Gender equality and women's participation in transport cycling

Gender Equality and Women's Participation in Transport Cycling

Abstract

Population-level health benefits are associated with cycling as a means for day-to-day travel. Several factors inhibit women's participation in transport cycling. The aim of the present study was to investigate the relationship between gender equality using the composite indicator of Gender Equality Index and its six core domains (work, money, knowledge, time, power, and health) plus violence and women's participation in transport cycling across the 28 member states of the European Union. The gross domestic product was included as a controlling variable. Results showed that the composite indicator of Gender Equality Index was associated with women's participation in transport cycling as well as with gender differences in participation in transport cycling. The core domains of health and work were not related to women's participation in transport cycling. Women's participation in transport cycling was associated with the following domains: time, power, and violence. The effect of gender equality varied across different indicators, with the strongest effect size found for time. The traditional sexual division of labour (gender gaps in caring and educating children or grandchildren, as well as in cooking and housework) may inhibit women's participation in transport cycling.

Keywords: bicycling, gender equality, active transport, mobility, Bayesian inference

1. Introduction

Cycling as a means for day-to-day travel offers population-level health benefits (Götschi, Garrard, & Giles-Corti, 2016; Kelly et al., 2014). For example, commuter cycling is associated with a reduction in all-cause mortality and improvements in cardiovascular fitness (Oja et al., 2011). I note that there are detrimental effects of cycling such as exposure to air pollution (Zuurbier et al., 2010) and involvement in traffic safety incidents, especially collisions with motorized vehicles (Prati, Marín Puchades, De Angelis, Fraboni, & Pietrantoni, 2017). However, the health benefits of cycling are substantially larger than the potential mortality effect of greater exposure to air pollution and the increase in traffic accidents (de Hartog, Boogaard, Nijland, & Hoek, 2010). Moreover, shifting to active modes of transport can achieve environmental and economic benefits, including reduced traffic congestion, air and noise pollution, and fossil fuel consumption (de Nazelle et al., 2011; Macmillan et al., 2014; Xia, Zhang, Crabb, & Shah, 2013).

Although policy interest in promoting bicycle use as a mode of transport has increased substantially, the promotion of cycling does not seem associated with greater diversity (i.e., inclusion of different types of people) among cyclists. For instance, higher levels of bicycle use in United Kingdom were not related to an increase in the representation of women (Aldred, Woodcock, & Goodman, 2016) and inequalities in the London bicycle sharing system persist (Goodman & Cheshire, 2014).

Women's travel patterns are often more complex than those of men because of differing household and work roles buttressed by societal norms (Garrard, Handy, & Dill, 2012; McGuckin & Nakamoto, 2004; Nobis & Lenz, 2004; Rosenbloom, 1989, 2004). Although there is evidence of health benefits of cycling for women (Garrard et al., 2012), gender differences in mobility patterns include also women's lower use of bicycle. In an Eurobarometer by the

European Commission on attitudes of Europeans towards mobility, the percentages of women

who reported never using the bicycle as transportation mode were higher than that of men for all

countries (European Commission, 2013). In Australia, Canada, and the United States, men make

up a large share of cyclists (Garrard et al., 2012; Pucher, Garrard, & Greaves, 2011). Different

explanations have been advanced to account for under-representation of women in transport

cycling. First, women tend to perceive more barriers or constraints to transport cycling and report

lower levels of willingness to cycle (Akar, Fischer, & Namgung, 2013; Dickinson, Kingham,

Copsey, & Hougie, 2003; Heesch, Sahlqvist, & Garrard, 2012). However, it seems likely that

socio-cultural and infrastructural factors influence these perceptions because the women's

participation in transport cycling is relatively high in countries with a well-developed cycling

culture (Pucher & Buehler, 2008). The wider body of evidence is of a strong relationship

between overall levels of bicycle use and women's cycling (Garrard et al., 2012). Indeed,

women's participation in transport cycling in high-cycling countries may be due to their

relatively high-quality cycling infrastructure. According to Aldred et al. (2016) and Krizek,

Johnson, and Tilahun (2005), there are attitudinal differences towards infrastructure and cycling

environments (e.g., a preference for segregation from motor traffic) between men and women.

