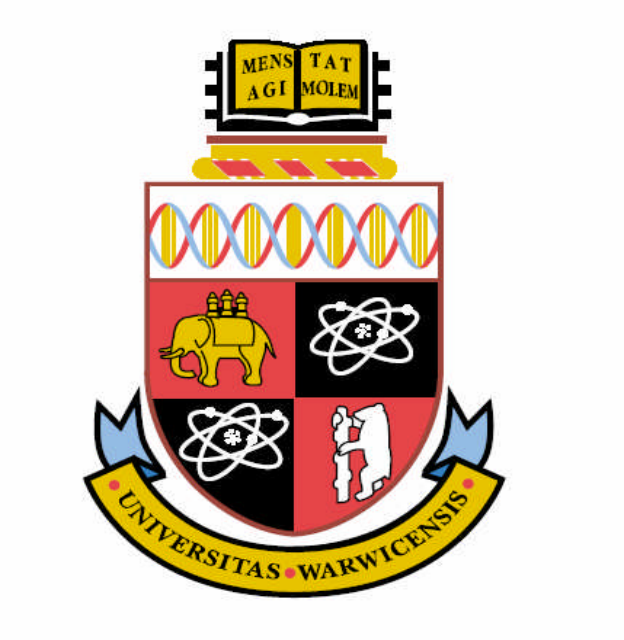
Research in Applied Economics EC 331

An Economic Analysis of Parking Behaviour in the University of Warwick Car Parks.



University Number: 0308882

Abstract

This project combines and tests a lot of theoretical and empirical predictions around the crime and punishment model developed in a range of papers by analyzing economically parking behaviour in the University of Warwick.

The rationality of individuals parking illegally is assessed and the factors that affect the decision of an individual to commit a parking offence are investigated. Using a range of papers we put together a list of variables that are likely to affect the decision of an individual to commit a parking offence. After collecting the data with the method of Random Response (RR) Survey, a probit regression was carried out to investigate which variables are significant in explaining parking behaviour and then the marginal effects of each were calculated.

Parking offences are an important problem within University of Warwick with 33% of participants in the survey admitting to have committed a parking offence at least once. Young males originating from countries classified as “corrupt”, with monthly disposable income <£1000 and with no moral restraints in regards to illegal parking, are more likely to commit a parking offence. Sentimental views regarding the University were not found to be a significant determinant in the decision to commit a parking offence or not.

The great majority of individuals taking part in the research showed signs of rational behaviour. Increases in probability of detection and severity of punishment discourage illegal parking. Non-Credible penalties however are deemed not enforcible. The current enforcement system is characterized by low probabilities of detection. Corresponding to these low probabilities are relatively high sanctions exceeding harm. The magnitude of sanctions tends to increase with the severity of harms whilst sanctions are higher for repeated offenders. There is room for improvement in increasing the probability of detection but this should only be done after conducting a cost and benefit analysis.

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Introduction:

"Obedience to law is not taken for granted and public and private resources are generally spent in order to both to prevent offenses and to apprehend offenders[1]*".*

Illegal parking has been for years a widespread problem around the world. Badly parked vehicles slow down other users including emergency services and buses thus creating congestion. The roads become more dangerous for drivers, cyclists and pedestrians and the environment is damaged. Police and local councils have a lot of resources tied up in tackling parking offences which they could devote elsewhere and especially in tackling more serious forms of crime. It is therefore interesting to look at the factors driving an individual to commit a parking offence.

This project analyses economically the parking behaviour of car park users in University of Warwick car parks. Following Becker's paper, several studies have been conducted on the economics of crime and punishment. There have been only a few papers however focusing specifically on illegal parking as a form of crime. I will try and put together a number of papers on crime and punishment model with studies focusing specifically on parking offences and this is where the novelty of this project lies. The research is based within the closed community of Warwick University something which has both advantages and disadvantages both of which are discussed later on in the project.

In this project I will look in depth at the specific personal characteristics of Warwick University car park users and try to find signs of rationality in their behaviour. I will also discuss the effectiveness and rationality of current university parking policies and suggest possible measures to combat the problem of increasing parking offences. Finally I will compare my results with relevant literature and point out to similarities and differences in my conclusions.

[1] Becker *"Crime and Punishment: An Economic Approach"* 1968

I first outline the relevant literature in Section 1. I then explain the main idea, theoretical background and methodology of my project in Section 2 and link it with the relevant literature. In Section 3 the data collected are described and a preliminary analysis is carried out on them. In Section 4 I outline model formulation, econometric procedure and my results. Finally in Section 5 the results are interpreted and comparison is made with relevant literature. The Project concludes with criticisms and suggested extensions.

Section 1: Literature Review:

Over the years there have been a number of papers on crime and punishment. I used Becker's work (1968) as my basic building block but I also used a number of papers written since then which also provide insights into the behaviour of criminals and others which are directly focused on parking behaviour. The papers I used the most are the ones from, Ehrlich (1973), Block and Heineke (1975), Nuno Garoupa (1997), Mitchel Polinsky and Steven Shavell (2000), and Ray Fisman and Edward Miguel (2006).

The Becker Model was the first article which rigorously examined the concept that crimes have an economic explanation and is thus the cornerstone of economic analysis of crime and punishment. Ever since policy makers used economic models at their disposal to achieve effective law enforcement.

Becker treats criminals as utility maximisers. A rational individual would only commit a crime if its expected utility was greater than the utility he would gain from engaging in an alternative legitimate activity. According to Becker there exists an optimal combination of probability of detection (P) and severity of punishment (F) that leads to "crime does not pay" situation, therefore only risk lovers would commit a crime.

After a criminal's motivations are identified policies can be made more effective by trying to reduce utility gained by criminals. Risk lovers could be targeted and the optimal level of punishment could be ascertained to change their perceptions of the costs of illegal activity. A criminal decision is based on subjectively held views on probability of being caught and severity of punishment and usually these are different from their

objective counterparts. Dealing with crime consumes resources and hence the minimum social loss from crime is greater than zero. Policymakers are aware of this tradeoff between extra resources and achieving the "crime does not pay" situation and thus need to choose the optimum balance between the two.

With every model however comes a criticism. Becker oversimplifies the model by assuming legitimate activity is risk free, however this may not be true in periods of job insecurity and sickness during which returns from legitimate activity are risky. Monetary wealth changes can not be the only determining factor in choosing to commit a crime. The model underestimates the pleasure derived from committing risky crimes and other personal characteristics of criminals. The most significant criticism of the model is in its conclusions. Becker supports the deterrence theory of crime however he has little to say about the specific magnitude of the deterrent effect or whether it is the certainty or the severity of punishment that is most effective in deterrence.

Isaac Ehrlich (1973) uses a more elaborate framework than Becker. He employs state preference theory in his model. The only uncertainty in the model is over which state will occur. The states used are: (1) The individual is apprehended and convicted (2) The individual is not caught. Ehrlich ignores states: (3) The individual is caught but not punished (4) Innocent individuals are wrongfully punished.

Ehrlich finds a strong deterrent effect of law enforcement activity on all crimes and a strong positive correlation between income inequality and crimes against property. He also points out specific characteristics of individual offenders. Young males with little schooling or other legitimate training are more likely to commit a crime. Many continue their participation in illegitimate activities even after being apprehended and punished. Looking from a purely rational economic individual's point of view, if engaging in crime would guarantee a higher level of wealth (despite detection) than in engaging in legal work, only the highly moral or misinformed would bother with honesty.

Under Block and Heineke model, decision to partake in crime is not only based on the effect of the individual's monetary wealth. They argue that "psychic" costs of

illegitimate activity need to be considered explicitly. The crucial difference of this model from the previous two is that utility is affected directly because of honest work or a crime's "disagreeability" rather than indirectly through changes in wealth. In some situations there can be no monetary wealth equivalent to psychic costs incurred when committing a crime.

