factors (the energy cost of firms which is labelled *Consume_el* and *Consume_fuel* in the Correlogram in Figure 3). Therefore, factor

analysis is used as a data reduction technique. The process of generating the factor scores is explained next.

5. Generating factor variables (factor scores)

A first step in generating the factor scores is to run Bartlett's test. It investigates the hypothesis that the variances across the potential explanatory variables exhibit a high degree of homogeneity or covariation. Across the country cases, the test value is highly significant (this statistic is reported in the Appendix, along with the output from the factor analysis) for both the set of independent and dependent variables discussed above (demonstrating that factor analysis is highly relevant to apply to this dataset).

The second step is to generate the factors based on different rotation techniques and assumptions about the number of factors inherent in the data. As there are prior or theoretical conceptions about the constructs looked for (informal institutions, formal institutions, and economic factors), confirmatory factor analysis is the more relevant method (for an introduction see Kim and Mueller, 1978). Hence, it is assumed, that there will be 3 factors (formal and informal institutions and economic factors) inherent in the data. This can also be tested but is only done here ex-post and in an evaluating manner.

In the Appendix, the output of the factor analysis is shown for both the independent variables (Factor 1, Factor 2 and Factor 3), and the composite dependent variable (Adopt_all_EC). The assumption, that there is only one factor needed for the composite dependent variable, is strongly confirmed across all eight countries. On the other hand, results vary for the confirmatory factor analysis with respect to the assumption that there are 3 factors inherent in the data for the explanatory variables. To reiterate, it is expected that informal institutional factors, such as the exigencies of customers on firms' load on to the first factor (that is named Factor 1 in the regressions). Formal institutions, such as regulations, taxes and standards, load on to the second factor (Factor 2). Finally, that economic factors, such as energy consumption loads on to the third factor (Factor 3). However, in practice, there are considerable differences for these factor loadings by country case. The eigenvalues (the total amount of variance explained by a given factor) also differ across the eight countries.

The results for Lithuania and Turkey come closest towards confirming the assumption behind the factor analysis and are in, general, more in accordance with the theoretical assumptions for the market economies: Factor 1 reflects mostly informal institutions, Factor 2 the formal ones and finally Factor 3 captures important economic aspects not captured with the other variables, such as prior or current energy consumption with firms. In a total of 6 cases, the informal institutions load more strongly onto Factor 1, with Portugal and Slovenia being the exception. Here instead, economic factors take precedence and load more strongly onto Factor 1. Only in the case of Tajikistan higher energy cost gives a negative factor loading. But this may be due to the earlier discussed differences in energy systems across the country cases. Hence, across the country cases, we can only weakly assume that Factor 1 represents informal institutions such as organisational

culture, Factor 2 represents the coercive or formal institutions, such as public standards and energy taxes, while Factor 3 represents pure economic factors, such as energy consumption cost (which in practice will also be determined by the underlying energy system in each country).

Therefore, when adopting the three factor scores (Factor 1, Factor 2 and Factor 3) as explanatory variables in the regression analysis, it reflects that institutional factors are allowed to depend on firms perceiving them as relevant, in terms of affecting their behaviour (subjectively) and within their own context of economic operating environment.

6. Econometric models

The following two versions of the model are estimated in the paper. Equation 1 shows the standard specification, when using the underlying explanatory variables coded directly based on the responses to the survey. In contrast, Equation 2 is the collapsed version, where instead of using individual survey items, the factor scores are adopted as explanatory variables, as a data reduction technique. One advantage, thus, is that the influence of the original underlying variables may differ by country, but this also makes them more difficult to interpret in a cross-country comparison.

The intention is to estimate the models with a binomial logit model as shown. However, this is not feasible in combination with using the stratified sampling weights², published with the Enterprise Survey data. In a trade-off, it is therefore necessary to calculate the ordinary Gaussian estimators. Hence, the interpretation of the coefficients, as shown in the subsequent tables, is straightforward, however, with the usual caveat that they are based in a linear model and cannot be extrapolated beyond the dichotomy of the dependent variable (i.e. 0 - 1). Also, when a factor score is involved, there is no direct interpretation possible because the factors do not have a scale.

Equation 1:

$$\begin{aligned}
 Prob(Adopt_{X_i} = 1) = & \Phi(\alpha_0 + \beta_1 * Regulation1_i + \beta_2 * Regulation2_i + \\
 & \beta_3 * Prioritise_i + \beta_4 * Strategy_i + \beta_5 * Management_i + \beta_6 * Customers_i \\
 & + \beta_7 * Targeting1_i + \beta_8 * Targeting2_i + \beta_9 * Taxes_i + \beta_{10} * Standards_i \\
 & + \beta_{11} * \log(Consumeel_i) + \beta_{12} * \log(Consumefuel_i) + \beta_{13} * Capitalcity_i + \beta_{14} * \log(Sales_i) \\
 & + \beta_{15} * \log(Age_i) + \beta_{16} * Foreign_i + \beta_{17} * Family_i + \beta_{18} * Female_i + \beta_{19} * TMexp_i + \delta_j * ISIC_j + \epsilon_i)
 \end{aligned}$$

² The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country. See also <https://www.enterprisesurveys.org/en/methodology>.

Equation 2:

$$\begin{aligned} Prob(Adopt_{X_i} = 1) = & \Phi(\alpha_0 + \beta_1 * Factor1_i + \beta_2 * Factor2_i + \beta_3 * Factor3_i \\ & + \beta_4 * Capitalcity_i + \beta_5 * \log(Sales_i) + \beta_6 * \log(Age_i) + \beta_7 * Foreign_i \\ & + \beta_8 * Family_i + \beta_9 * Female_i + \beta_{10} * TMexp_i + \delta_j * ISIC_j + \epsilon_i) \end{aligned}$$

7. Country-level results (comparing country cases)

Table 4 shows the results from estimating Equation 1 across the four country cases studied. Firstly, results are shown for the background (or what is also considered a ‘control’) dependent variable *Adopt_tech_Mach* (did the firm adopt any machinery or equipment upgrades?). The results demonstrate the problem, inherent in the analysis, when using all the potential explanatory variables in the same equation. It is likely that, due to multicollinearity and the inherent overlap that there is between many of these explanatory factors of firms’ propensities to adopt new technologies, that they are crowded out and, hereby, rendered insignificant.

Only in the cases of the samples for Italy, Portugal and Turkiye (which are also larger), do we get coefficient estimates, where several of the expected explanatory factors are significant and of expected sign/size. At the same time, the R^2 suggests that the model is relevant and explains at least 40% or more of the variation in technology adoption across the four countries. Finally, the adjusted R^2 is penalised heavily by too many overlapping independent variables. However, the large differences between the R^2 and adjusted R^2 across all tables, are also due to the inclusion of 4-digit industry dummies. (As the Enterprise Survey samples are stratified by industry, it implies, often, the inclusion of in excess of 60 - 70 additional dummies in the equations (not shown in the tables).

Table 4: Results for background dependent variable without factor scores as regressors

	<i>Dependent variable:</i>							
	Adopt_tech_Mach							
	Azerbaijan (1)	Italy (2)	Kyrgyz Rep. (3)	Lithuania (4)	Portugal (5)	Slovenia (6)	Tajikistan (7)	Turkiye (8)
Regulation1	-0.367 (0.378)	0.007 (0.016)	0.073* (0.038)	-0.008 (0.029)	0.009 (0.022)	0.031 (0.033)	0.505*** (0.179)	-0.010 (0.014)
Regulation2	0.015 (0.031)	-0.004 (0.006)	0.003 (0.018)	0.006 (0.013)	0.012** (0.005)	0.013 (0.014)	0.034 (0.030)	-0.019*** (0.006)
Prioritise	0.099 (0.320)	0.002 (0.041)	-0.554*** (0.182)	0.148 (0.119)	-0.114* (0.067)	0.317** (0.127)	-0.187 (0.169)	-0.146 (0.091)
Strategy	0.279 (0.350)	-0.050 (0.060)	-0.054 (0.127)	0.604*** (0.148)	0.106 (0.068)	0.053 (0.129)	-0.232 (0.296)	-0.011 (0.057)
Management	0.879 (1.029)	-0.202** (0.097)	0.420** (0.169)	-0.389* (0.217)	0.498*** (0.114)	0.331 (0.204)	0.271 (0.299)	0.626*** (0.116)
Customers	0.357 (2.429)	0.136 (0.085)	-0.077 (0.105)	0.387 (0.247)	-0.011 (0.073)	0.174 (0.137)	0.516* (0.255)	0.203*** (0.050)
Targeting1	-1.079** (0.445)	0.254*** (0.054)	0.078 (0.114)	-0.053 (0.087)	-0.042 (0.068)	0.015 (0.105)	-0.218 (0.156)	0.134** (0.057)
Targeting2		0.423*** (0.079)	-0.409 (0.292)	-0.336** (0.160)	0.315** (0.149)	0.355* (0.206)	0.256 (0.399)	-0.036 (0.075)
Taxes	0.224 (1.210)	0.231*** (0.085)	0.112 (0.168)	0.090 (0.093)	-0.247*** (0.049)	0.026 (0.093)	-0.013 (0.162)	-0.103* (0.053)
Standards	1.403** (0.539)	0.109 (0.104)	-0.314** (0.144)	-0.216 (0.150)	-0.007 (0.204)	0.036 (0.113)	0.515*** (0.179)	0.092 (0.065)
log(Consume_el)	0.146** (0.070)	-0.010 (0.010)	0.040 (0.036)	0.035** (0.018)	0.036** (0.016)	-0.012 (0.026)	0.025 (0.028)	0.025* (0.014)
log(Consume_fuel)	-0.002 (0.017)	0.003 (0.005)	0.005 (0.010)	0.052*** (0.014)	-0.024*** (0.007)	-0.010 (0.019)	0.025 (0.018)	-0.028* (0.016)
Capital_city	0.045 (0.325)	-0.202*** (0.038)	-0.194 (0.129)	-0.304*** (0.078)	-0.481*** (0.035)	0.180** (0.088)	0.445*** (0.150)	-0.114 (0.075)
log(Sales)	-0.108* (0.055)	0.040*** (0.014)	0.057 (0.037)	-0.054* (0.029)	-0.004 (0.015)	0.015 (0.044)	-0.069* (0.038)	0.007 (0.015)
log(Age)	0.135 (0.168)	-0.057 (0.036)	-0.037 (0.104)	-0.171* (0.096)	0.038 (0.032)	0.035 (0.090)	-0.199 (0.221)	-0.131*** (0.044)
Foreign	-0.487 (0.369)	0.125 (0.106)	-0.071 (0.126)	0.030 (0.119)	0.156* (0.082)	-0.172 (0.125)	0.886** (0.345)	-0.196 (0.190)
Family	-0.057 (0.151)	0.030 (0.035)	-0.177 (0.111)	-0.126 (0.077)	-0.021 (0.040)	-0.266*** (0.095)	0.188 (0.175)	0.146*** (0.037)
Female	0.330 (0.280)	0.076* (0.039)	-0.036 (0.103)	0.048 (0.070)	-0.098*** (0.032)	-0.027 (0.076)	0.065 (0.192)	0.053 (0.051)
TMexp	-0.022** (0.009)	0.004** (0.002)	0.005 (0.004)	-0.008* (0.004)	0.002 (0.001)	-0.006 (0.005)	0.008 (0.008)	0.004* (0.002)
Constant	1.535 (1.109)	-0.611** (0.308)	-0.889 (0.778)	1.993 (1.263)	0.412 (0.336)	0.092 (0.607)	0.474 (0.812)	0.340 (2.371)
Observations	84	484	201	264	743	230	89	802
R ²	0.785	0.666	0.606	0.545	0.607	0.637	0.893	0.464
Adjusted R ²	0.423	0.551	0.271	0.284	0.523	0.334	0.639	0.361

Note:

*p<0.1; **p<0.05; ***p<0.01

Therefore, in Tables 5 - 7 we turn to the models based on Equation 2, that adopt the scores from the factor analysis instead. While Factor 1 captures informal institutions, Factor 2 captures formal institutions, and finally Factor 3 captures economic factors, such as energy cost (measured in local currency units), but also keeping in mind that the exact interpretation of the 3 factors is allowed to vary across the country cases studied.