Furthermore, safety seems more of a concern for female cyclists than male cyclists and is a

significant factor in bicycling choice (Akar et al., 2013; Dickinson et al., 2003; Garrard et al.,

2012; Heesch et al., 2012; Krizek et al., 2005).

In addition to these explanations, Aldred et al. (2016) pointed out that culturally specific

factors and gender roles are responsible for female take-up of cycling. For example, female

students are less likely to have permission to bike to and from school without an adult than male

students of the same age (McDonald, 2012). In her analysis of gender equality into transport

policy in Sweden, Polk (2008) posits that the priorities of transport politics have been focussed on more traditional goals and gender equality was not considered an important aim.

Trip characteristics and division of time and distribution of tasks between women and men can be considered others important factors influencing women's participation in transport cycling. Specifically, in comparison with men, women are more likely to make escort trips or travel with heavy objects (Aldred et al., 2016; Dickinson et al., 2003). These trip characteristics are all less suited for bicycle travel. A difference in this domain reveals the persistence of sexual division of labour (e.g., housework and child care as women's responsibility). Indeed, the presence of children as well as household responsibilities plays a significant role in incrementing the probability of car use for women (Emond, Tang, & Handy, 2009; Vance, Buchheim, & Brockfeld, 2004). In addition, the birth of a child is associated with a larger decrease in bicycle use among mothers than fathers (Scheiner, 2014). This greater use of car for child care and pickup services arises from patriarchal constraints that dictate traditional gender roles. In sum, wide gender inequalities in the division of time between women and men in relation to the different roles assigned to them by society (e.g., time spent on caring and educating family members, as well as time spent on cooking and housework) may prevent women from bicycle use. Therefore, it is possible to hypothesize that gender equality may be associated with women's participation in transport cycling. Specifically, the aim of the study was to test the hypothesis that levels of gender equality are negatively associated with the percentage of women who report never using the bicycle as a mode of transport across European Union (EU) countries.

Throughout all European countries, an unequal division of time and distribution of tasks between women and men persists, with women spending more time in housework and care activities (European Institute for Gender Equality, 2015). To measure gender gaps within a range

of areas across European Member States, the European Institute for Gender Equality put forward

the Gender Equality Index (European Institute for Gender Equality, 2015). The Gender Equality

Index involves a composite measure that relies on information disaggregated by sex (sex-

disaggregated data) to allow for a gender analysis of the situation across of European Member

States. The aim of the Gender Equality Index is to measure gaps between women and men,

where the equality in outcomes is the form of equality that is considered. Since gender equality is

a complex and multi-dimensional concept, different domains of gender equality are considered.

Specifically, eight domains of gender equality are considered: work (i.e., participation,

segregation, and quality of work), money (i.e., financial resources and economic situation),

knowledge (i.e., educational attainment, segregation, and lifelong learning), time (i.e., economic,

care activities, and social activities), power (i.e., political, social, and economic aspects of

power), health (status, behaviour, and access), violence (i.e., direct and indirect forms of

violence) and intersecting inequalities (i.e., discrimination and other social grounds). The

combination of these six core domains (i.e., work, money, knowledge, time, power, and health)

forms the Gender Equality Index and, as such, synthesises the complexity of the concept of

gender equality. The composite indicator of Gender Equality Index provides an overall measure

of the complex concept of gender equality, while the six core domains (work, money,

knowledge, time, power, health) focus on specific aspects of gender equality. The remaining two

satellite domains (violence and intersecting inequalities) are conceptually related to gender

equality, but are not included in the core index because they measure "an illustrative

phenomenon — that is, a phenomenon that only applies to a selected group of the population

issues focussing on protecting the integrity and dignity of individuals" (European Institute for

Gender Equality, 2015, p. 11). The two satellite domains consider issues that are related to

women only or examine gender gaps among specific segments of the population such as people with a disability or lone parents.