Is there disutility from the stigma of being caught? To find out we need to introduce an additional variable which will catch this effect. Risk preference does not necessarily imply an inclination towards crime. For risk averse individuals who showed preference for honesty, criminal indulgence was reduced by an increase in probability of detection or level of fine. However such changes would not deter even a risk averse individual with inclination towards crime.

Dealing with crime consumes resources and hence the minimum social loss from crime is greater than zero. Policymakers are aware of this tradeoff between extra resources and achieving the "crime does not pay" situation and thus need to choose the optimum balance between the two. How much of society resources should be devoted to apprehending violators?

Optimal enforcement tends to be characterized by some degree of under-deterrence relative to first-best behaviour, because allowing under-deterrence conserves enforcement resources. Public enforcement is therefore often characterized by low probabilities of detection. Corresponding to these low probabilities are relatively high sanctions often exceeding harm. The magnitude of sanctions tends to increase with the severity of harms whilst sanctions are higher for repeated offenders.

Possible suggestions for an enforcement system include setting P=1 but high costs are then incurred in enforcement. Another option is setting $F = \infty$ (used in ex-Communist and Third World Countries where P was low) but maximum penalties most of the times are not enforcible. Furthermore setting $F= \infty$ reduces the ex-ante utility of non-criminals. Therefore an optimal combination of P and F must be found to minimise social loss from criminal activities.

In the Fisman and Miguel paper (2006), the authors make use of a natural experiment, the fact that thousands of diplomats from around the world are stationed in New York City. Given that there is zero legal enforcement on diplomatic parking violations, they are able to examine the role of cultural norms alone. Their findings suggest that diplomats from countries ranking highly in the corruption index commit significantly more parking violations and these differences persist over time. Diplomats although stationed thousands of miles away from their country behave in a manner highly similar to officials in their home country. They also find that officials from countries which have less favourable popular views for the United States commit significantly more parking violations. This could provide evidence that sentiment plays an important role in economic decision making.

Section 2 : Main Idea and Methodology

2.1:Illegal Parking as a Crime:

"Although the word "crime" is used in the title to minimize terminological innovation, the analysis is intended to be sufficiently general to cover all violations, not just felonies-- like murder, robbery, and assault, which receive so much newspaper coverage-- but also tax evasion, the so called white collar crime, and ***traffic*** *and other violations"*[2].

"The University of Warwick is registered with the SIA (Security Industry Authority) as a body that operates a vehicle immobilisation operation, in line with Security Industry Act 2001 (Vehicle immobilisation)."[3]

Illegal parking within University of Warwick constitutes a form of crime. There are 20 car parks on campus which include 3 multi storey car parks giving in total 4212 parking spaces. The University of Warwick has established property rights over the University car parks. The "criminals" violate the property rights of the University without

[2] Becker 1968 "Crime and Punishment: An Economic Approach"
[3] A link to the webpage for Parking Regulation Enforcement, Warning and Vehicle Immobilisation Procedures can be found in References – Bibliography Section.

its consent for personal gains. In turn, Security team is given the task to protect the property rights and apprehend criminals.

As with any form of crime, there are social costs involved with illegal parking. A lot of car park users do not face the actual cost of bringing a car to university and wrong economic signals are sent out. Apart from congestion and safety matters mentioned above there is loss of income for the University which could be used for improving University facilities as a form of public good.

2:2 University of Warwick Car Park Regulations

The University's stand on illegal parking is the following:

"It is an offence to park anywhere on campus other than in a designated parking space. The university may take the following action against offenders: fit wheel clamps, exact fines, and tow vehicles away. The University may charge owners the cost of tracing ownership and of towing and storing vehicles"

List of offences and penalties can be seen in the screenshot below[4].

In 2006/2007 offences will attract the following fines:-

Parking in a space without displaying a valid ticket or permit	£20.00
parking in a non designated space	£20.00
Parking on double yellow lines	£25.00
Parking in loading bays, or grass verges	£25.00
Parking in a fire lane, or a space designated for disabled drivers	£35.00
Unauthorised Overnight Parking	£20.00

The fines will be charged for each 24 hours or part thereof. If a vehicle is clamped more than twice, the penalty will be doubled and thereafter trebbled and so on incrementaly. Frequent offenders will be disciplined for breach of University regulations.

Please see http://www2.warwick.ac.uk/services/ancillary/carparks/enforce/ for information on the enforcement of these regulations.

[4] A more detailed statement can be found in the relevant University of Warwick webpage the link of which is provided in the appendix.

A quick glance at the car park regulations demonstrates that a lot of them correspond to suggestions made in a range of papers around crime and punishment which were analysed before in the literature review. There is indeed increasing severity of punishment with increasing amount of damage done to society as Becker purports should be the case; that is a penalty proportionate to the seriousness of offences. Parking in fire lanes or spaces designated for disabled drivers possibly creates higher social costs than parking on double yellow lines or parking without displaying a valid ticket or permit and therefore the penalty is higher. Furthermore the University deals with repeated offenders the way Mitchell Polinsky and Steven Shavell suggest a policing authority should deal with them; with increasing sanctions as the offence is repeated over and over again.

2:3The Theory of the rational offender:

The theory of the rational offender first purported by Becker suggests that people will commit crime if the expected utility of committing the crime is more than the expected utility of not committing it.

- *Y = Income if no crime is committed.*
- *G = Gain from crime*
- *F = Fine if caught*
- *P = Probability of being caught*
- *E (U) of Committing Crime = (1-P) V (Y+G) + P V (Y+G-F)* → *In the case of parking without paying in pay and display car parks the individual does not loose the gains of committing the crime if he is caught.*
- *E (U) of not committing Crime = V (Y)*
- *Crime will be committed if E(U) Crime > E(U) No Crime*

As we do not know the utility functions of each individual we have to restrict our mathematical analysis to risk neutral individuals who have the same utility when they face two states of the world (caught, not caught) as long as the expected monetary wealth is equal[5]. Here we ignore the two states Ehrlich ignored that is: (1) The individual is caught but not punished (2) Innocent individuals are wrongfully punished.

[5] I.e. Utility function is linear in wealth whilst for risk averse individuals it is concave.

Given the current penalties we can easily do a pure mathematical analysis of parking behaviour based on expected returns. Since the cost of parking is 1.00 in most pay and display car parks and the penalty if you do not pay is 20.00 then a risk neutral individual will be indifferent between committing a parking offence or not if the probability of detection is 5%[6].

Another novelty in this project however, will be that we will not be constrained by monetary wealth analysis, and we will explore the possibility of certain personal characteristics that increase or decrease the probability of committing a parking offence.

Section 3 Data Description and Analysis

3:1 Source of Data

Data was collected from University of Warwick car park users including undergraduate and postgraduate students, members of staff, people working in the university and visitors. The method adopted was the Random Response survey (RR). The participants were asked to fill out answers to a series of questions[7].

Summary Table	
Committed Parking offence	33%
Mean Age	25 Years
Gender	
Males	55%
Females	45%
Income Groups	
<500	54%
500-1000	26%
>500	20%
Opinion regarding parking offences	
Morally Wrong	59%
Not Morally Wrong	41%
Country of origin	
“Corrupt”	23%
“Not corrupt”	77%
Sentimental feelings regarding university	
Favourable	94%
Unfavourable	6%

[6] Mathematical derivation can be found in appendix.

[7] A sample of the questionnaire used can be found in the appendix.

3:2 Description of variables

Dependent Variable: Commit Parking offence.

Participants in the survey were asked if they had ever committed a parking offence in the University of Warwick Car parks. The list of parking offences was created after consultation with security on reasons that require clamping action. Actions classified as parking offences included:

1. Parking in a space without displaying a valid ticket or permit, parking in a non designated space, or unauthorised overnight parking (Penalty £20)
2. Parking on double yellow lines, loading bays or grass verges (Penalty £25)
3. Parking in fire lanes, or a space designated for disabled drivers. (Penalty £35)

It was surprising that a large percentage of the participants (33 %) admitted to have committed a parking offence at least once. That means that approximately one in every three car park users has committed a parking offence at least once within the University of Warwick.