The theory suggests that all the underlying variables should add to *exerting* pressure on firms to adopt new technologies in a 'positive' way. When a firm responds to the survey positively, having felt the presence of such a pressure on its actions and behaviour, we expect it to respond by innovating through technology adoption. Across the three tables is investigated the influence of the three factors, and then the variable of main interest, which is the dummy for the female gender (i.e. the dummy takes the value of 1 when the ownership group involves female participation).

Table 5 reports the results for the background dependent variable anew, but now with the factor scores as explanatory variables, then, in Table 6, for the dependent variable which measures whether the firm has adopted any measure to improve energy efficiency (over the last three years). Finally, in Table 7, are the results for the dependent variable measuring whether the firm has adopted all the measure combined to address concerns related to negative externalities (the last one not only pertaining to energy efficiency, but all broad categories of environmental concerns including pollution of air, water and soil.) The advantage of the latter measure, is again, that it is derived as a composite or latent (hidden) construct, whereby specific measures may differ across firms, but when measured in this way it can capture the concerted effort across all firms to combat such negative externalities with one single variable.

Across all three tables there is a considerable improvement in the model, in terms of the ability of the model to explain the propensity of firms to adopt new technologies. Results vindicate the importance of institutional factors in exerting pressure on firms to adopt new technologies, in general, and more energy efficient or less polluting technologies. Several of the control factors are also relevant (such as family ownership and the experience of the Top Manager) and now gender does play an important role in several of the country cases when investigated individually.

Summarising the evidence across Tables 5-7: In the eight country cases is the influence of female owners' decision on firms' propensity to adopt new green technologies in most cases positive (Azerbaijan and Slovenia the only exception to this pattern) and in the larger samples also significant. In a comparison with the background dependent variable, there is also a difference which is positive for females: making them more likely to exhibit traits of ecopreneurship.

Next is investigated if there is a general effect for the gender variable across samples when pooling all the country cases into one dataset.

Table 5: Results for background dependent variable with factor scores as regressors

		<i>Dependent variable:</i>						
		Adopt_tech_Mach						
	Azerbaijan	Italy	Kyrgyz Rep.	Lithuania	Portugal	Slovenia	Tajikistan	Turkiye
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Factor1	0.083 (0.094)	0.240*** (0.023)	0.048 (0.044)	0.104* (0.060)	0.014 (0.028)	0.048 (0.050)	0.100** (0.043)	0.107*** (0.018)
Factor2	-0.013 (0.094)	-0.193*** (0.056)	0.009 (0.038)	0.072* (0.037)	0.015 (0.022)	0.104** (0.043)	0.095 (0.068)	0.052** (0.023)
Factor3	0.159* (0.082)	0.151*** (0.018)	0.045 (0.034)	-0.017 (0.034)	0.127*** (0.024)	0.036 (0.030)	0.151** (0.069)	-0.033 (0.043)
Capital_city	0.213 (0.284)	-0.183*** (0.036)	-0.093 (0.124)	-0.289*** (0.082)	-0.451*** (0.033)	0.188** (0.083)	0.284* (0.145)	-0.130* (0.069)
log(Sales)	0.003 (0.045)	0.054*** (0.012)	0.119*** (0.029)	-0.003 (0.028)	-0.012 (0.013)	0.009 (0.040)	-0.005 (0.039)	0.014 (0.013)
log(Age)	0.175 (0.151)	-0.028 (0.035)	-0.061 (0.103)	-0.195* (0.099)	0.051 (0.032)	-0.008 (0.083)	0.350* (0.177)	-0.158*** (0.043)
Foreign	-0.366 (0.363)	0.104 (0.105)	-0.056 (0.121)	-0.078 (0.127)	0.148* (0.080)	-0.103 (0.121)	0.804** (0.374)	-0.117 (0.189)
Family	-0.038 (0.133)	0.032 (0.035)	-0.151 (0.103)	-0.113 (0.080)	-0.072* (0.039)	-0.217** (0.092)	-0.083 (0.164)	0.095*** (0.035)
Female	0.380 (0.265)	0.067* (0.038)	0.024 (0.097)	0.083 (0.073)	-0.100*** (0.033)	-0.033 (0.070)	-0.371** (0.166)	0.119** (0.051)
TMexp	-0.023*** (0.008)	0.004** (0.002)	0.007 (0.004)	-0.007 (0.005)	0.001 (0.001)	-0.004 (0.004)	-0.008 (0.007)	0.003 (0.002)
Constant	1.255 (1.027)	-0.822*** (0.304)	-1.601** (0.737)	1.830 (1.375)	0.757** (0.346)	0.235 (0.608)	-0.514 (0.742)	0.230 (2.456)
Observations	84	484	201	264	743	230	89	802
R ²	0.680	0.656	0.538	0.418	0.570	0.600	0.802	0.416
Adjusted R ²	0.319	0.549	0.210	0.131	0.486	0.316	0.502	0.312

Note:

* p<0.1; ** p<0.05; *** p<0.01

Table 6: Results for adopting any energy efficiency improvement with factor scores as regressors

	<i>Dependent variable:</i>							
	Adopt_any_EE							
	Azerbaijan (1)	Italy (2)	Kyrgyz Rep. (3)	Lithuania (4)	Portugal (5)	Slovenia (6)	Tajikistan (7)	Turkiye (8)
Factor1	0.040 (0.061)	0.366*** (0.025)	0.0004 (0.042)	0.114* (0.058)	0.054* (0.029)	0.070 (0.045)	0.146*** (0.050)	0.025* (0.013)
Factor2	-0.056 (0.061)	-0.135** (0.060)	0.019 (0.036)	0.244*** (0.036)	0.122*** (0.023)	0.151*** (0.038)	0.016 (0.078)	0.070*** (0.016)
Factor3	0.120** (0.053)	0.097*** (0.019)	0.080** (0.032)	-0.012 (0.033)	0.076*** (0.025)	0.088*** (0.027)	0.125 (0.079)	-0.016 (0.031)
Capital_city	0.257 (0.184)	0.012 (0.038)	-0.351*** (0.117)	0.052 (0.078)	-0.308*** (0.035)	0.047 (0.074)	-0.276 (0.167)	0.702*** (0.050)
log(Sales)	0.038 (0.029)	0.0001 (0.013)	0.020 (0.028)	-0.043 (0.027)	-0.018 (0.014)	-0.046 (0.036)	0.128*** (0.044)	0.035*** (0.009)
log(Age)	-0.096 (0.098)	-0.006 (0.037)	0.075 (0.097)	-0.106 (0.095)	-0.027 (0.034)	-0.085 (0.075)	0.294 (0.204)	0.090*** (0.031)
Foreign	-0.072 (0.236)	0.201* (0.113)	0.047 (0.114)	0.004 (0.121)	0.029 (0.085)	-0.115 (0.109)	-0.214 (0.431)	-0.338** (0.135)
Family	0.123 (0.086)	0.067* (0.037)	-0.159 (0.097)	0.123 (0.076)	-0.143*** (0.041)	-0.038 (0.083)	0.258 (0.189)	-0.030 (0.025)
Female	-0.188 (0.172)	0.123*** (0.041)	0.198** (0.092)	0.032 (0.070)	0.107*** (0.034)	-0.028 (0.063)	0.328* (0.191)	0.043 (0.037)
TMexp	-0.003 (0.005)	0.001 (0.002)	0.005 (0.004)	0.004 (0.004)	-0.0002 (0.002)	0.007* (0.004)	0.001 (0.008)	-0.002 (0.002)
Constant	0.628 (0.666)	0.137 (0.325)	-0.194 (0.695)	0.355 (1.317)	1.105*** (0.366)	1.861*** (0.546)	-1.700* (0.854)	-0.841 (1.762)
Observations	84	484	201	264	743	230	89	802
R ²	0.681	0.649	0.557	0.456	0.493	0.659	0.746	0.750
Adjusted R ²	0.322	0.540	0.242	0.187	0.394	0.417	0.361	0.705

Note: *p<0.1; **p<0.05; ***p<0.01

Table 7: Results for adopting all EC measures with factor scores as regressors and regressand