The aim of the present study was to investigate whether women's participation in transport cycling is related to gender equality in general as well as to specific domains of gender equality. I hypothesised that a higher gender equality would be associated with higher women's participation in transport cycling.

Gender equality is a complex and multidimensional concept comprising a range of factors encompassing social, cultural, historical, and economic processes. This study helps to clarify the influence of gender equality on women's participation in transport cycling by disaggregating its dimensions. Therefore, to address the complexity of gender equality and to provide a more fine-grained analysis of the influence of gender equality, the six core domains (work, money, knowledge, time, power, and health) were examined separately. Indeed, each of the six core domains has the potential to influence the choice of mobility mode and ways of moving, including bicycle use (Camargo, Fermino, & Reis, 2015; Garrard et al., 2012; Handy, van Wee, & Kroesen, 2014). In addition, since fear of crime and violence is supposed to influence women's travel behaviour, including cycling (Emond et al., 2009; Loukaitou-Sideris, 2010), the satellite domain of violence was added to the analysis. Thus, the focus of the study was on the composite score of gender equality (i.e., Gender Equality Index) as well as on the core domains separately (work, money, knowledge, time, power, and health) plus the satellite domain of violence. Furthermore, since EU countries differ widely in their level of economic activity, the gross domestic product was included as a controlling variable.

2. Material and methods

2.1 Data

This study used data from three datasets. To measure the extent to which bicycle was used as mode of transport among women, data from the Eurobarometer survey on the attitudes toward mobility in the EU (European Commission, 2013) were used. Specifically, the data provide the percentages of women who never cycle as mode of transport across the 28 member states. TNS Opinion & Social network carried out the survey in the 28 member states of the European Union in 2013. Scores on Gender Equality Index across the 28 member states were provided by the European Institute for Gender Equality (2015). The Gender Equality Index was based on indicators available from different sources including Eurostat, the European Foundation for the Improvement of Living and Working Conditions (Eurofound) and DG Justice and Consumers (DG Justice). The Gender Equality Index considers the position of women and men to each other, producing a score bound between 0 and 1, where 1 stands for complete gender equality, while values below indicate a proportional lack of gender equality in a given indicator, with full gender inequality at 0. Information about the measurement framework, indicator selection, data, metric, and calculation of the Gender Equality Index is provided by the European Institute for Gender Equality (2015). The present study used the scores for the year 2012.

The gross domestic product of 2012 provided by Eurostat was included in the analysis as a measure for the economic activity. To eliminate the differences in price levels between countries and to allow meaningful volume comparisons of the gross domestic product between the 28 member states, it was employed the purchasing power standard expressed in relation to the European Union (EU28) average set to equal 100. Data were provided by Eurostat (http://ec.europa.eu/eurostat/web/purchasing-power-parities/overview).

2.2 Statistical Analysis

A default Bayesian hypothesis test for correlations and partial correlations (Wetzels &

Wagenmakers, 2012) was performed. The Bayesian hypothesis test has important practical

advantages, as compared with the standard frequentist test. For example, when parameters are

not normally distributed or sample size is small, Bayesian methods provide more accurate results

than the frequentist test (e.g., Lee & Song, 2004; Stegmueller, 2013). Bayesian hypothesis test

involves the use of a statistic called the Bayes factor that has different advantages over

frequentist statistics (Morey & Rouder, 2011). For example, it does not emphasize small,

uninteresting effects. More important, in contrast to the standard frequentist test that is based on

p value, the Bayes factor quantifies evidence in favour of both the null and the alternative

hypotheses simultaneously. Specifically, the Bayes factor computes the overall likelihood of the

observed data for the null hypothesis relative to the overall likelihood of the data for an

alternative hypothesis. When the Bayes factor has a value greater than 1, this indicates that the

relationship is significant (i.e., data are more likely to have occurred under the alternative

hypothesis than under the null hypothesis). Bayes factor of 1 to 3, 3 to 10, 10 to 30, 30 to 100,

and greater than 100 were considered anecdotal evidence, substantial evidence, strong evidence,

very strong evidence, and decisive evidence for associations, respectively (Wetzels &

Wagenmakers, 2012). The analyses were conducted using the program JAGS and the R package

Bayesmed developed by Nuijten, Wetzels, Matzke, Dolan, and Wagenmakers (2015).