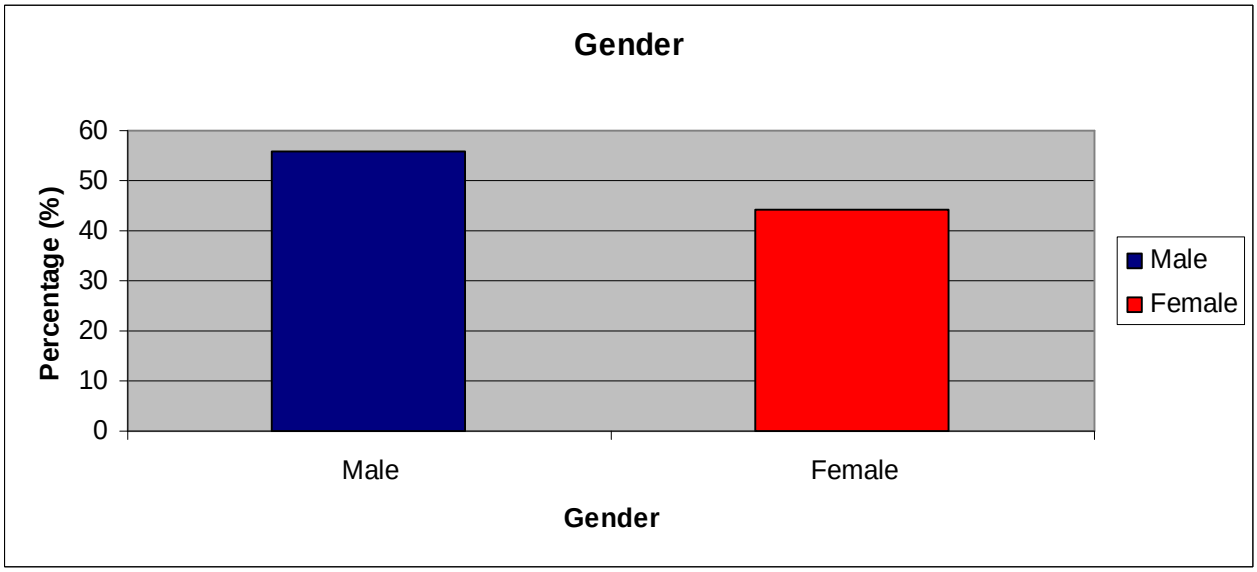
Participants were also asked to list in which way they committed the parking offence having the 3 choices listed above. Every participant could tick more than one ways to commit a parking offence relevant to them.

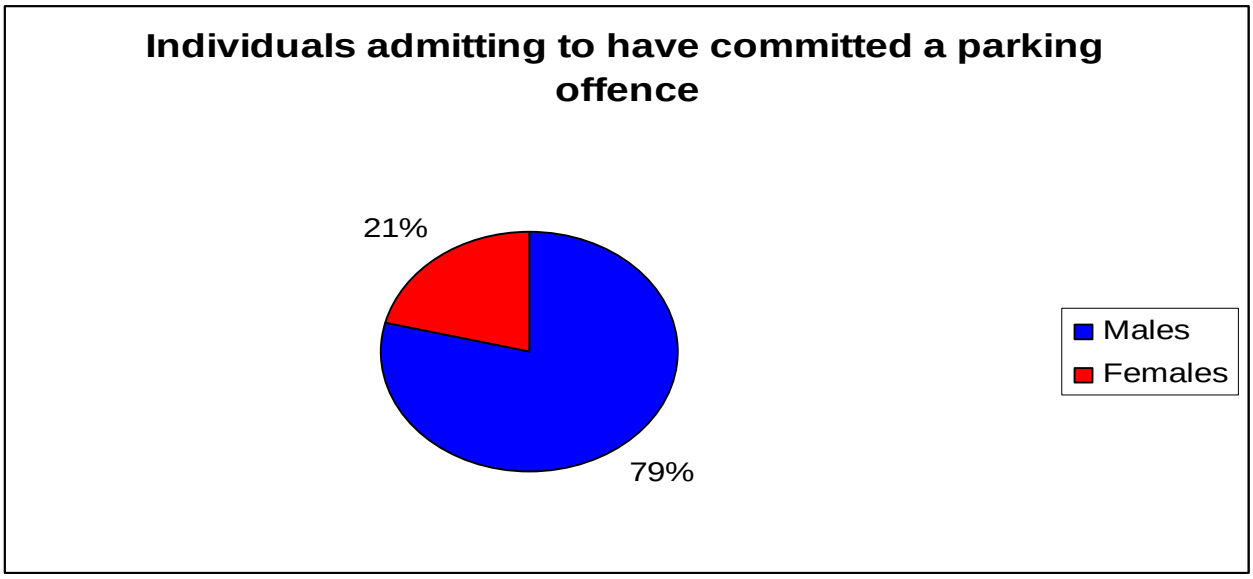
1. Out of the participants, 24 % admitted parking without displaying valid ticket or permit, parking in a non designated space or unauthorised overnight parking.
2. Out of the participants, 15 % admitted parking on double yellow lines, loading bays or grass verges.
3. No one admitted parking in fire lanes or spaces designated for disabled drivers.

Independent explanatory variables:

1. Gender

Previous studies (Ehrlich 1973) have shown that males are more inclined to crime than females. Women are socialized differently and view crime more negatively than men and therefore commit fewer offences in general. I will test to see if there are actually differences between male and female behaviour. Out of the participants in the survey 55% were male. At the same time males constituted 79% of the people admitting to have committed a parking offence whilst females constituted only 21% of the offenders.