<i>Dependent variable:</i>								
Adopt_all_EC								
	Azerbaijan	Italy	Kyrgyz Rep.	Lithuania	Portugal	Slovenia	Tajikistan	Turkiye
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Factor1	0.085 (0.172)	0.660*** (0.035)	0.158* (0.083)	0.234** (0.106)	0.080 (0.053)	0.195* (0.100)	0.410*** (0.089)	0.419*** (0.021)
Factor2	-0.038 (0.171)	-0.242*** (0.084)	0.103 (0.071)	0.359*** (0.066)	0.193*** (0.041)	0.480*** (0.085)	-0.047 (0.141)	0.316*** (0.028)
Factor3	0.308** (0.149)	0.258*** (0.027)	0.226*** (0.064)	0.105* (0.060)	0.290*** (0.045)	0.103* (0.059)	0.279* (0.142)	0.063 (0.052)
Capital_city	0.134 (0.517)	-0.393*** (0.054)	-0.403* (0.231)	-0.561*** (0.144)	-0.569*** (0.062)	-0.172 (0.164)	-0.222 (0.300)	1.220*** (0.083)
log(Sales)	0.124 (0.083)	0.026 (0.018)	0.144*** (0.055)	-0.022 (0.049)	0.048* (0.025)	-0.058 (0.080)	0.073 (0.080)	-0.058*** (0.016)
log(Age)	-0.018 (0.275)	0.077 (0.052)	-0.436** (0.193)	-0.168 (0.175)	-0.013 (0.060)	-0.177 (0.164)	0.446 (0.367)	-0.046 (0.052)
Foreign	-0.695 (0.662)	-0.054 (0.158)	-0.222 (0.227)	-0.193 (0.223)	-0.021 (0.152)	-0.440* (0.239)	0.435 (0.776)	-1.272*** (0.228)
Family	-0.092 (0.242)	-0.024 (0.052)	-0.397** (0.193)	-0.073 (0.140)	-0.169** (0.073)	-0.371** (0.182)	0.224 (0.339)	0.198*** (0.042)
Female	0.975** (0.482)	0.178*** (0.057)	0.196 (0.182)	0.164 (0.129)	0.00000 (0.062)	0.078 (0.138)	0.002 (0.344)	0.087 (0.062)
TMexp	-0.022 (0.014)	0.001 (0.003)	0.033*** (0.008)	-0.019** (0.008)	0.002 (0.003)	-0.005 (0.009)	0.017 (0.015)	0.005* (0.003)
Constant	2.478 (1.870)	-0.790* (0.455)	-1.573 (1.377)	3.404 (2.424)	0.441 (0.657)	0.979 (1.202)	-2.354 (1.536)	0.373 (2.959)
Observations	84	484	201	264	743	230	89	802
R ²	0.781	0.758	0.640	0.537	0.490	0.636	0.819	0.904
Adjusted R ²	0.534	0.682	0.384	0.308	0.390	0.378	0.546	0.886

Note:

*p<0.1; **p<0.05; ***p<0.01

8. Combined results (combining country cases)

In Table 8, the eight country cases are stacked into one dataset. Equation 2 was re-estimated for each of the dependent variables for this full dataset, but now with the additional inclusion of a country-level dummy (Azerbaijan being the benchmark or omitted dummy). Consequently, it is possible to investigate for the general association between gender and technology adoption in the full sample.

Results show that across the three dependent variables, female gender, of owners and/or managers, is positively associated with technology adoption. The higher propensity among women to adopt

new and greener technologies appears to be strongest for the composite dependent indicator that captures all environmental measures. Across tables, and when interpretation is feasible, the gender effect for adoption rates is 7.7%, 7.8% and 10.7 % higher in firms owned, majority owned or managed by females respectively, but the coefficient estimates are not directly comparable for column 3 in these tables. Only in column 1 and 2 we can interpret the coefficient estimate as the deviation in the decision, of the female gender, to adopt green new technologies or more energy efficient technologies. The exact interpretation is more difficult in column 3 (for all environmentally concerned technologies), because the dependent variable is a factor score. For the combined sample, the effects are larger and more significant than in any of the underlying samples (results are reported in Section 7). These results, therefore, document that the propensity of women to adopt more green or environmentally concerned technologies could be universal for samples across Europe and Central Asia. For several reasons (such as the necessity to use a linear model and that the results across dependent variables are not directly comparable), the research design hinders a more precise interpretation of the effect sizes for some of the results. But for those results, where we can make inference, it can be concluded that the propensity of adopting green technologies is around 8 - 11% higher in firms owned and/or led by females, across samples of firms in Central Asia and Europe.

Table 8: Combined results across eight country cases

	<i>Dependent variable:</i>		
	Adopt_tech_Mach	Adopt_any_EE	Adopt_all_EC
	(1)	(2)	(3)
Factor1	0.170*** (0.009)	0.267*** (0.009)	0.633*** (0.014)
Factor2	0.033*** (0.011)	0.155*** (0.012)	0.496*** (0.019)
Factor3	0.095*** (0.008)	0.062*** (0.008)	0.206*** (0.013)
Capital_city	-0.186*** (0.016)	0.021 (0.016)	-0.214*** (0.026)
log(Sales)	0.024*** (0.005)	-0.023*** (0.005)	-0.057*** (0.008)
log(Age)	-0.005 (0.015)	0.042*** (0.016)	0.027 (0.026)
Foreign	0.104** (0.044)	0.141*** (0.045)	-0.044 (0.073)
Family	0.050*** (0.015)	0.065*** (0.016)	0.061** (0.026)
Female	0.051*** (0.017)	0.077*** (0.018)	0.145*** (0.029)
TMexp	0.002 [†] (0.001)	0.00004 (0.001)	0.002 [†] (0.001)
factor(Country)Italy	-0.242** (0.109)	0.292*** (0.111)	-0.203 (0.182)
factor(Country)Kyrgyz Republic	-0.128 (0.200)	0.307 (0.204)	0.052 (0.335)
factor(Country)Lithuania	-0.121 (0.115)	0.297** (0.118)	-0.234 (0.193)
factor(Country)Portugal	-0.150 (0.112)	0.259** (0.114)	-0.385** (0.187)
factor(Country)Slovenia	0.034 (0.116)	0.289** (0.118)	-0.184 (0.194)
factor(Country)Tajikistan	-0.158 (0.208)	0.416 [†] (0.213)	-0.334 (0.348)
factor(Country)Turkiye	-0.275** (0.110)	0.266** (0.113)	0.103 (0.184)
Constant	0.013 (0.175)	0.287 (0.179)	0.911*** (0.293)
Observations	2,897	2,897	2,897
R ²	0.468	0.498	0.664
Adjusted R ²	0.431	0.463	0.641

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 9a: Combined results across eight country cases with alternative gender indicator

	<i>Dependent variable:</i>		
	Adopt_tech_Mach	Adopt_any_EE	Adopt_all_EC
	(1)	(2)	(3)
Factor1	0.172 ^{***} (0.009)	0.268 ^{***} (0.009)	0.637 ^{***} (0.014)
Factor2	0.032 ^{***} (0.011)	0.154 ^{***} (0.012)	0.495 ^{***} (0.019)
Factor3	0.095 ^{***} (0.008)	0.061 ^{***} (0.008)	0.206 ^{***} (0.013)
Capital_city	-0.187 ^{***} (0.016)	0.021 (0.016)	-0.216 ^{***} (0.026)
log(Sales)	0.023 ^{***} (0.005)	-0.024 ^{***} (0.005)	-0.059 ^{***} (0.008)
log(Age)	-0.002 (0.015)	0.048 ^{***} (0.015)	0.036 (0.025)
Foreign	0.114 ^{***} (0.044)	0.156 ^{***} (0.045)	-0.014 (0.073)
Family	0.048 ^{***} (0.015)	0.065 ^{***} (0.016)	0.057 ^{**} (0.026)
TMFem	0.068 ^{***} (0.020)	0.078 ^{***} (0.021)	0.191 ^{***} (0.034)
TMexp	0.002 ^{**} (0.001)	-0.00004 (0.001)	0.003 ^{**} (0.001)
factor(Country)Italy	-0.238 ^{**} (0.108)	0.300 ^{***} (0.111)	-0.190 (0.181)
factor(Country)Kyrgyz Republic	-0.123 (0.200)	0.320 (0.204)	0.068 (0.334)
factor(Country)Lithuania	-0.114 (0.115)	0.311 ^{***} (0.118)	-0.213 (0.193)
factor(Country)Portugal	-0.136 (0.112)	0.281 ^{**} (0.114)	-0.343 [*] (0.187)
factor(Country)Slovenia	0.047 (0.115)	0.311 ^{***} (0.118)	-0.146 (0.193)
factor(Country)Tajikistan	-0.148 (0.208)	0.431 ^{**} (0.213)	-0.304 (0.348)
factor(Country)Turkiye	-0.267 ^{**} (0.110)	0.278 ^{**} (0.113)	0.127 (0.184)
Constant	0.013 (0.175)	0.288 (0.179)	0.913 ^{***} (0.293)
Observations	2,897	2,897	2,897
R ²	0.469	0.497	0.665
Adjusted R ²	0.432	0.462	0.642

Note: *p<0.1; **p<0.05; ***p<0.01

Table 9b: Combined results across four country cases with alternative gender indicator

	<i>Dependent variable:</i>		
	Adopt_tech_Mach	Adopt_any_EE	Adopt_all_EC
	(1)	(2)	(3)
Factor1	0.170*** (0.009)	0.268*** (0.009)	0.635*** (0.014)
Factor2	0.033*** (0.011)	0.156*** (0.012)	0.498*** (0.019)
Factor3	0.095*** (0.008)	0.063*** (0.008)	0.208*** (0.013)
Capital_city	-0.186*** (0.016)	0.017 (0.016)	-0.218*** (0.026)
log(Sales)	0.023*** (0.005)	-0.022*** (0.005)	-0.057*** (0.008)
log(Age)	-0.0001 (0.015)	0.049*** (0.015)	0.041 (0.025)
Foreign	0.112** (0.044)	0.155*** (0.045)	-0.019 (0.073)
Family	0.053*** (0.015)	0.065*** (0.016)	0.064** (0.026)
FemMaj	0.016 (0.022)	0.107*** (0.023)	0.153*** (0.037)
TMexp	0.001 (0.001)	-0.0003 (0.001)	0.002 (0.001)
factor(Country)Italy	-0.236** (0.109)	0.295*** (0.111)	-0.193 (0.182)
factor(Country)Kyrgyz Republic	-0.112 (0.200)	0.313 (0.204)	0.074 (0.335)
factor(Country)Lithuania	-0.106 (0.115)	0.311*** (0.118)	-0.201 (0.193)
factor(Country)Portugal	-0.134 (0.112)	0.283** (0.114)	-0.338* (0.187)
factor(Country)Slovenia	0.050 (0.116)	0.305*** (0.118)	-0.150 (0.194)
factor(Country)Tajikistan	-0.150 (0.208)	0.427** (0.213)	-0.312 (0.349)
factor(Country)Turkiye	-0.269** (0.110)	0.269** (0.112)	0.113 (0.185)
Constant	0.013 (0.175)	0.272 (0.179)	0.892*** (0.294)
Observations	2,897	2,897	2,897
R ²	0.467	0.499	0.663
Adjusted R ²	0.430	0.464	0.640

Note: *p<0.1; **p<0.05; ***p<0.01

8.1 Robustness checks related to the influence of socialism on gendered and green behaviour

Robustness checks on the above results were conducted in relation to the inheritance of the socialist system, because past economic systems and ingrained institutions may matter for gendered green behaviour and green behaviour, more generally, in these countries. First, the analysis was rerun only for the former socialist countries as a group (without Italy, Portugal and Turkiye) in the total sample. The results confirm that gendered behaviour is more mainstreamed in the socialist part of the sample (as reported in Table 10a for the part of the sample only pertaining to the five former socialist countries - Azerbaijan, Kyrgyz Republic, Lithuania, Slovenia and Tajikistan). In this part of the sample, there is still a positive, but weaker and now only insignificant, association between the gender of owners and/or managers and the likelihood that respondents say they have taken action to adopt greener technologies in the firms over the last 3-year period.