3. Results

Table 1 displays the results of default Bayesian test for partial correlation. The percentage

of women reporting never cycling was significantly related to the composite score of the Gender

Equality Index as well as with the following domains: knowledge, time, power, and violence.

Although the relationship between the percentage of women reporting never cycling and

knowledge was significant, it could be considered anecdotal evidence. It was found substantial

evidence that violence as well as the Gender Equality Index were related with the percentage of

women reporting never cycling. The analysis also revealed strong evidence for the association

between time and power and the percentage of women reporting never cycling.

Table 1

Correlations between the Percentage of Women Reporting Never Cycling and Gender Equality

Index Composite Score and Domains

	Percentage of women reporting never cycling		
	Unstandardized partial coefficient*	Bayes Factor	95% CIs
Gender Equality Index	-0.57	8.80	-0.98, -0.17
Domains			
Work	-0.21	0.39	-0.61, 0.18
Money	-0.21	0.17	-0.86, 0.45
Knowledge	-0.43	1.05	-0.89, 0.02
Time	-0.61	14.38	-1.01, -0.21
Power	-0.51	16.12	-0.83, -0.18
Health	0.35	0.62	-0.10, 0.80
Violence	0.42	4.21	0.08, 0.76

Note. * the relationship between variables was calculated after excluding the effect of the gross

domestic product. CIs = Credible Intervals.

Figure 1 in Appendix A shows the relationship between Gender Equality Index and women's participation in transport cycling for each country. The Scandinavian countries and the Netherlands have extensive pro-cycling investment, infrastructure, and policies as well as lower levels of gender inequality. It is possible to hypothesize that in these countries there are pro-cycling conditions that are independent of the gross domestic product. To control for these pro-cycling conditions, I included in the analysis the percentage of men who reported never cycling. Specifically, I calculated the difference between the percentage of men and women who reported never cycling. Then, I calculated a comparable Bayesian analysis using difference between the percentage of men and women who reported never cycling to control for confounding factors due to pro-cycling conditions across the different countries. As stated earlier, the percentages of women who reported never using the bicycle as mean of transport were higher than that of men for all countries. Thus, the results of the difference between the percentage of men and women who reported never cycling were denoted by the minus sign.

Table 2 displays the findings of the results of default Bayesian test for partial correlation using the difference between the percentage of men and women reporting never cycling and gender equality index composite score and domains controlling for gross domestic product. The Gender Equality Index as well as money, time, power, and violence domains were associated with the difference between the percentage of men and women reporting never cycling. Figure 2 in Appendix B shows the relationship between Gender Equality Index and the difference between the percentage of men and women reporting never cycling for each country. Southern and eastern European countries reported low levels of both gender equality and a lower women's participation in transport cycling compared to men. Scandinavian countries and the Netherlands

were characterized by high levels of gender equality and percentages of women reporting never

cycling similar to that of men.

Table 2

Correlations between the Difference between the Percentage of Men and Women Reporting

Never Cycling and Gender Equality Index Composite Score and Domains

	Difference between the percentage of men and women reporting never cycling		
	Unstandardized partial coefficient*	Bayes Factor	95% CIs
Gender Equality Index	0.59	9.62	0.19, 0.99
Domains			
Work	0.23	0.41	-0.17, 0.63
Money	0.79	3.36	0.19, 1.38
Knowledge	0.42	0.96	-0.04, 0.89
Time	0.66	29.36	0.27, 1.05
Power	0.38	2.08	0.03, 0.74
Health	0.11	0.21	-0.36, 0.59
Violence	-0.32	1.04	-0.68, 0.04

Note. * the relationship between variables was calculated after excluding the effect of the gross

domestic product. CIs = Credible Intervals.