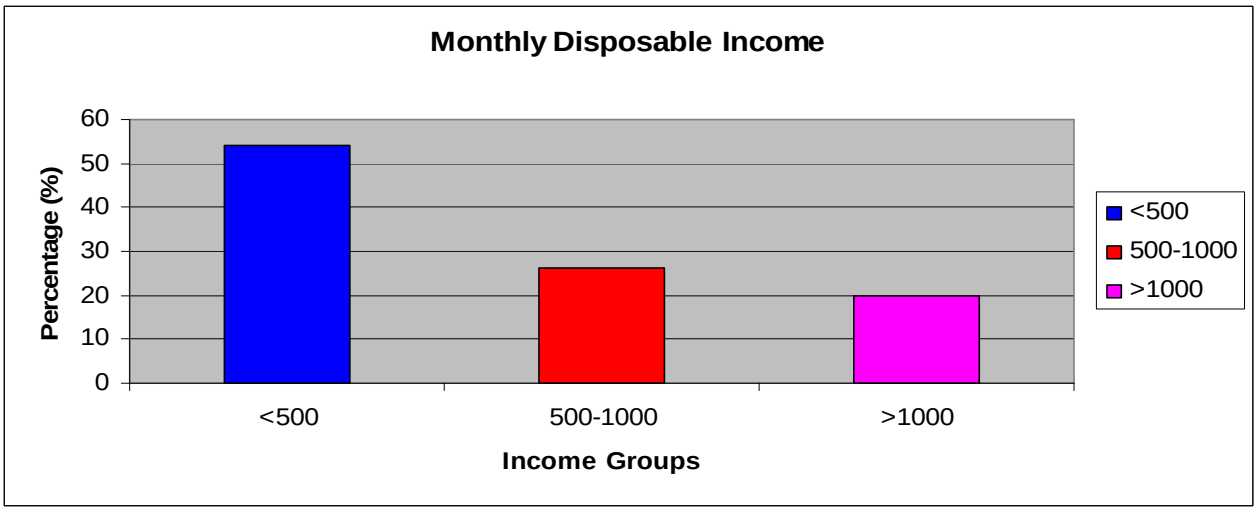


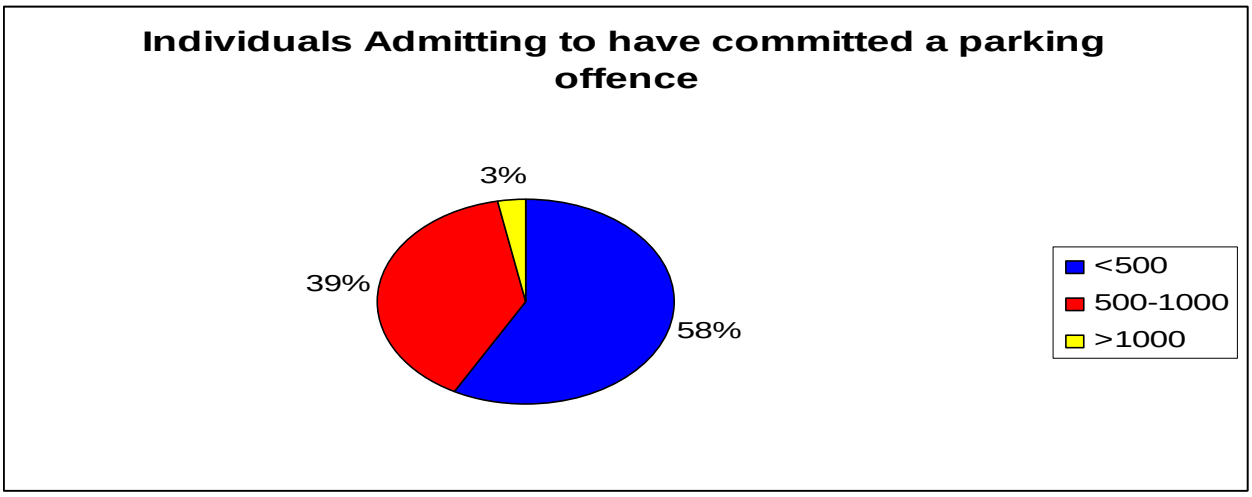


2. Income

I asked participants for their monthly income. For students this is how much they have disposable each month either through their student loan or through parental or other family contribution including any paid work they undertake. Previous studies have shown that there is a significant positive correlation between income inequality and crime. I will use the data to test whether income is significant in explaining parking offences.

Out of the participants 54% belong to <500 income group, 26% belong to 500-1000 income group and only 20% belong to >1000 income group. This is unsurprising however given that the vast majority of car park users are students. Out of the individuals admitting to have committed a parking offence, 58% belonged to <500 income group, 39% belong to 500-1000 and only 3% belong to >1000.

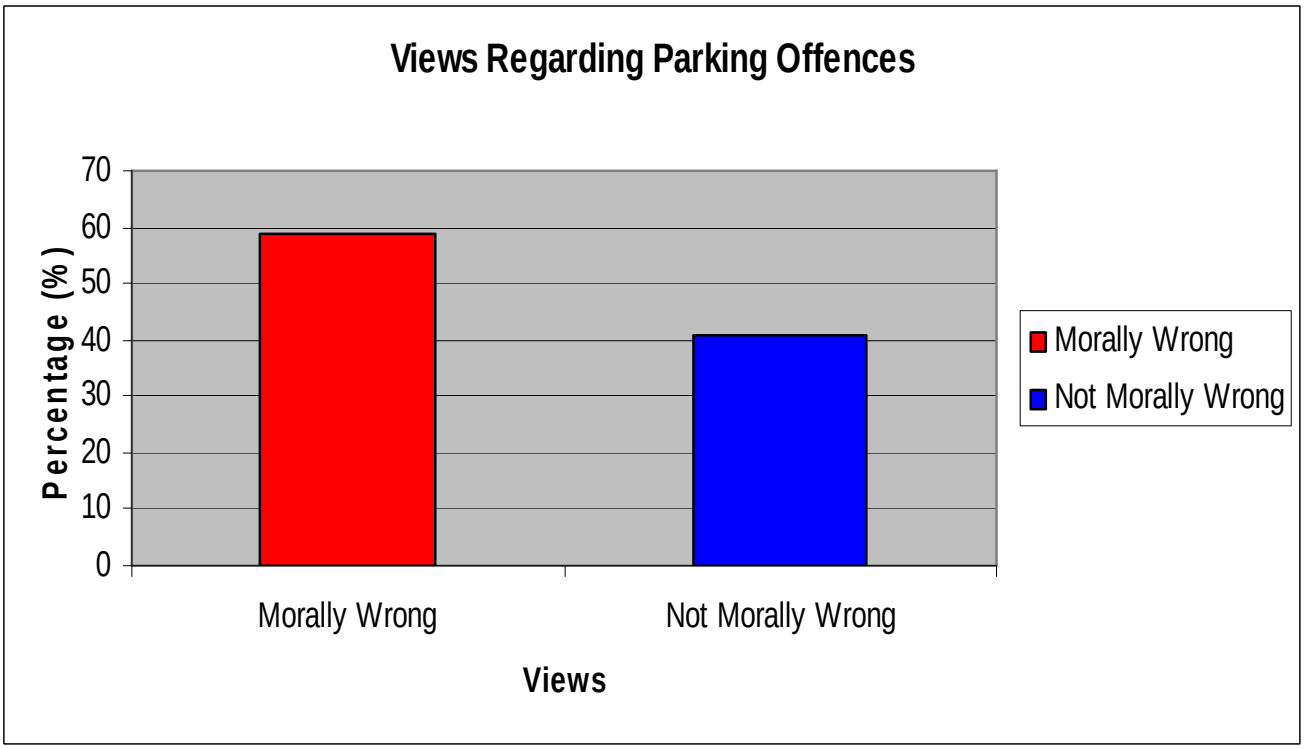




3. Opinion Regarding Parking Offence. (Based on Morality)

Participants were asked questions regarding their opinions on each of the 3 parking offences listed by security as reasons requiring clamping action. In general if participants feel its wrong, (i.e. face high "Psychic Costs") to commit a parking offence they would not do so as purported by Block and Heineke (1975). Using this variable we can test the "preference for honesty" of individuals using University of Warwick car parks.

Out of the participants in the survey only 59% believe it is morally wrong in principle to commit a parking offence. This percentage increases however to 94% regarding parking in fire lanes or spaces designated for disabled drivers. Out of the people believing that committing a parking offence is wrong only 26% committed one in the past whilst the percentage for the whole sample was 33%. We should therefore expect a negative relationship between the moral dummy and the probability of committing a parking offence.

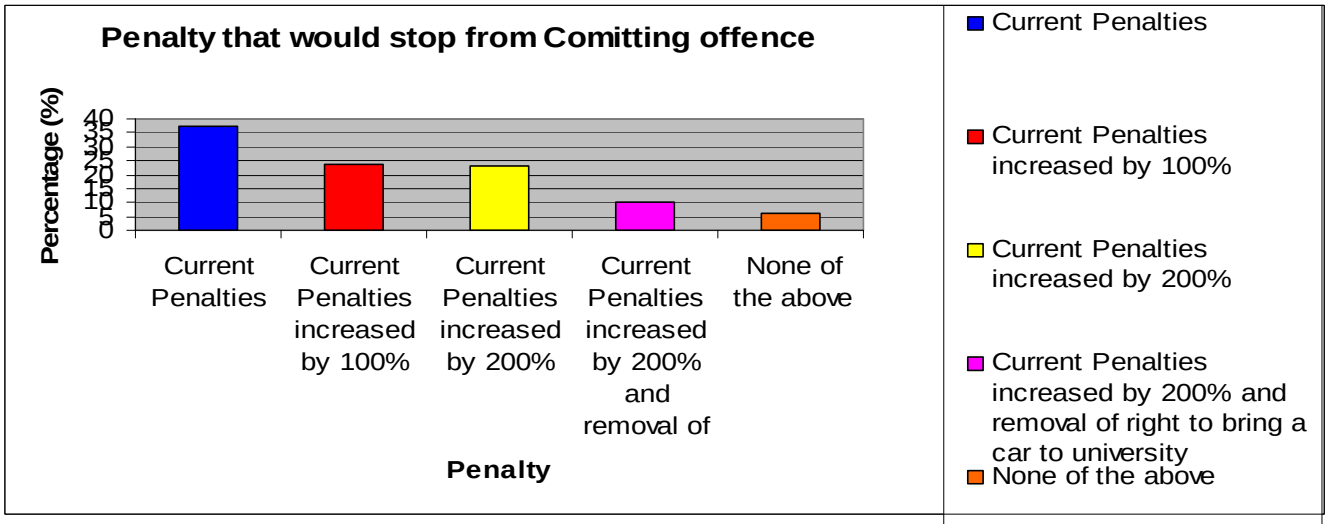


4. Punishment

Economic theory suggests that as the penalty imposed on crime gets higher the less likely is a person to commit the crime. Participants were asked to choose what forms of punishment would deter them from parking illegally. The question asked students to assume they already used to park illegally and ceteris paribus choose a penalty that would deter them from doing so. Options were listed in increasing levels of severity.