Given this result, it is natural to ask then, did the mainstreaming of green behaviour under socialism have a positive, neutral or negative influence on the mainstream? For example, did mainstreaming imply a positive spillover from females to males or vice versa?

Lastly, Table 10b of this research shows that, if there was a mainstreaming under the socialist systems of the past in Europe and Central Asia, the implication is that there is no general positive effect of such mainstreaming on overall green behaviour (because there is no positive deviation when inserting a dummy for the former socialist countries instead of a per country basis into Equation 2). This result is perhaps not surprising, in view to the many environmental problems, which also, in part, led to the demise of the socialist experiments in Europe and Central Asia. But the results could also owe to the type of industries and activities that have been promoted in the former socialist countries after they entered the global economy in the early 1990s. This is discussed further in the last part of the paper.

Table 10a: Results for the five country cases of former socialist countries

	<i>Dependent variable:</i>		
	Adopt_tech_Mach	Adopt_any_EE	Adopt_all_EC
	(1)	(2)	(3)
Factor1	0.094 ^{***} (0.022)	0.067 ^{***} (0.021)	0.285 ^{***} (0.041)
Factor2	0.067 ^{***} (0.019)	0.154 ^{***} (0.018)	0.372 ^{***} (0.035)
Factor3	0.0005 (0.015)	0.041 ^{***} (0.013)	0.110 ^{***} (0.027)
Capital_city	-0.039 (0.036)	0.002 (0.033)	-0.338 ^{***} (0.066)
log(Sales)	0.014 (0.013)	-0.014 (0.012)	0.001 (0.024)
log(Age)	-0.039 (0.043)	-0.047 (0.039)	-0.138 [*] (0.078)
Foreign	-0.159 ^{***} (0.061)	-0.055 (0.056)	-0.369 ^{***} (0.112)
Family	-0.118 ^{***} (0.040)	0.061 (0.037)	-0.144 [*] (0.074)
Female	0.051 (0.035)	-0.003 (0.033)	0.078 (0.065)
TMexp	-0.004 [*] (0.002)	0.005 ^{***} (0.002)	-0.006 [*] (0.004)
Constant	0.177 (0.287)	1.239 ^{***} (0.266)	0.014 (0.526)
Observations	868	868	868
R ²	0.334	0.382	0.449
Adjusted R ²	0.197	0.254	0.335

Note: ^{*} p<0.1; ^{**} p<0.05; ^{***} p<0.01

Table 10b: Comparative green behaviour across past economic systems

	<i>Dependent variable:</i>		
	Adopt_tech_Mach	Adopt_any_EE	Adopt_all_EC
	(1)	(2)	(3)
Factor1	0.182*** (0.008)	0.264*** (0.008)	0.661*** (0.014)
Factor2	0.029** (0.012)	0.154*** (0.011)	0.539*** (0.019)
Factor3	0.106*** (0.008)	0.061*** (0.008)	0.211*** (0.013)
Capital_city	-0.184*** (0.016)	0.019 (0.016)	-0.256*** (0.026)
log(Sales)	0.022*** (0.005)	-0.023*** (0.005)	-0.037*** (0.008)
log(Age)	0.033** (0.015)	0.046*** (0.015)	-0.001 (0.025)
Foreign	0.161*** (0.045)	0.147*** (0.044)	-0.094 (0.074)
Family	0.058*** (0.016)	0.066*** (0.015)	0.031 (0.026)
Female	0.049*** (0.018)	0.077*** (0.017)	0.131*** (0.029)
TMexp	0.0004 (0.001)	-0.0001 (0.001)	0.002* (0.001)
factor(FSC)1	0.167*** (0.032)	-0.008 (0.030)	-0.007 (0.050)
Constant	-0.110 (0.073)	0.576*** (0.142)	0.499** (0.237)
Observations	2,897	2,897	2,897
R ²	0.229	0.496	0.654
Adjusted R ²	0.226	0.463	0.631

Note: *p<0.1; **p<0.05; ***p<0.01

9. Discussion, concluding remarks and policy perspectives

Historical selection could, potentially, account for a universal propensity among firm owners and managers, associated with gender, to act in ecopreneurial ways. Historical selection comes into the picture here due to the astonishingly comparable division of labour, that has existed over time and across cultures according to a study by Wood and Eagly (2012). Therefore, women, through historical-institutional determination, have faced tasks that require patience, commitment to a local place and long-term thinking (i.e. by running households sustainably and rearing children in ways

that guarantee their future), whereas their male counterparts have been predestined for short-term thinking and gain, and in some instances, therefore, they are potentially less committed to a particular place. According to Wood and Eagly (2012), throughout human history, or until quite recently (with such changes possibly starting with the industrial revolution), there has been a gendered division of labour that sent the men out hunting, fighting and defending their territories, mainly due to their superior physiology for commanding over these tasks. Similarly, biology has made it necessary for women to stay close to the household. Nonetheless, the socialist experiment in Central and Eastern Europe and Asia may have had some influence on these traditional differences across the sexes, in part, because it is one of the sole historical occurrences of the state intervening into the intimate institutions of family life (Kornai, 1992).

In the research, when investigated separately, socialist countries stand out with a weak or absent gender effect. At the same time, female ownership and/or top management, is often more prevalent across the five former socialist countries included in the research and could, therefore, still count towards the general association that exists between gender and entrepreneurship across the country cases investigated in the research. Yet, when adopting a dummy for the former socialist countries in the general econometric specification, the results also demonstrate that mainstreaming has not implied positive spillovers from female-led firms onto other groups, but perhaps rather that the *for environment* (fe) has been taken out of female owners and managers. This result could have multiple explanations. For example, that mainstreaming in socialism has implied more male-dominated institutions, rather than less. But it could also reflect that owners and managers in Central and Eastern Europe are driven more by economic necessity (and opportunity in combination with globalisation and different environmental legislative regimes inside and outside the EU), than idealistic concerns over the environment as expressed in the eco-feminist ideology (Bauhardt, 2014; Shiva and Mies, 2014).

Due to the differences in results across more traditional market-economic systems (Italy, Portugal and Turkiye) and the former socialist countries (as Azerbaijan, Lithuania, the Kyrgyz Republic and Tajikistan were part of the Former Soviet Union), this research, also demonstrates that economic system may have an influence on gendered behaviour through: (1) the share of women's ownership and stakes in firms, and (2) by mainstreaming gendered behaviour, as it is a direct objective in socialism to erase these types of biases. Despite mainstreaming of gendered behaviour under socialism, it did not lead to any type of institution-building, that has involved a positive spillover from the long-term ecological thinking of households to the short-termism, that often plagues the efficiency concerned professional manager of the firm. The socialist experiment had few positive connotations on the natural environment, in the form that we know it from the European, Central Asian and East Asian experience. In fact, the vast environmental problems that led to internal resistance against socialism were soon forgotten when the transition started (Jancar-Webster, 2016).

However, globalisation, and especially its 'hyper' form since the 1990s (Rodrik, 2011; 2019), has fundamentally altered the relationship between the human species and commitment to the local place and, thereby, the responsibility over and about the pollution of the natural environment,

where production takes place. Both elements of change introduced during the 20th Century in Europe and globally, could explain the results obtained in the study about the differences in gendered behaviour and ecopreneurship.

Another contesting explanation is drawn from the affordability of idealistic values. According to the green version of the Kuznets Curve (Ekins, 1997) there is a trickle-down effect on environmental or green preference as society progresses. Another version of the same hypothesis, based in psychology, also suggests that the observed difference has more to do with trade-offs between survival concerns and idealism or green preference (Van der Werff, et al., 2013). However, there is no direct link between the green version of the Kuznets Curve and gendered behaviour, except perhaps that feminine values can start to take precedence as income increases, or we can afford trading off short-term survival concerns for longer-term sustainability of the economic and social system (see also Hechavarria, Ingram, Justo and Terjesen, 2012). Nevertheless, and despite our afforded idealism, in societies having progressed towards more feminist values, we must also face the real issue of concern which is that a large share of the pollution that goes into producing the goods we consume, often takes place far away from us in other corners of the world.

Therefore, nothing is irreversible or genetically inherent in such gendered or gender-based value driven patterns. The patterns can be reversed, and despite the domestic division of labour, through new technologies, arrangements can be made for work-life balance and constellations for family life, in other words, separating biology from task and identity. However, real change for mainstreaming by gender in a positive way, requires also confrontation with the underlying institutions that create and recreate these patterns across societies and over time. For example, it has never been understood or confronted in depth, why there is a negative relationship between socialism and the natural environment, even though one obvious explanation is the absence of innovation for long-term economic change and progress (such as towards renewable technologies). Another unknown factor is what fundamentally happens to society when, and if, the state intervenes too much into family life. Absurdly enough, globalisation has now proven to provide capitalism with a similar mechanism to escape caring about the natural environment, by putting the emphasis and consequences of 'growth' or societal progress on households elsewhere in the world.

The result of this research demonstrates the importance of a more gendered and diverse inclusion in decision-making, at all levels of society and across all countries. It may be necessary, if we are to breach the transition towards sustainable and greener technologies in 1-2 decades. Yet, the contrasting results across historical divides of past economic systems in the analysed region, also suggest that it is not gender, as such, that needs to be the target of future policy, but rather that future institution building and economic theory making needs to be subjected to gender mainstreamed thinking. Then only by putting 'for environment' responsibility into all individuals, independent of background, gender, age etc., will real change be possible.