4. Discussion

The aim of the present study was to investigate the association between baseline gender equality and its six core domains (work, money, knowledge, time, power, health) plus violence and later women's participation in transport cycling across EU countries. Results showed that the composite score of gender equality was associated with women's participation in transport cycling. Specifically, as the composite score of gender equality increased, the percentage of women reporting never cycling decreased. This relationship persisted even after controlling for the gross domestic product. Moreover, this relationship was also significant when considering the difference between the percentage of men and women who reported never cycling. In particular, the higher the composite score of gender equality, the closer to zero was the difference between the percentage of men and women who reported never cycling. These findings suggest that changes in women's roles and opportunities that challenge adherence to traditional gender roles and patriarchal and gendered division of labour may influence women's participation in transport cycling. As it was argued, an unequal division of time spent in carrying out the family responsibilities of child care and housework between women and men may prevent women from using bicycle in their daily trips (Aldred et al., 2016; Dickinson et al., 2003; Scheiner, 2014) and increment the likelihood of car use among women (Emond et al., 2009; Vance et al., 2004). Moreover, since the current cycling promotion efforts failed to increase representation of women (Aldred et al., 2016; McDonald, 2012), these results emphasize the need consider gender equality.

Gender equality is a complex and multidimensional concept, and more clarity can be achieved using a disaggregated measure of gender equality, rather than an overall index. To address the complex effect of gender equality on women's participation in transport cycling, this

study focussed on the distinct effects of the six core domains (work, money, knowledge, time, power, and health) plus violence of the Gender Equality Index (European Institute for Gender Equality, 2015) in explaining women's participation in transport cycling.

The present study has documented decisive evidence for the association between time (e.g., gender gaps in time spent on caring activities, cooking, and housework) and women's participation in transport cycling. This finding provided support for the hypothesis that gender gaps in the way in which individuals allocate their time on activities other than paid work are associated with lower women's participation in transport cycling. This association may be at least partially explained by gender differences in trip characteristics that are all less suited for bicycle travel. In their study on gender difference in bicycling choice, Akar et al. (2013) showed that among car drivers that actually have all or most of the options in their choice sets (e.g., proximity to destination), women are more likely than men to report that they do not have travel options. One likely reason is that women may think that car is their only option because of household responsibilities and associated trip characteristics. There is evidence that the division of roles in the labour market and the family affect women's employment conditions, income levels, and mobility needs and account for gender differences in travel patterns (Garrard et al., 2012; McGuckin & Nakamoto, 2004; Nobis & Lenz, 2004; Rosenbloom, 1989, 2004). Of course, it is also possible that women are more likely to ignore other options because of factors such as concerns about the vehicular traffic and lack of appropriate infrastructures (Akar et al., 2013; Garrard et al., 2012; Heesch et al., 2012). This explanation brings up questions about gender balance in governance/power structures rather than gender balance in daily tasks. The present study demonstrated that the equal representation of women and men in decision-making positions (power domain) was associated with women's participation in transport cycling. A

gender-balanced representation in positions of power is likely to switch the priorities of transport

politics from traditional goals to gender equality as well as to address the culturally specific

factors that are responsible for female take-up of cycling (Aldred et al., 2016; Polk, 2008).

Gender equality is likely to affect decisions about investments in cycling infrastructure. For

instance, addressing women' concerns about personal safety and traffic risks through improved

cycling conditions (e.g., a dense, well-connected network of separate paths together with good

intersection treatments, and complemented with low-speed, low traffic neighbourhood streets)

may succeed in attracting large numbers of new women cyclists (Garrard et al., 2012). Compared

to men, women are more likely to benefit from transportation systems that enable accessible and

safe cycling (Garrard et al., 2012). One important reason is that female workers tend to undertake

more trips to serve other passengers (usually children) than male workers (McGuckin &

Nakamoto, 2004; Nobis & Lenz, 2004; Rosenbloom, 1989, 2004). When cycling-friendly

conditions support independent trips (including using bicycle) by children and older adults,

women may be more likely to use bicycle as a transport mode even if equality in household-

serving tasks is not achieved.