1. Pay current penalties. (£20, £25, £35)
2. Increased penalties by 100% (£40, £50, £70)
3. Increased penalties by 200% (£60, £75, £105)
4. Increased penalties by 200% and removal of the right to bring a car in University of Warwick.

Out of the participants 37% stated that would be stopped from committing a parking offence by current penalties 24 % stated that increased penalties by 100% would stop them, 23% that increased penalties by 200% would stop them and only 10% would be stopped by the additional sanction of removal of right to bring car to university. This is probably because removal of right to bring a car to university is not considered as a credible threat. Only 6% stated that none of the above penalties would deter them from committing parking offences.



5. Country of Origin of Participant.

Previous studies (Fisman and Miguel 2006) have shown that people living in a foreign country usually carry with them the "corruption" they are used to in their country of origin. It was shown that Scandinavian people are the most law abiding whilst people from African and the Middle Eastern countries are more prone to committing a parking offence. The country of origin will be therefore used as a dummy variable to see if there is a significant difference in parking behaviour between people from different countries in the world.

As there is not enough data to investigate this on an individual country level what I decided to do is to split the sample into people coming from "corrupt" countries and people coming from "non-corrupt" countries. I used the transparency international index[8] an index ranking countries according to how corrupt they are. The index ranges from 1-10 with increasing numbers showing less corruption. I chose an arbitrary cutoff point of 5 which is the mid value of the index classifying as corrupt all countries with a value below 5 and non corrupt all countries with a value above 5.

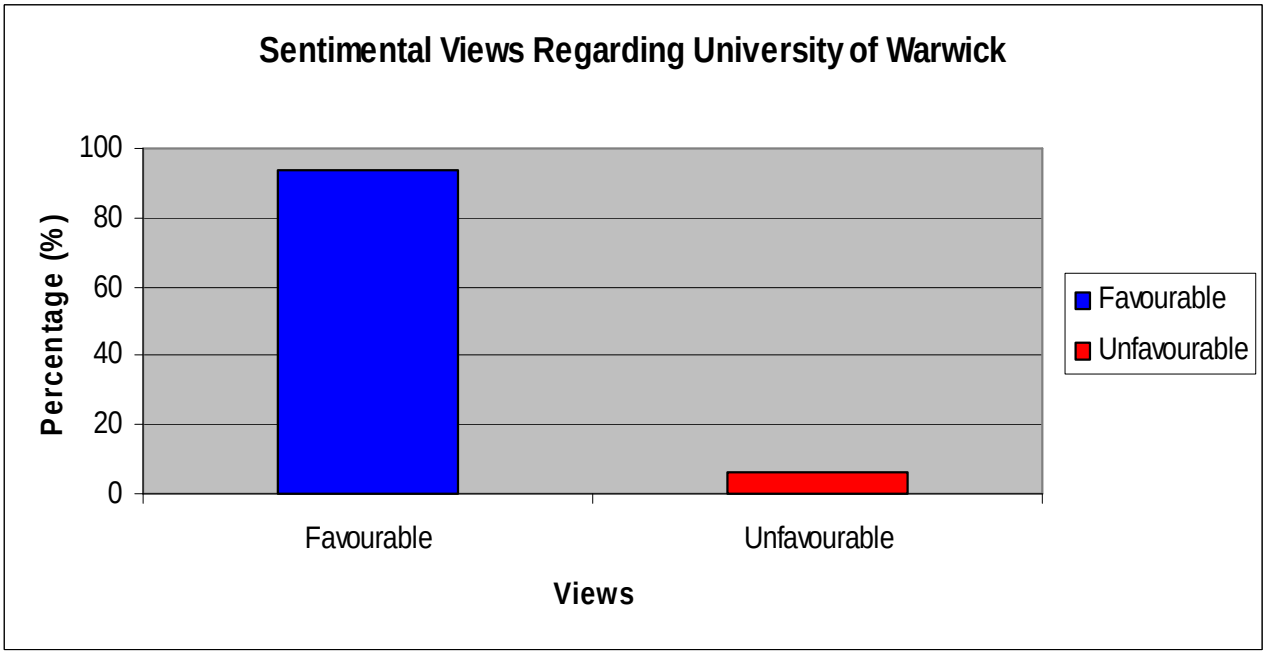
Out of the participants in the survey 23% originated from countries classified as "corrupt" according to transparency international index. Within that classification we can find a few European Union countries such as Greece, Romania, Italy, Czech Republic, Lithuania, Latvia, Slovakia and many more Latin American, Asian and African countries.

[8] Transparency international corruption index can be found in appendix.

6. General Sentimental feelings about the University of Warwick.

The participants in the survey were asked to indicate their general sentimental feelings about the university (Favourable/Unfavourable). Fisman and Miguel (2006) have shown that sentiment could play an important role in economic decision making. Diplomats from countries in which the public sentimental feelings regarding the US were low, were shown to commit more parking offences in New York City. I will therefore test whether the participants' general view regarding the University plays a role in their decision to commit a parking offence or not.

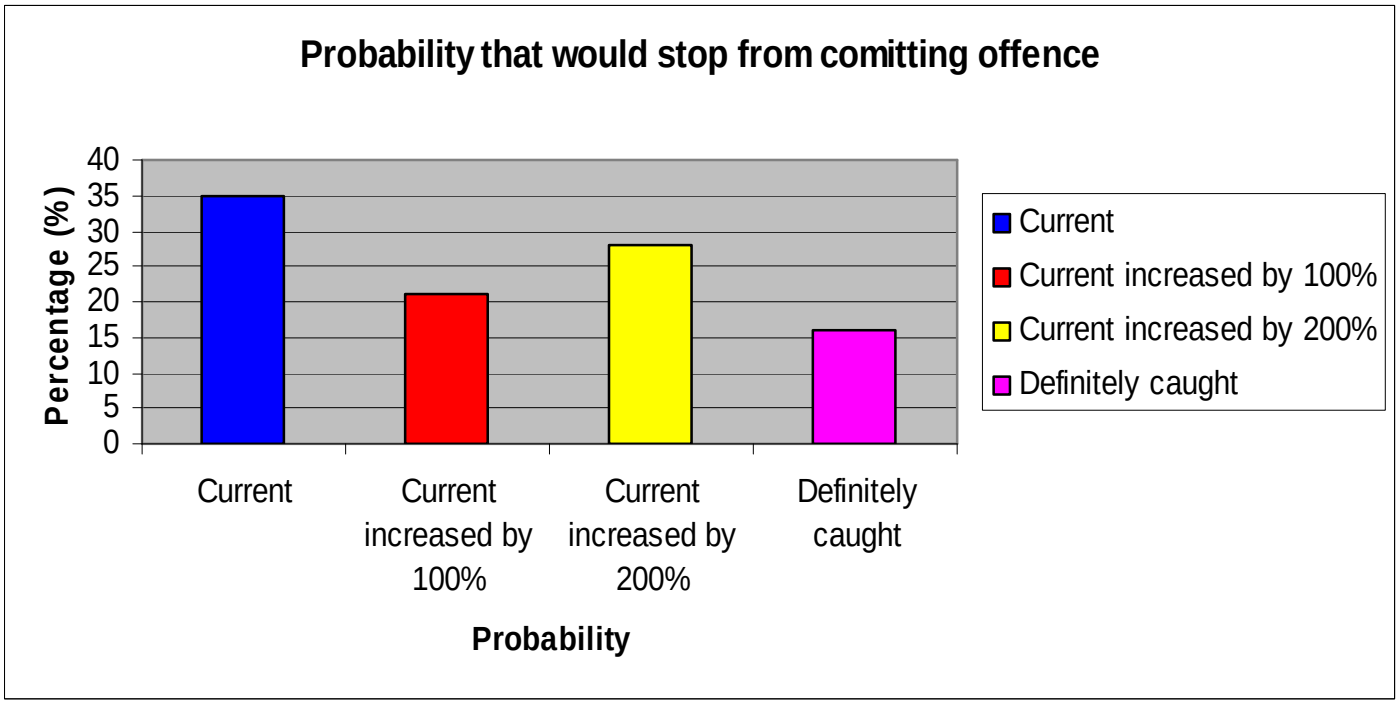
Out of the participants in the survey 94% held favourable feelings in general regarding the University of Warwick and only 6% held unfavourable feelings. The percentage of individuals holding favourable feelings is much higher than the one yielded in satisfaction survey conducted by the University of Warwick. A possible reason is that a lot of people may have not felt comfortable to write their true feelings as the questionnaire was handed back on the spot and their individual views could be seen.