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Appendix I

Figure A1.1 – Extract from the Enterprise Survey Questionnaire (dependent variable wording)

BMGC.23	Over the last three years, did this establishment adopt any of the following measures? SHOW CARD 39 (READ OUT IF OVER THE PHONE)				
			(SPONTANEOUS)		
	Yes	No	DOES NOT APPLY	DON'T KNOW	
Heating and cooling improvements	1	2	-7	-9	BMGc23a
More climate-friendly energy generation on site	1	2	-7	-9	BMGc23b
Machinery and equipment upgrades	1	2	-7	-9	BMGc23c
Energy management	1	2	-7	-9	BMGc23d
Waste minimization, recycling and waste management	1	2	-7	-9	BMGc23e
Air pollution control measures	1	2	-7	-9	BMGc23f
Water management	1	2	-7	-9	BMGc23g
Upgrades of vehicles	1	2	-7	-9	BMGc23h
Improvements to lighting systems	1	2	-7	-9	BMGc23i
Other pollution control measures	1	2	-7	-9	BMGc23j

Figure A1.2 – Extracts from the Enterprise Survey Questionnaire (dependent variable wording)

BMGC.25	Over the last three years, did this establishment adopt any measures to enhance energy efficiency?				
Yes	1				
No	2				GO TO BMGC.27
DON'T KNOW (SPONTANEOUS)	-9				GO TO BMGD.1
REFUSAL (SPONTANEOUS)	-8				GO TO BMGD.1
					BMGc25

Appendix II

List of independent variables

- *Female (dummy that takes the value of 1 when one of the owners of the firm are female and 0 otherwise, var. code in ES: b4)
- *TMFem (dummy that takes the value of 1 when the top manager of the firm is female and 0 otherwise, var. code in ES: b7a)
- *FemMaj (dummy that takes the value of 1 when more than 50% of the firm is owned by females, var. code in ES: b4a)
- *TMexp (number of years of experience of the firm's top manager, var. code in ES: b7)
- *Foreign (dummy that takes the value of 1 when one of the owners of the firm are foreign and 0 otherwise, var. code in ES: b2)
- *Family (dummy that takes the value of 1 when more than 50% of the firm is owned by the same family, var. code in ES: BMb1)
- *Age (age of the firm in years since the year of establishment until 2023, var code in ES: b6b)
- *Sales (quoted in Euros or local currency, var. code in ES: d2)
- *Capital_city (dummy that takes the value of 1 when the firm is located in the Capital city and 0 otherwise, var. code in ES: a2)
- *Regulation1 (How much of an obstacle: Environmental regulations? Scale 0 (=no obstacle) - 4 (=very severe obstacle), var. code in ES: BMj4c)
- *Regulation2 (How much of an obstacle relative to other obstacles? Scale 1 (=most important) - 9 (=least important), var. code in ES: j30_environment_pos)
- *Prioritise (For the next 3 years, which public spending should be of highest priority? (Recoded into a dummy that takes the value of 1 when the respondent prioritises the environment (=3) and 0 otherwise), var. code in ES: BMJ5)
- *Strategy (In last FY, Strategic objectives mention environmental or climate change issues? 1=Yes, 0=No, var. code in ES: BMGa1)
- *Management (In last FY, Have manager responsible for environmental or climate issues? 1=Yes, 0=No, var. code in ES: BMGa2)
- *Customers (Customers require certifications or adherence to some environmental standards? 1=Yes, 0=No, var. code in ES: BMGa4)

*Monitoring (A dummy that takes the value of 1 if the firm incurs compliance costs due to its participation in the emissions trading system (ETS), including monitoring, verification, management, maintenance, staff time, and fees, var. code in ES: BMGd4)

*Emissions (A dummy that takes the value of 1 if the firm has received free emissions allowances, var. code in ES: BMGd5)

*Taxes (In Last Fy, Was this establishment subject to an energy tax or levy? 1=Yes, 0=No, var. code in ES: BMGd6)

*Standards (In Last Fy, Subject to an energy performance standard in its operations? 1=Yes, 0=No, var. code in ES: BMGd7)

*Consume_el (Electricity consumption quoted in Euros, var. code in ES: n2b)

*Consume_fuel (Fuel consumption quoted in Euros, var. code in ES: n2f)

Appendix III

Output of the factor analysis for the composite dependent variable (Adopt_all_EC)

```
##
## Bartlett test of homogeneity of variances
##
## data: ESS_AZ[, 28:38]
## Bartlett's K-squared = 93.599, df = 10, p-value = 1.033e-15
##
## Bartlett test of homogeneity of variances
##
## data: ESS_IT[, 28:38]
## Bartlett's K-squared = 93.828, df = 10, p-value = 9.297e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_KR[, 28:38]
## Bartlett's K-squared = 122.48, df = 10, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_LI[, 28:38]
## Bartlett's K-squared = 262.64, df = 10, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_PT[, 28:38]
## Bartlett's K-squared = 282.11, df = 10, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_SL[, 28:38]
## Bartlett's K-squared = 138.4, df = 10, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_TJ[, 28:38]
## Bartlett's K-squared = 23.254, df = 10, p-value = 0.009846
```

```

##
## Bartlett test of homogeneity of variances
##
## data: ESS_TR[, 21:31]
## Bartlett's K-squared = 198477, df = 10, p-value < 2.2e-16
##
## Call:
## factanal(x = ESS_AZ[, 28:37], factors = 1, scores = "Bartlett")
##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##      0.847      0.888      0.759      0.466
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##      0.791      0.579      0.533      0.859
##   Adopt_tech_Light   Adopt_man_Poll
##      0.744      0.673
##
## Loadings:
##           Factor1
## Adopt_tech_HC   0.392
## Adopt_tech_RE   0.335
## Adopt_tech_Mach 0.491
## Adopt_man_Energy 0.731
## Adopt_man_Waste 0.457
## Adopt_man_Air   0.649
## Adopt_man_Water 0.683
## Adopt_tech_Transp 0.376
## Adopt_tech_Light 0.505
## Adopt_man_Poll  0.572
##
##           Factor1
## SS loadings   2.861
## Proportion Var 0.286
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 120.61 on 35 degrees of freedom.
## The p-value is 2.45e-11
##
## Call:
## factanal(x = ESS_IT[, 28:37], factors = 1, scores = "Bartlett")

```

```

##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##       0.527       0.633       0.383       0.272
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##       0.379       0.373       0.311       0.471
##   Adopt_tech_Light   Adopt_man_Poll
##       0.532       0.694
##
## Loadings:
##           Factor1
## Adopt_tech_HC   0.688
## Adopt_tech_RE   0.606
## Adopt_tech_Mach 0.785
## Adopt_man_Energy 0.853
## Adopt_man_Waste 0.788
## Adopt_man_Air   0.792
## Adopt_man_Water 0.830
## Adopt_tech_Transp 0.727
## Adopt_tech_Light 0.684
## Adopt_man_Poll  0.553
##
##           Factor1
## SS loadings    5.424
## Proportion Var 0.542
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 271.52 on 35 degrees of freedom.
## The p-value is 2.26e-38
##
## Call:
## factanal(x = ESS_KR[, 28:37], factors = 1, scores = "Bartlett")
##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##       0.612       0.924       0.538       0.502
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##       0.636       0.737       0.634       0.693
##   Adopt_tech_Light   Adopt_man_Poll
##       0.393       0.872

```

```

##
## Loadings:
##          Factor1
## Adopt_tech_HC   0.623
## Adopt_tech_RE   0.276
## Adopt_tech_Mach 0.679
## Adopt_man_Energy 0.706
## Adopt_man_Waste 0.603
## Adopt_man_Air   0.512
## Adopt_man_Water 0.605
## Adopt_tech_Transp 0.554
## Adopt_tech_Light 0.779
## Adopt_man_Poll  0.358
##
##          Factor1
## SS loadings   3.458
## Proportion Var 0.346
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 176.74 on 35 degrees of freedom.
## The p-value is 7.77e-21
##
## Call:
## factanal(x = ESS_LI[, 28:37], factors = 1, scores = "Bartlett")
##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##         0.669         0.765         0.478         0.513
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##         0.664         0.781         0.652         0.700
##   Adopt_tech_Light   Adopt_man_Poll
##         0.773         0.725
##
## Loadings:
##          Factor1
## Adopt_tech_HC   0.575
## Adopt_tech_RE   0.485
## Adopt_tech_Mach 0.722
## Adopt_man_Energy 0.698
## Adopt_man_Waste 0.580

```

```

## Adopt_man_Air 0.468
## Adopt_man_Water 0.590
## Adopt_tech_Transp 0.548
## Adopt_tech_Light 0.477
## Adopt_man_Poll 0.524
##
##          Factor1
## SS loadings 3.280
## Proportion Var 0.328
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 87.75 on 35 degrees of freedom.
## The p-value is 2.02e-06
##
## Call:
## factanal(x = ESS_PT[, 28:37], factors = 1, scores = "Bartlett")
##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##      0.643      0.551      0.705      0.423
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##      0.881      0.805      0.907      0.969
##   Adopt_tech_Light   Adopt_man_Poll
##      0.735      0.738
##
## Loadings:
##          Factor1
## Adopt_tech_HC 0.598
## Adopt_tech_RE 0.670
## Adopt_tech_Mach 0.543
## Adopt_man_Energy 0.759
## Adopt_man_Waste 0.346
## Adopt_man_Air 0.442
## Adopt_man_Water 0.306
## Adopt_tech_Transp 0.177
## Adopt_tech_Light 0.515
## Adopt_man_Poll 0.512
##
##          Factor1
## SS loadings 2.645

```

```

## Proportion Var  0.265
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 205.16 on 35 degrees of freedom.
## The p-value is 5.97e-26
##
## Call:
## factanal(x = ESS_SL[, 28:37], factors = 1, scores = "Bartlett")
##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##      0.752      0.578      0.757      0.584
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##      0.816      0.686      0.532      0.918
##   Adopt_tech_Light   Adopt_man_Poll
##      0.688      0.739
##
## Loadings:
##           Factor1
## Adopt_tech_HC   0.498
## Adopt_tech_RE   0.649
## Adopt_tech_Mach 0.493
## Adopt_man_Energy 0.645
## Adopt_man_Waste 0.429
## Adopt_man_Air   0.560
## Adopt_man_Water 0.684
## Adopt_tech_Transp 0.287
## Adopt_tech_Light 0.558
## Adopt_man_Poll  0.511
##
##           Factor1
## SS loadings   2.950
## Proportion Var 0.295
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 68.53 on 35 degrees of freedom.
## The p-value is 0.000599
##
## Call:
## factanal(x = ESS_TJ[, 28:37], factors = 1, scores = "Bartlett")

```



```

##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##       0.679       0.846       0.801       0.691
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##       0.465       0.324       0.812       0.804
##   Adopt_tech_Light   Adopt_man_Poll
##       0.712       0.390
##
## Loadings:
##           Factor1
##   Adopt_tech_HC   0.567
##   Adopt_tech_RE   0.392
##   Adopt_tech_Mach 0.447
##   Adopt_man_Energy 0.556
##   Adopt_man_Waste 0.731
##   Adopt_man_Air   0.822
##   Adopt_man_Water 0.434
##   Adopt_tech_Transp 0.443
##   Adopt_tech_Light 0.536
##   Adopt_man_Poll  0.781
##
##           Factor1
##   SS loadings    3.476
##   Proportion Var 0.348
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 88.62 on 35 degrees of freedom.
## The p-value is 1.53e-06
##
## Call:
## factanal(x = ESS_TR[, 28:37], factors = 1, scores = "Bartlett")
##
## Uniquenesses:
##   Adopt_tech_HC   Adopt_tech_RE   Adopt_tech_Mach   Adopt_man_Energy
##       0.856       0.914       0.807       0.544
##   Adopt_man_Waste   Adopt_man_Air   Adopt_man_Water   Adopt_tech_Transp
##       0.354       0.609       0.626       0.895
##   Adopt_tech_Light   Adopt_man_Poll
##       0.519       0.417