The core domains of work and health were not associated with women's participation in

transport cycling. Although it is obvious that poor health could reduce bicycle use and commuter

cycling could be considered a health behaviour (Oja et al., 2011), the way gender gap in health

was measured may be part of the reason why there was not a significant association with

women's participation in transport cycling. While conceptually the sub-domains of health refer

to gender gaps in health status, health behaviours, and access to health structures, the second sub-

domain was not included in the Gender Equality Index due to constraints in the availability of

data. Concerning access to health structures, among EU countries there is small or no gender

gaps in terms of access to health structures. In terms of health status, in the course of the last years, the gender gap narrowed in self-perceived health (European Institute for Gender Equality, 2015). The combination of these factors may explain why health was not associated with women's participation in transport cycling.

The findings of the present study regarding the domain of work may be due to two conflicting effects of gender equality on women's participation in transport cycling. On the one hand, it is possible to hypothesize that the extent to which women have equal access to employment and suitable working conditions is associated with women's use of bicycle in their daily trips (e.g., commuting). On the other hand, car use among women is associated with employment (e.g., Best & Lanzendorf, 2005; Polk, 2004; Scheiner, 2014; Vance et al., 2004). A detraditionalization of women's role in the labour market may lead to a higher increase in car use than bicycle use because of a gendered division of household tasks. According to Best and Lanzendorf (2005), the concept of the 'transport disadvantage' applied to women's travel is closely related to their participation in the labour market as well as a gendered division of household tasks.

The role of knowledge and money was mixed: significant in one analysis and non-significant in the other. Knowledge refers to equal access to and participation in education and training. In the domain of knowledge, the gaps did not act to the detriment of women in the majority of EU countries. Concerning money, in contrast to developing countries where women's use of bicycles is limited for economic reasons (Fernando, 1998), the issues of poverty and unequal income distribution may not play an important role in women's participation in transport cycling in developed countries.

Women's participation in transport cycling was significantly related to violence. It is important to note that, although the change was significant, the effect sizes were small. Both direct (i.e., physical, sexual, psychological, and economic violence) and indirect (attitudes, stereotypes, and cultural norms that support gender-based aggression) violence against women may increment fear of crime and violence (e.g., Yodanis, 2004) which, in turn, is likely to affect women's participation in transport cycling (Emond et al., 2009; Loukaitou-Sideris, 2010).

The findings reported in the present study, however, need to be evaluated in light of several limitations. First, the sample of countries used was relatively small. Therefore, I cannot exclude that a small change in any given value could alter the pattern of results. The focus on a measure of effect size such as the Bayes factor and the use of Bayesian methods, which provide more accurate results than frequentist test with a small sample size, mitigate this limitation. It should be noted that, whereas the standard frequentist test is based on p value, the Bayes factor calculates the evidence in favour of both the null and the alternative hypotheses simultaneously. This is very important, since the level of significance by itself is not associated with effect size. Unlike significance tests, effect size is independent of sample size. Small effect sizes are not emphasized when using Bayes factor.

Second, the design of the study was not experimental and, thus, I cannot rule out the possibility that a third variable might account for the observed effects. It is important to bear in mind that the relationships examined were controlled for the effect of gross domestic product. In addition, the difference between the percentage of men and women who reported never cycling was used to control for confounding factors due to differences in pro-cycling conditions across the different countries.

4.1 Conclusions and Suggestions for Future Research

In summary, women's participation in transport cycling was higher in EU countries with higher scores on gender equality index, particularly for the domain of time (i.e., the trade-off between economic, care and other social activities). Although there are different barriers and motivators for cycling among women, the findings suggest that women's under-representation in positions of power and the traditional task division between the genders for childcare and household responsibilities may inhibit women's participation in transport cycling.

It has been observed that women (Hacker, 1951) as well as cyclists or people who cycle (Prati, Marín Puchades, & Pietrantoni, 2017) may be understood as a minority group. If this appears to be true, female cyclists may exist as minorities within minorities. It would be interesting in future studies to focus on rights and experience of women who cycle. Moreover, since infrastructure and the physical environment are important to improve women's participation in transport cycling (Garrard et al., 2012), future studies should investigate whether gender equality affects decisions about investments in cycling infrastructure or the two conditions (gender equality and quality of cycling infrastructure) simply coexist.