7. Perceived probability of getting caught.

The results of the survey on the participants' perceived probability to get caught are very important. The average perceived probability of getting caught if you commit a parking offence is 25%.There is however tremendous variability between the responses. The highest perceived probability is 75% and the lowest 0.01%. The median probability is 20% and the modal one is 5%.Given that the true probability of getting caught is unique it is clear that the perceived subjective probability of getting caught of the offenders is different from the objective. This finding verifies Becker's (1968) propositions, that criminals commit crime based on subjective probabilities of getting caught which are different from the objective.

Out of the participants, 35% would be stopped from committing a parking offence by the current probability of getting caught, 21% would be stopped if the current probability is doubled, 28% if the current probability increases by 200% and 16% would be deterred from committing a parking offence only if they were definitely caught.



Section 4: Model Formulation:

I entered the collected data into a Stata dataset file and I carried out a probit regression[9] to find how the probability of committing a parking offence increases or decreases with a change in the explanatory variables.

4:1: Suggested Model:

My suggested model is:

CPO = a + b1age + b2wco + b3inc1 + b4inc2 + b5 fav + b6 male + b7 corrupt

Where **age** is age of participants, **wco** is a dummy for people believing its morally wrong to commit the offence, **inc1** and **inc2** are the income groups <1000, **fav** are the people having favourable views regarding Warwick University, **male** is a dummy for males and **corrupt** is a dummy for participants coming from countries classified as "corrupt" according to the corruption index

The expected signs of the coefficients based on previous literature are:

b1= -ve, b2= -ve, b3= +ve, b4= +ve, b5= -ve b6=+ve and b7=+ve

Coefficients with –ve sign imply that the variable decreases the probability of committing a parking offence whilst coefficients with +ve sign imply that the variable increases the probability of committing a parking offence.

[9] Explanation of probit model can be found in appendix.

4:2 Probit Regression Results (s.e. in parentheses):

CPO = -0.891 -0.032**age** + 0.803**corrupt** + 0.726**male** -0.296**wco** -0.228**fav** +0.999**inc1** +1.28**inc2**
(0.708) (0.209) (0.190) (0.178) (0.166) (0.350) (0.307) (0.328)

4:3 Marginal Effects:

Variable	**Marginal Effects**	**Z-Statistic.**
Age	-0.011 (0.007)	-1.59
Corrupt	0.288 (0.070)	4.09
Male	0.230 (0.054)	4.30
WCO(Believe it is morally wrong to commit offence)	-0.099 (0.056)	-1.77
FAV (Have favourable feelings regarding university)	-0.079 (0.128)	-0.62
Inc1	0.311 (0.088)	3.55
Inc2	0.459 (0.113)	4.06

4:4Econometric tests on the model:

It is very useful to conduct diagnostic LM tests of the selected model for Heteroscedasticity and non-normality[10]. It would also be interesting to check whether the impulse effects are the same for the two income groups <1000 and thus they can be included as a joint variable rather than as 2 separate ones.

[10] Full results, methodology and regression output can be found in the appendix under the relevant sections.

Test 1: LM test for Heteroscedasticity with respect to the variable **male**

V{ ε_i }=kh(z'_i a) if a=0 then V{ ε_i }= σ^2

$H_o : a = 0$ (I.e. No Heteroscedasticity)

$H_1 : a \neq 0$ (I.e. Heteroscedasticity)

To construct an LM test for Heteroscedasticity we run a regression of ones upon the variables states in the following table[11].

Constant	***COEFFICIENT***	***STANDARD ERROR***
Gres	0.332	0.838
Gres 1= gres*corrupt	0.597	0.331
Gres 2 = gres*age	-0.030	0.035
Gres 3 = gres*male	1.461	0.684
Gres 4= gres*wco	-0.372	0.240
Gres 5 =gres*fav	-0.471	0.371
Gres 6 = gres*inc1	0.798	0.467
Gres 7= gres*inc2	0.977	0.551
Ghet1 =gres*xb*male	-2.927	1.321

Test Results:

Sample Size TSS	***343***
RSS	338.04
p-value	0.026
DOF	1

Test Statistic:

$\xi_{LM} = N * uncentredR^2 = ESS = TSS - RSS = N - RSS =$ 343 – 338.04 = 4.96

Conclusions:

The null hypothesis of Homoscedasticity with respect to variable male is not rejected at the 1% significance level but is rejected at 5%. Apparent heteroscedasticity could also be caused by other factors such as omitted relevant variables or incorrect functional form.

[11] In this table gres are the generalised residuals from our model probit regression and regression results are in 3decimal places.

Test 2: LM test for non-normality

$H_O : E\{\varepsilon^3{}_i\} = 0$ and E $\{\varepsilon_i{}^4 - 3\sigma^4\}$ =0, corresponding to the absence of skewness and excess kurtosis.

(I.e. Normality)

$H_1 : E\{\varepsilon^3{}_i\} \neq 0$ and E $\{\varepsilon_i{}^4 - 3\sigma^4\}$ >0, (i.e. Non-Normality)

To construct an LM test for non-normality we run a regression of ones upon the variables stated in the following table:

Constant	***COEFFICIENT***	***STANDARD ERROR***
Gres	1.770	0.946
Gres 1= gres*corrupt	3.037	0.814
Gres 2 = gres*age	-0.121	0.046
Gres 3 = gres*male	2.684	0.739
Gres 4= gres*wco	-1.328	0.386
Gres 5 =gres*fav	-1.434	0.480
Gres 6 = gres*inc1	3.487	0.959
Gres 7= gres*inc2	4.664	1.271
Gnorm2=gres*xb^2	-27.035	8.066
Gnorm3=gres*xb^3	19.505	6.873

Test Results:

Sample Size TSS	***343***
RSS	328.48
p-value	0.0007
DOF	2

Test Statistic:

$\xi_{LM} = N * uncentredR^2 = ESS = TSS - RSS = N - RSS =$ 343-328.48 = 14.52

Conclusions:

The null hypothesis of normal distribution of the error term is rejected at the 1% significance level. This implies that estimators will be inconsistent. This problem is alleviated however when we use a big enough sample.

Test 3: Likelihood ratio (LR) test of the hypothesis that inc1 and inc2 have equal coefficients.

Null Hypothesis: $H_O : \beta_3 = \beta_4$ under H_0 the test statistic follows a X^2 distribution

Alternative Hypothesis : $H_1 : \beta_3 \neq \beta_4$

Test Statistic: LR chi2 (1) = 2.33

P-Value: Prob > chi2 = 0.1271

Degrees of Freedom: 1

Conclusion: We can not reject the null hypothesis even at the 10% significance level.