```

```
##
## Loadings:
##          Factor1
## Adopt_tech_HC   0.380
## Adopt_tech_RE   0.293
## Adopt_tech_Mach 0.440
## Adopt_man_Energy 0.675
## Adopt_man_Waste 0.804
## Adopt_man_Air   0.626
## Adopt_man_Water 0.611
## Adopt_tech_Transp 0.325
## Adopt_tech_Light 0.694
## Adopt_man_Poll  0.763
##
##          Factor1
## SS loadings   3.460
## Proportion Var 0.346
##
## Test of the hypothesis that 1 factor is sufficient.
## The chi square statistic is 284.36 on 35 degrees of freedom.
## The p-value is 7.83e-41
```

Appendix IV

Output of the factor analysis for the explanatory variables (Factor1, Factor2, Factor3)

```
##
## Bartlett test of homogeneity of variances
##
## data: ESS_AZ[, 14:27]
## Bartlett's K-squared = Inf, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_IT[, 14:27]
## Bartlett's K-squared = 169769, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_KR[, 14:27]
## Bartlett's K-squared = 73603, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_LI[, 14:27]
## Bartlett's K-squared = 76960, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_PT[, 14:27]
## Bartlett's K-squared = 282964, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_SL[, 14:27]
## Bartlett's K-squared = 69338, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
##
## data: ESS_TJ[, 14:27]
## Bartlett's K-squared = 26602, df = 13, p-value < 2.2e-16
##
## Bartlett test of homogeneity of variances
```

```

##
## data: ESS_TR[, 14:27]
## Bartlett's K-squared = 258970, df = 13, p-value < 2.2e-16
##
## Call:
## factanal(x = ESS_AZ[, c(14:22, 24:27)], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
## 0.935 0.935 0.928 0.499 0.642 0.215
## Monitoring Emissions Targeting1 Taxes Standards Consume_el
## 0.979 0.988 0.553 0.705 0.005 0.873
## Consume_fuel
## 0.005
##
## Loadings:
## Factor1 Factor2 Factor3
## Regulation1 0.253
## Regulation2 -0.204 -0.143
## Prioritise 0.257
## Strategy 0.554 0.298 0.324
## Management 0.466 0.374
## Customers 0.886
## Monitoring 0.138
## Emissions
## Targeting1 0.514 0.427
## Taxes 0.541
## Standards 0.997
## Consume_el 0.352
## Consume_fuel 0.996
##
## Factor1 Factor2 Factor3
## SS loadings 1.735 1.621 1.382
## Proportion Var 0.133 0.125 0.106
## Cumulative Var 0.133 0.258 0.364
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 41.94 on 42 degrees of freedom.
## The p-value is 0.473

```

```

##
## Call:
## factanal(x = ESS_IT[, 14:27], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
## 0.784 0.988 0.916 0.423 0.759 0.481
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
## 0.404 0.609 0.284 0.358 0.466 0.668
## Consume_el Consume_fuel
## 0.268 0.348
##
## Loadings:
## Factor1 Factor2 Factor3
## Regulation1 0.462
## Regulation2
## Prioritise 0.279
## Strategy 0.759
## Management 0.455 0.171
## Customers 0.713
## Monitoring 0.764
## Emissions 0.577 0.238
## Targeting1 0.835 0.119
## Targeting2 0.739 0.309
## Taxes 0.178 0.709
## Standards 0.370 0.441
## Consume_el 0.852
## Consume_fuel 0.806
##
## Factor1 Factor2 Factor3
## SS loadings 3.705 1.427 1.111
## Proportion Var 0.265 0.102 0.079
## Cumulative Var 0.265 0.367 0.446
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 277.54 on 52 degrees of freedom.
## The p-value is 1.53e-32
##
## Call:
## factanal(x = ESS_KR[, 14:27], factors = 3, scores = "Bartlett")

```

```

##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
## 0.890 0.962 0.988 0.005 0.614 0.929
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
## 0.701 0.773 0.736 0.536 0.908 0.689
## Consume_el Consume_fuel
## 0.799 0.896
##
## Loadings:
## Factor1 Factor2 Factor3
## Regulation1 0.140 0.300
## Regulation2 -0.158
## Prioritise
## Strategy 0.991 0.108
## Management 0.464 0.290 0.295
## Customers 0.195 0.163
## Monitoring 0.158 0.520
## Emissions 0.259 0.400
## Targeting1 0.136 0.487
## Targeting2 0.180 0.655
## Taxes 0.264 0.140
## Standards 0.551
## Consume_el 0.433
## Consume_fuel 0.306
##
## Factor1 Factor2 Factor3
## SS loadings 1.420 1.086 1.066
## Proportion Var 0.101 0.078 0.076
## Cumulative Var 0.101 0.179 0.255
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 61.65 on 52 degrees of freedom.
## The p-value is 0.169
##
## Call:
## factanal(x = ESS_LI[, 14:27], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers

```

```

##      0.994      0.996      0.987      0.594      0.435      0.505
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
##      0.874      0.887      0.005      0.005      0.990      0.873
## Consume_el Consume_fuel
##      0.689      0.831
##
## Loadings:
##      Factor1 Factor2 Factor3
## Regulation1
## Regulation2
## Prioritise
## Strategy      0.513  0.346  0.152
## Management    0.741  0.112
## Customers     0.673  0.203
## Monitoring    0.159  0.313
## Emissions           0.221  0.253
## Targeting1    0.164  0.982
## Targeting2    0.356  0.130  0.923
## Taxes
## Standards     0.354
## Consume_el    0.507           0.226
## Consume_fuel 0.107           0.395
##
##      Factor1 Factor2 Factor3
## SS loadings   1.851  1.316  1.169
## Proportion Var 0.132  0.094  0.083
## Cumulative Var 0.132  0.226  0.310
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 57.86 on 52 degrees of freedom.
## The p-value is 0.268
##
## Call:
## factanal(x = ESS_PT[, 14:27], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
##      0.807      0.995      0.971      0.675      0.381      0.666
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
##      0.361      0.652      0.636      0.832      0.772      0.728

```

```

## Consume_el Consume_fuel
## 0.005 0.118
##
## Loadings:
## Factor1 Factor2 Factor3
## Regulation1 0.416 0.136
## Regulation2
## Prioritise 0.156
## Strategy 0.141 0.549
## Management 0.106 0.167 0.761
## Customers 0.569
## Monitoring 0.786 0.118
## Emissions 0.574
## Targeting1 0.114 0.536 0.251
## Targeting2 0.373 0.171
## Taxes 0.470
## Standards 0.175 0.182 0.456
## Consume_el 0.994
## Consume_fuel 0.935
##
## Factor1 Factor2 Factor3
## SS loadings 1.980 1.862 1.560
## Proportion Var 0.141 0.133 0.111
## Cumulative Var 0.141 0.274 0.386
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 282.55 on 52 degrees of freedom.
## The p-value is 1.95e-33
##
## Call:
## factanal(x = ESS_SL[, 14:27], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
## 0.988 0.997 0.998 0.614 0.425 0.778
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
## 0.647 0.907 0.759 0.772 0.758 0.763
## Consume_el Consume_fuel
## 0.607 0.148
##

```



```

## Loadings:
##      Factor1 Factor2 Factor3
## Regulation1
## Regulation2
## Prioritise
## Strategy   0.132  0.603
## Management      0.756
## Customers   0.145  0.436  0.102
## Monitoring   0.158  0.571
## Emissions   0.298
## Targeting1   0.355  0.338
## Targeting2  0.452      0.126
## Taxes       0.107 -0.105  0.468
## Standards   0.161  0.265  0.376
## Consume_el  0.568  0.253
## Consume_fuel 0.922
##
##      Factor1 Factor2 Factor3
## SS loadings  1.548  1.439  0.852
## Proportion Var 0.111  0.103  0.061
## Cumulative Var 0.111  0.213  0.274
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 57.05 on 52 degrees of freedom.
## The p-value is 0.293
##
## Call:
## factanal(x = ESS_TJ[, 14:27], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
##      0.994      0.978      0.932      0.531      0.112      0.829
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
##      0.840      0.005      0.793      0.279      0.005      0.834
## Consume_el Consume_fuel
##      0.975      0.961
##
## Loadings:
##      Factor1 Factor2 Factor3
## Regulation1

```

```

## Regulation2      0.131
## Prioritise      0.126  0.227
## Strategy      0.541  0.251  0.335
## Management    0.380      0.861
## Customers          0.409
## Monitoring    0.126  0.330  0.188
## Emissions     0.985     -0.158
## Targeting1    0.206  0.400
## Targeting2    0.840
## Taxes         0.197  0.974
## Standards     0.275  0.265  0.139
## Consume_el    -0.157
## Consume_fuel  -0.195
##
##           Factor1 Factor2 Factor3
## SS loadings  2.293  1.459  1.179
## Proportion Var 0.164  0.104  0.084
## Cumulative Var 0.164  0.268  0.352
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 59.46 on 52 degrees of freedom.
## The p-value is 0.222
##
## Call:
## factanal(x = ESS_TR[, 14:27], factors = 3, scores = "Bartlett")
##
## Uniquenesses:
## Regulation1 Regulation2 Prioritise Strategy Management Customers
## 0.908 0.994 0.966 0.374 0.641 0.472
## Monitoring Emissions Targeting1 Targeting2 Taxes Standards
## 0.726 0.942 0.457 0.510 0.384 0.330
## Consume_el Consume_fuel
## 0.005 0.845
##
## Loadings:
##           Factor1 Factor2 Factor3
## Regulation1 -0.292
## Regulation2
## Prioritise -0.158
## Strategy 0.737 0.286

```

```
## Management 0.589
## Customers 0.662 0.299
## Monitoring 0.516
## Emissions 0.238
## Targeting1 0.434 0.592
## Targeting2 0.668 0.211
## Taxes 0.139 0.748 -0.196
## Standards 0.401 0.708
## Consume_el 0.995
## Consume_fuel 0.392
##
##          Factor1 Factor2 Factor3
## SS loadings 2.247 1.986 1.213
## Proportion Var 0.160 0.142 0.087
## Cumulative Var 0.160 0.302 0.389
##
## Test of the hypothesis that 3 factors are sufficient.
## The chi square statistic is 251.04 on 52 degrees of freedom.
## The p-value is 7.24e-28
```