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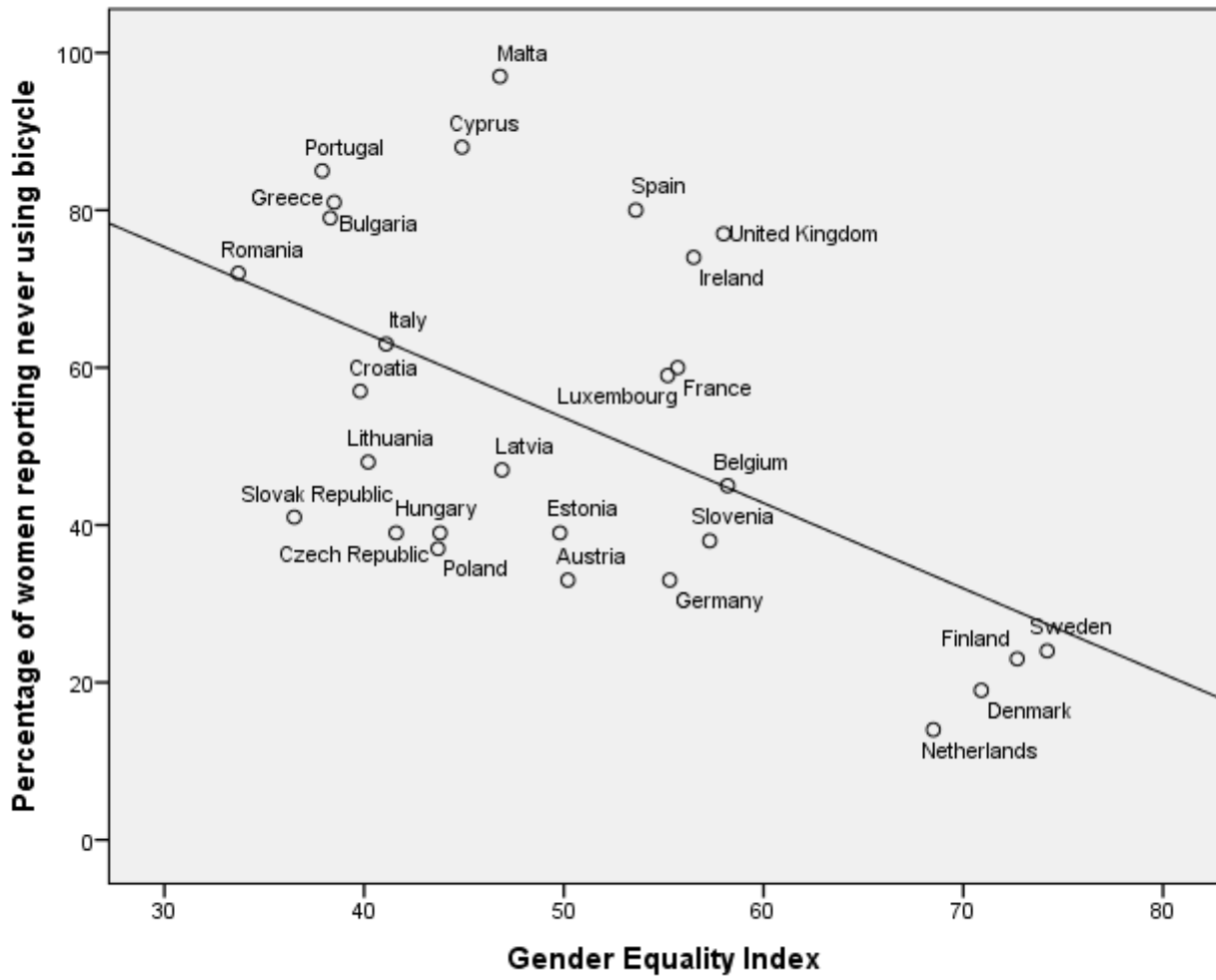
Appendix A