Marginal Effects of new model with INC1 and INC2 included as a joint variable INC:

Variable	**Marginal Effects**	**Z-Statistic.**
Age	-0.012 (.00665)	-1.74
Corrupt	0.284 (.06981)	4.07
Male	0.245 (.0521)	4.71
WCO(Believe it is morally wrong to commit offence)	-0.086 (.05473)	-1.56
FAV (Have favourable feelings regarding university)	-0.089 (.12744)	-0.70
Inc	0.273 (.05518)	4.95

Section 5:1 Interpretation of results:

As discussed in literature review, Isaac Ehrlich (1973) concludes that the vast majority of the offenders are young males. He suggests that males are socialized different than females who view crime more negatively. Indeed our results verify this and other past findings. Males are 24.5% more probable to commit a parking offence compared to females. The coefficient on **male** is positive and highly significant.

An extra year of **age** decreases the probability of committing a parking offence by 1.2%. This shows that as car park users get older they are less likely to commit a parking offence. This could be possibly due to the fact they face a higher psychic cost. The coefficient on age however is marginally insignificant but the fact that it has at least the expected sign is satisfactory.

The marginal effect for **WCO** is negative showing that people that think that committing a parking offence is wrong are less likely to commit one. This is because they face higher psychic costs. Car park users who believe that it is morally wrong to commit an offence are 8.6% less probable to commit a parking offence. This result is consistent with Block and Heineke (1975) who purport that utility is affected directly as well because of honest work or a crime's "disagreeability" rather than only indirectly through changes in wealth.

The marginal effect for **FAV** is insignificant. It has however the expected negative sign, in line with the conclusions of Fisman and Miguel (2006) paper which showed that "sentiment" plays an important role in the decision to commit a parking offence. Car park users with favourable feelings regarding the University of Warwick are 8.9% less likely to commit a parking offence within the University of Warwick campus.

Fisman and Miguel showed that people living in a foreign country usually carry with them the "corruption" they are used to in their home country. Individuals originating from countries that are classified as **Corrupt** are 28.4% more probable to commit a parking offence compared to those originating from countries classified as not corrupt.

The income group of a car park user appears to be a significant determinant of his decision to commit a parking offence or not. The marginal effects for both **INC1** and **INC2** are positive and significant in the model where they are included separately. They imply that individuals in the income groups <500 and 500-1000 are more probable to commit a parking offence relative to individuals in the >1000 group. In the model in which they are included as joint variable **INC**, having a monthly disposable income of <1000 increases the probability of committing a parking offence by 27.3 % compared to those belonging in the >1000 income group.

5:2 Comparison with relevant literature:

Illegal parking is a form of crime. The "criminals" derive utility over something for which another party has property rights. In our case the party holding the property rights is the University of Warwick. In this project a lot of predictions from relevant papers have been confirmed.

The theory of the "rational offender" purports that a rational offender weighs the cost and benefits of his actions before deciding whether to commit the offence or not. Becker in his influential paper in 1968 stated that *"some people become criminals not because their motivation differs from others, but because their costs and benefits differ"*. In this point however some other researchers have taken the matter one step further. Yes costs and benefits do differ but we are not only talking about monetary costs and benefits. If that was the case a simple mathematical analysis would prove whether an offender behaves rationally or not. There is however more into the analysis of crime and punishment and the analysis certainly varies with the nature of each crime.

Illegal parking does not constitute a serious form of crime. There are groups of people that would commit such a crime just for the personal satisfaction seeing it as a form of gamble. This is why I investigated certain personal lifestyle characteristics of the participants in the survey.

Age seems to play an important part especially when we are talking of petty crime. Younger car park users are more prone to committing a parking offence. Gender also plays an important role. Males apparently commit proportionately more parking offences that females something which can be traced to the different socialization processes of the two genders with males showing less fear towards a possible penalty and showing less moral restraint towards committing an offence. Females usually face higher "psychic costs" when committing a crime. Both findings verify Ehrlich's findings.

Country of origin does play an important role. As it was the case with diplomats in New York put forward by Fisman and Miguel, it seems that all individuals carry with them corruption in their home country when they go abroad. Sentimental feelings however also purported by Fisman and Miguel were not shown to have a great influence on the decision to commit a parking offence or not.

Together with these results we should also consider the important implications of results yielded through data analysis. Starting with the penalties we can see that the predictions of Nuno Garoupa, Mitchel Polinsky and Steven Shavell hold. Ceteris paribus as the penalties increase more and more people are discouraged from committing a parking offence. On the other hand however, the decision to partake in "crime" is affected only by penalties considered as enforcible. Removal of right to bring a car to University is not considered enforcible by the majority of the participants and thus affects the decision of only few of them.

On the probability of detection front we can see that Becker's inferences, regarding individuals partaking in crime without knowing the exact probability of getting caught, are valid. The tremendous variability in perceived probability of getting caught verifies that most people base their decision of committing a parking offence or not on subjectively held views of how much the probability of getting caught is.

5:3 Criticisms:

A common problem with projects for which data are not available is data collection. Data collection is time consuming and it is very difficult to acquire a large sample. I believe that although my sample is relatively small (343) it is representative of individual parking behaviour. A larger sample however could have generated better results.

An important criticism of this project is in regards to the survey questionnaire used. Questions based on fair bets could have been asked to assess whether individuals are risk loving, neutral or averse. I could then investigate any relationship between risk profiles of individuals and their probability of committing parking offences. Becker purported that criminals are risk loving however this prediction was rejected by Block and Heineke who said that there is another variable we should consider, "preference" for honesty or dishonesty. Furthermore I could have investigated the possible crime scenes by asking participants in which car park they commit the offence to see if technologies of detection indeed plays an important role as Becker purported.

Therefore given the criticisms above it is important to consider the possibility of biased sample. There is a range of car park policies implemented in different car parks. There are car parks which are free for use, other which operate a pay and display policy others which are for official visitors and others which are designated only for permit holders. There are some car parks which operate barriers and some others that do not. There are certain car parks in which it is relatively difficult to commit a parking offence. These are 7, 15 and 16 which operate barriers and therefore you can not enter without holding a valid permit or without paying the necessary fee[12].

The majority of participants in the survey who are not students have not admitted to committing a parking offence and we can not be sure whether this is the truth or they are just reluctant to admit so. This could be due to the fact that the questionnaire was returned back on the spot and not returned secretly like a ballot. The conductor of the

[12] A car parks map together with the policy operated on each car park can be found in appendix

survey could therefore see the response of every individual and this could have made some individuals uncomfortable to state the truth on a range of questions.

5:4 Extensions

It would be very important to estimate the total social cost of parking offences within the University of Warwick car parks. Unfortunately to do so I would need much more data and given that data collection was time consuming, I was time restricted to do so. The total cost of parking offences does not only include lost income from people not paying but also includes net damages to society that could arise because of people parking in fire lanes, loading bays or on pavements and other unathorised areas. Estimates of such damages are difficult to make and are probably very time consuming. A cost-benefit analysis can then be carried out to see if it is desirable to increase detection.

Another factor that should draw much attention and could probably lead to policy recommendations is which car parks "attract" the most offenders. Without being able to state with certainty I would suggest car parks without barriers as more common "crime scenes". As Becker stated prophetically, improvements in detection technology may affect the optimal probability of detection and the optimal level of punishment. But can security run different apprehension and punishment schemes in every single car park?

5:5 Conclusions:

This paper combined and tested a lot of theoretical and empirical predictions around the crime and punishment model developed in a range of papers by analyzing economically parking behaviour in University of Warwick. A lot of similarities with previous literature were found and many theoretical and empirical predictions were verified.

Testing a large theoretical framework such that of crime and punishment within a small closed community of a University is difficult however the findings of this project are in line with most proposals. This model should be extended to enable better policy recommendations in order to tackle the increasing problem of illegal parking.