Appendix V

Figure AV.1 – Scree plot For Azerbaijan

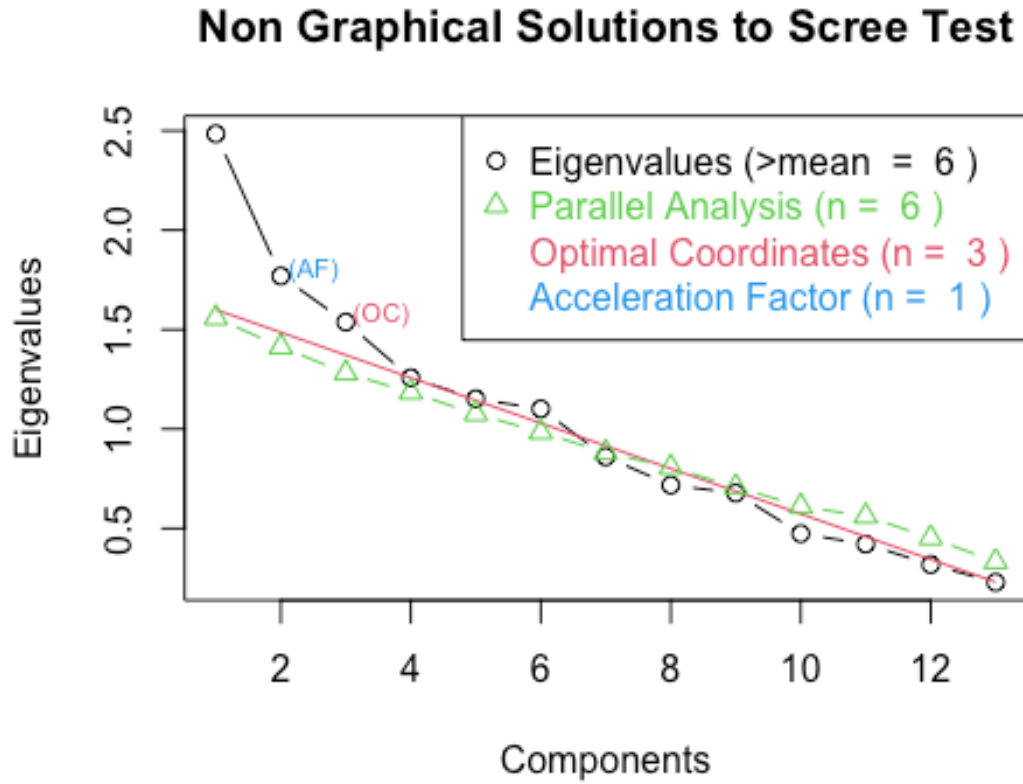


Figure AV.2 – Scree plot for Italy

Non Graphical Solutions to Scree Test

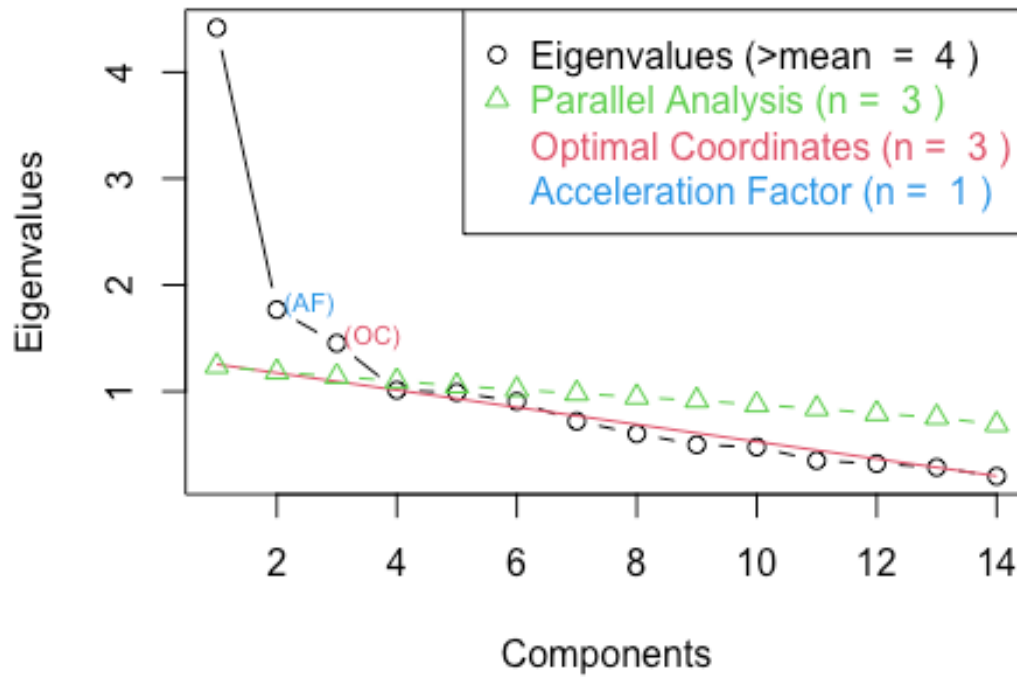


Figure AV.3 – Scree plot for Kyrgyzstan

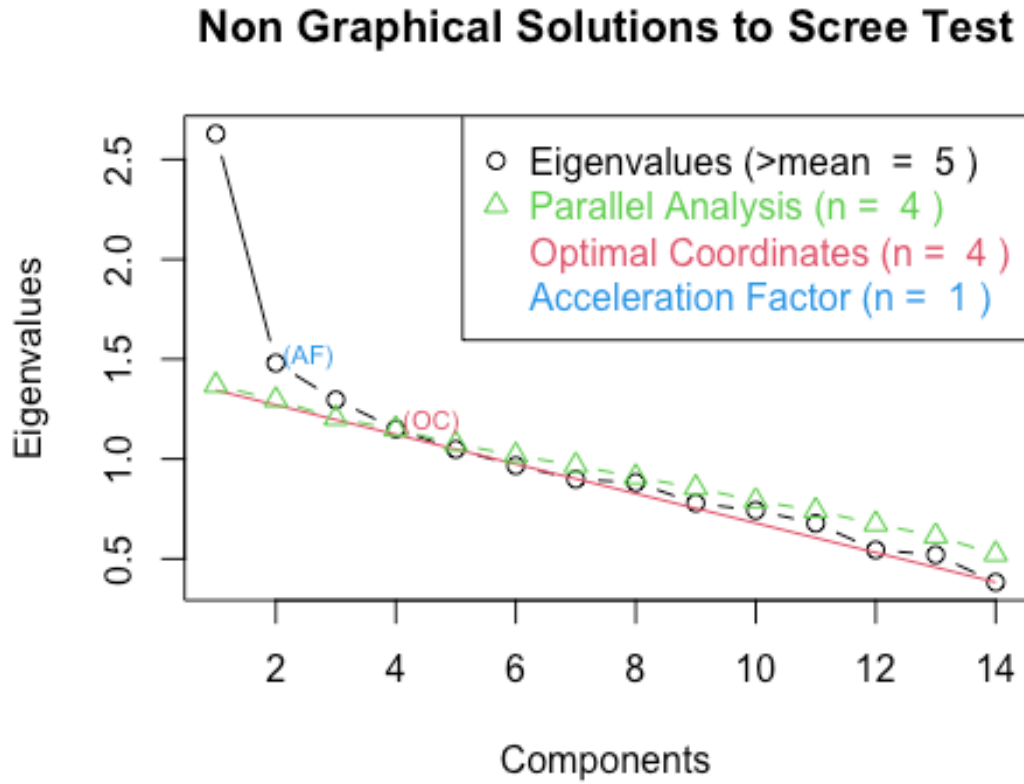


Figure AV.4 – Scree plot for Lithuania

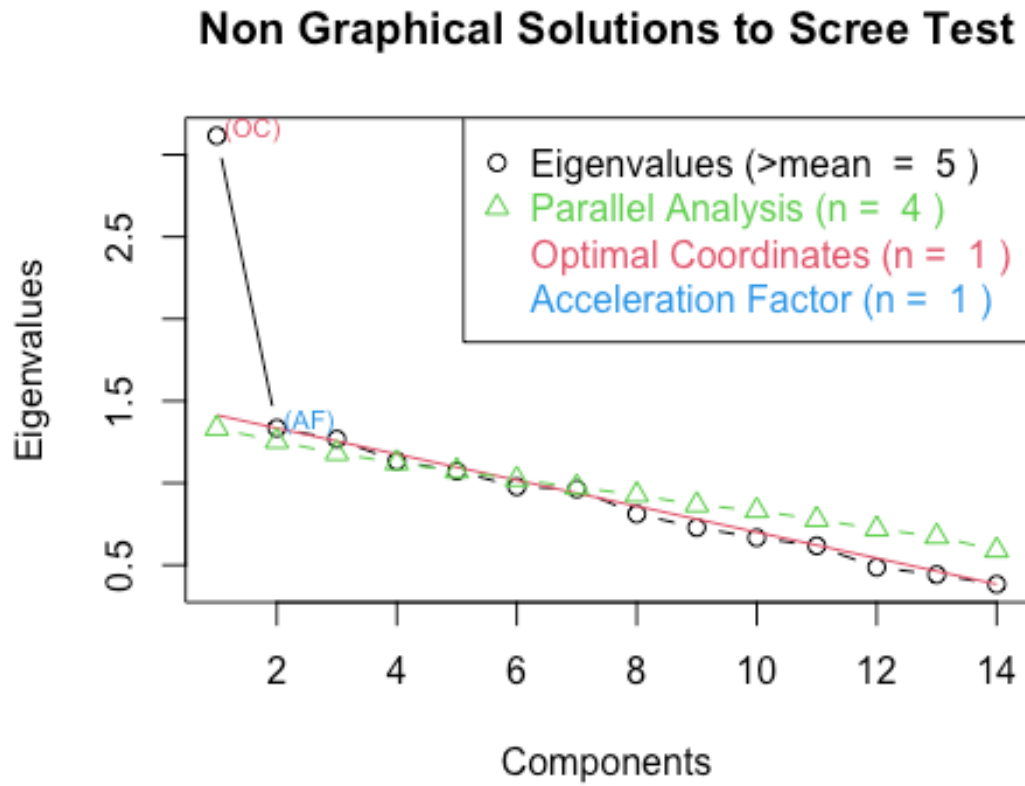


Figure AV.5 – Scree plot for Portugal

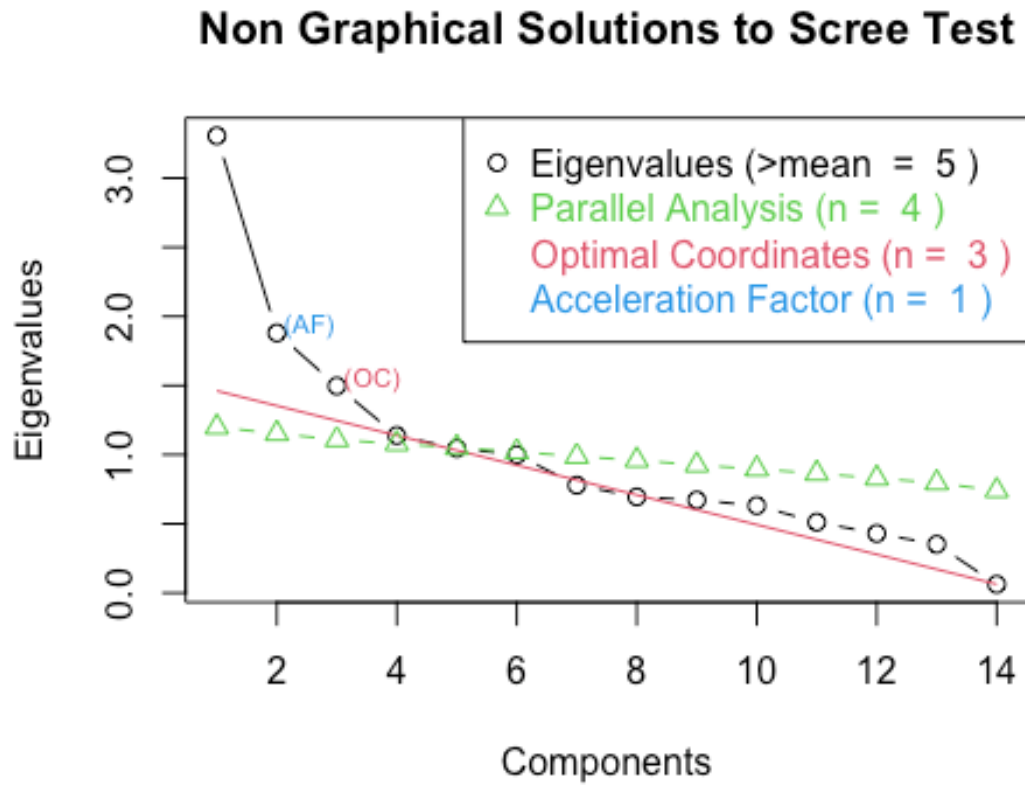


Figure AV.6 – Scree plot for Slovenia

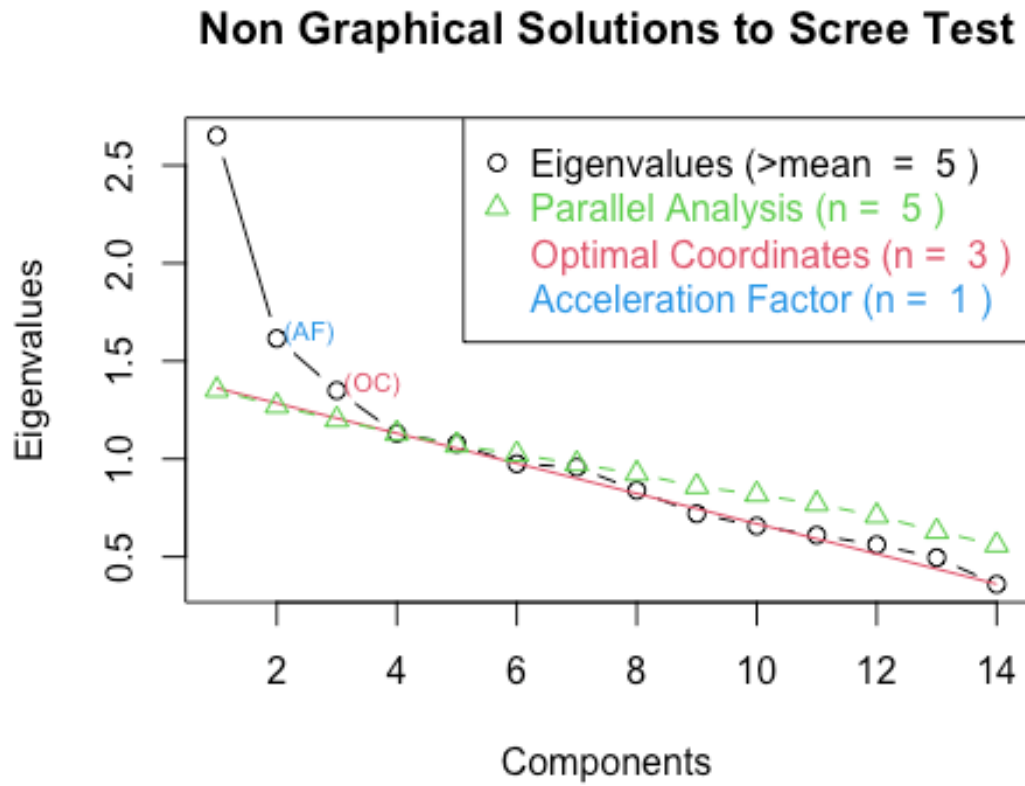