Figure 1. Percentage of Women Reporting Never Cycling and Gender Equality Index for each
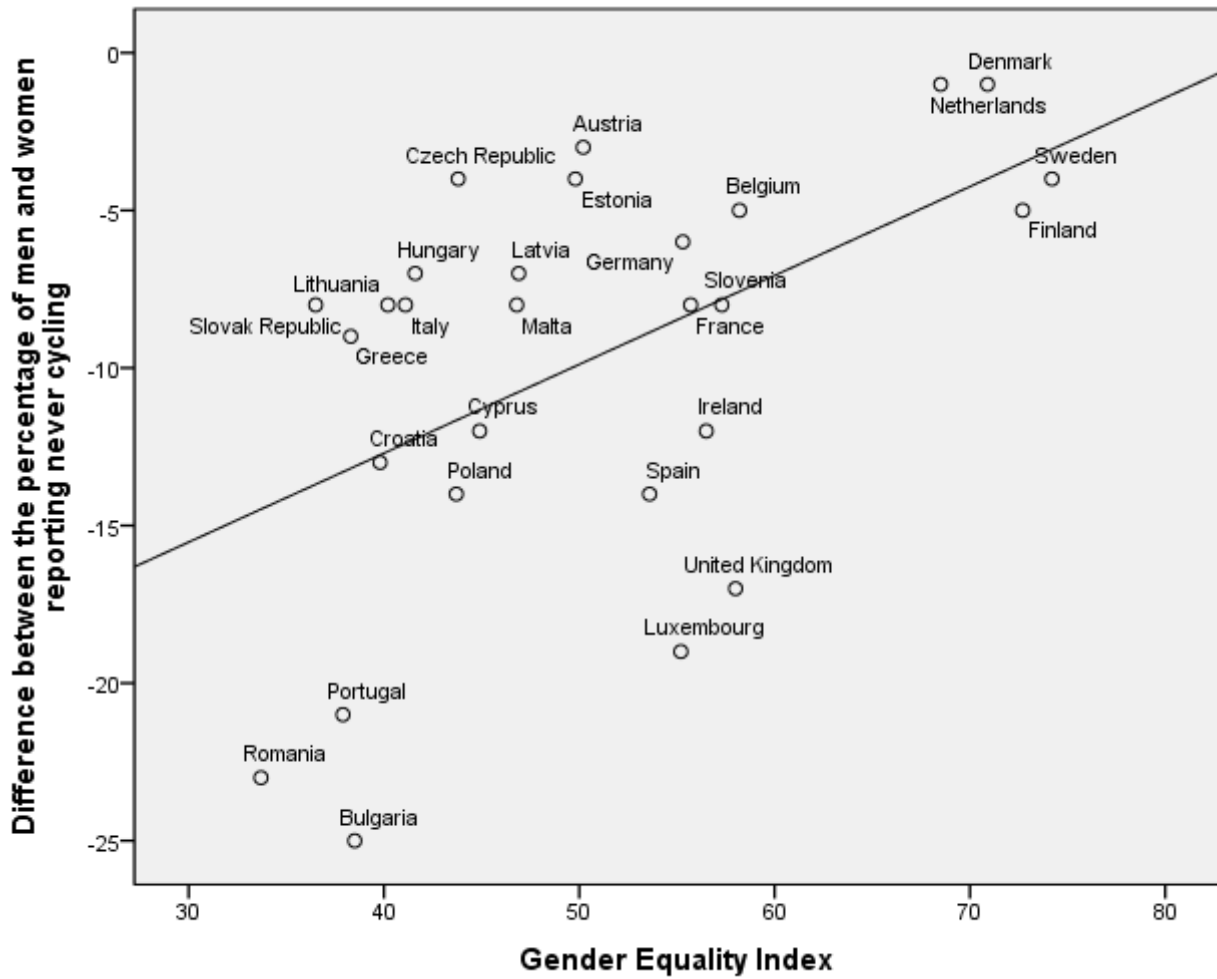
EU country.

Appendix B

Figure 2. Difference between the Percentage of Men and Women Reporting Never Cycling and

Gender Equality Index for each EU country.