Figure AV.7 – Scree plot for Tajikistan

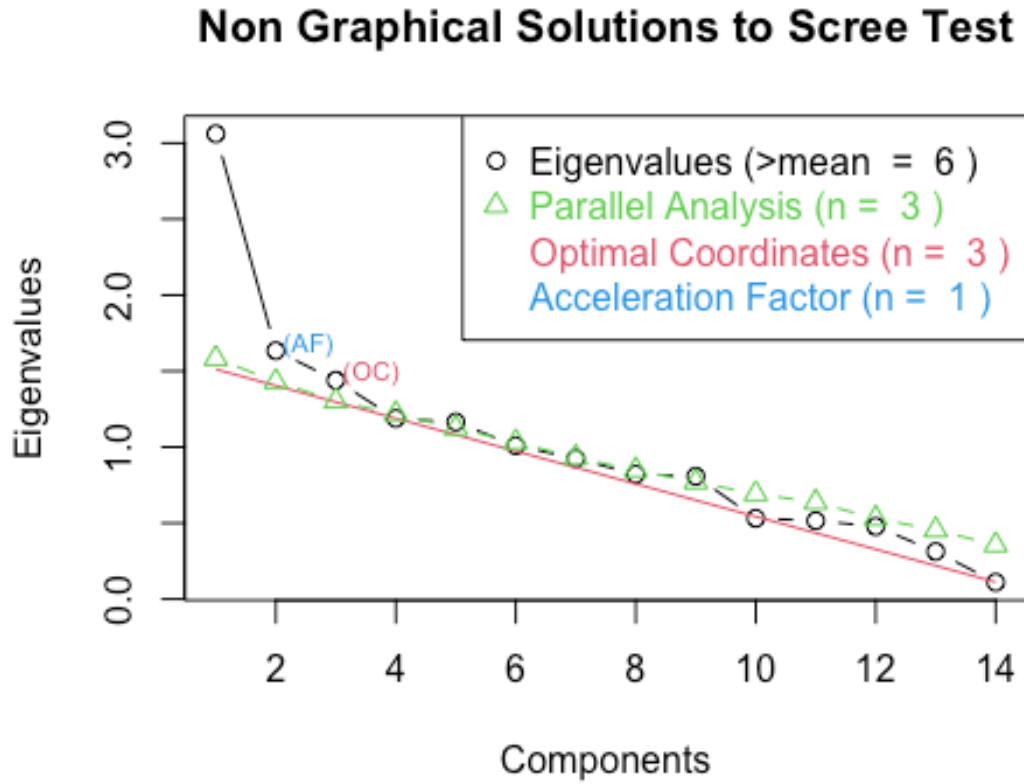
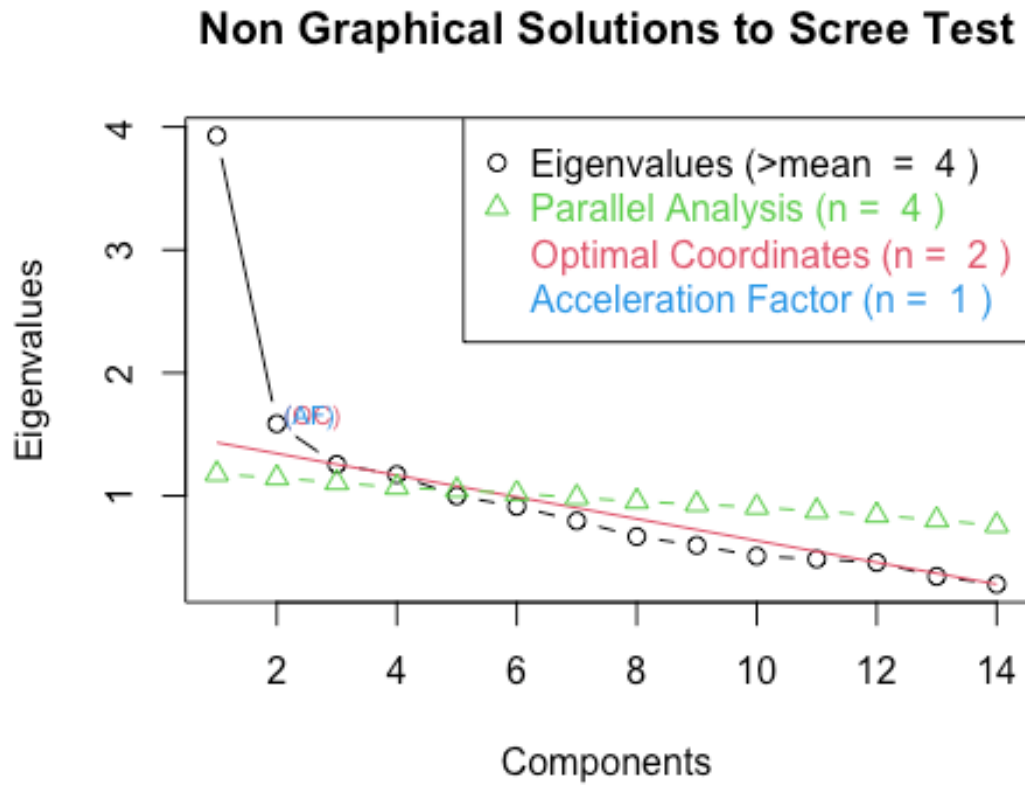


Figure AV.8 – Scree plot for Turkiye



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- The nature, pace and outcomes of processes of capitalist transformation
- The social and financial challenges of transitioning to a net-zero carbon economy
- The political economy of natural-resource extraction, with implications for political instability
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