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Questionnaire

Parking Offences

1.Age:

2.Country Of Origin:

3.Sex ☐Male ☐Female

4. Have you ever committed a Parking Offence within the University of Warwick Campus ?

☐Yes ☐No

5.If yes in which ways (Current Penalty for each offence in brackets) ?

☐(A) Parking without displaying valid ticket or permit, parking in non-designated space or unauthorized overnight parking (Penalty £20)

☐(B) Parking on double yellow lines , loading bays or grass verges (Penalty £25)

☐(C) Parking in fire lanes or space designated for disabled drivers (Penalty £35)

6. Do you feel it's wrong to commit parking offence in general ?

☐Yes ☐No

7. Which of the three do you feel is particularly wrong (You can choose more than one)?

☐(A) Parking without displaying valid ticket or permit, parking in non-designated space or unauthorized overnight parking

☐(B) Parking on double yellow lines , loading bays or grass verges

☐(C) Parking in fire lanes or space designated for disabled drivers

8. General sentimental feelings about University of Warwick:

☐ Favourable ☐ Unfavourable

9.Have you ever been clamped or given a ticket ? ☐Yes ☐No

How many times ?

10. Did you pay the penalty ? ☐Yes ☐No

How many times you did not ?

11. Assuming you are used to park illegally . What sort of punishment would stop you from doing so ?

1. ☐ Current Penalties (£20,£25,£35)
2. ☐ Increased by 100 % (£40,£50,£70)
3. ☐ Increased by 200 % (£60,£75,£100)
4. ☐ Increased by 200% and removal of right to bring a car to university
5. ☐ None of the above

12. What do you think the probability of getting caught if you commit a parking offence is (in %) ?

13. What probability would stop you from committing a parking offence?

1. ☐ Current Probability?
2. ☐ Increased by 100 % (i.e. double)
3. ☐ Increased by 200 % (i.e. three times the current)
4. ☐ Definitely Caught.

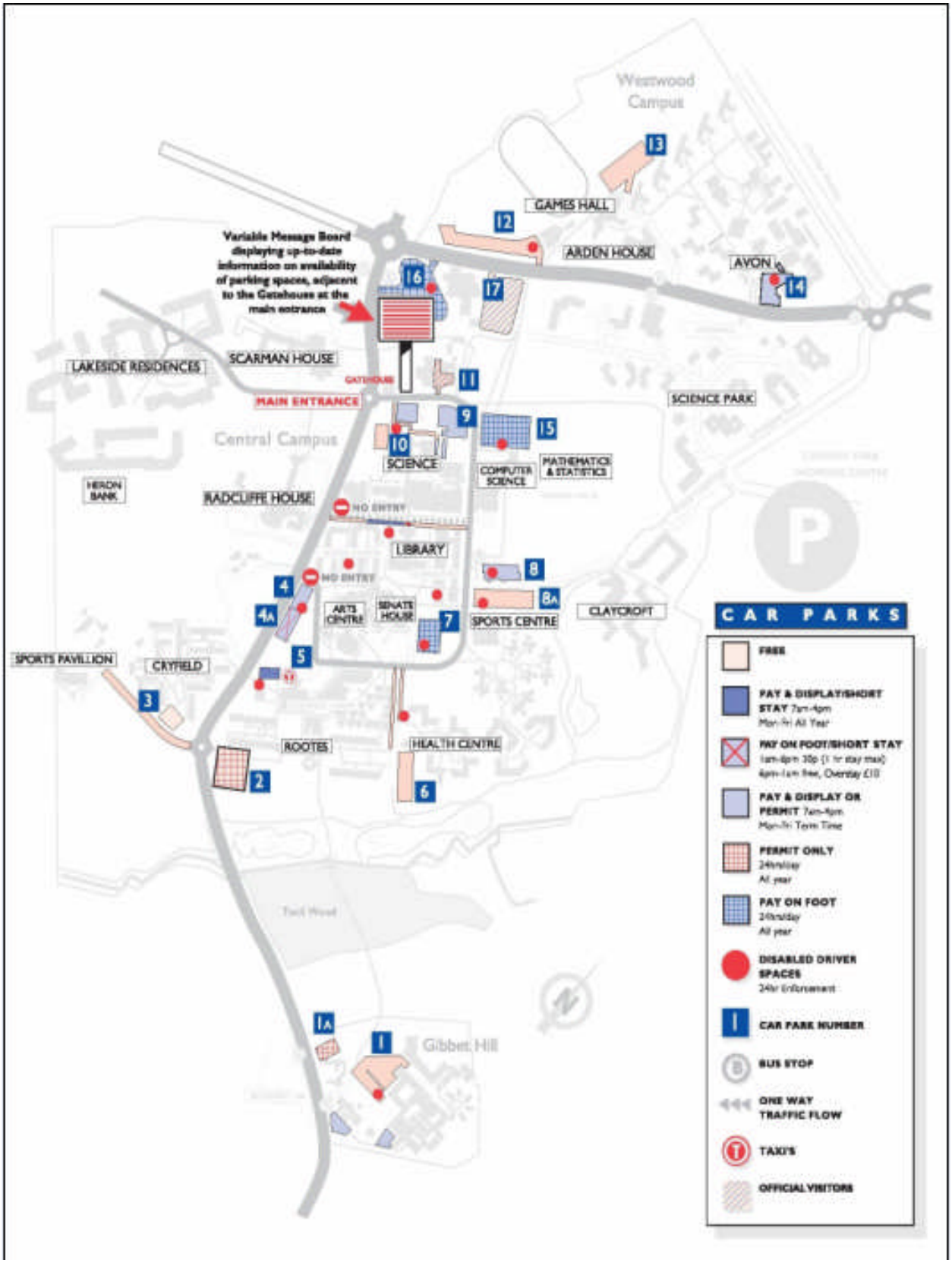
14. Income per month (for students this is how much they have disposable each month either through student loans, parental contributions or paid work they undertake)

☐ < £500

☐ £500-£1000

☐ > £1000

Car Park Map:


Westwood Campus
GAMES HALL
ARDEN HOUSE
AVON
Variable Message Board displaying up-to-date information on availability of parking spaces, adjacent to the Gatehouse at the main entrance
LAKESIDE RESIDENCES
SCARMAN HOUSE
GATEHOUSE
MAIN ENTRANCE
SCIENCE PARK
Central Campus
SCIENCE
COMPUTER SCIENCE
MATHEMATICS & STATISTICS
HERON BANK
RADCLIFFE HOUSE
NO ENTRY
LIBRARY
ARTS CENTRE
SENATE HOUSE
SPORTS CENTRE
CLAYCROFT
SPORTS PAVILION
CRYFIELD
ROOTES
HEALTH CENTRE
Gibbet Hill
CAR PARKS
FREE
PAY & DISPLAY/SHORT STAY 7am-4pm Mon-Fri All Year
PAY ON FOOT/SHORT STAY
PAY & DISPLAY OR PERMIT 7am-4pm Mon-Fri Term Time
PERMIT ONLY 24hr/day All year
PAY ON FOOT 24hr/day All year
DISABLED DRIVER SPACES 24hr Enforcement
CAR PARK NUMBER
BUS STOP
ONE WAY TRAFFIC FLOW
TAXI'S
OFFICIAL VISITORS

Calculations for the decision to commit a parking offence for a rational risk neutral offender.

- *E (U) of Committing Crime = (1-P) V (Y+G) + P V (Y+G-F)*
- *E (U) of not committing Crime = V (Y) ---For risk neutral individual utility function is linear in wealth.*

Crime will be committed if E(W) Crime > E(W) No Crime

Given Y=0

E (W) no crime = 0

E (W) crime = (1-P) (1) + P(1-20) = 1-1P-19P=1-20P*

A risk neutral individual will be indifferent between committing a crime or not if and only if:

0=1-20P → that is if P=1/20=5% .

Transparency International Corruption Index:

Country Rank	Country	2006 CPI Score	Surveys used	Confidence range
1	Finland	9.6	7	9.4 - 9.7
1	Iceland	9.6	6	9.5 - 9.7
1	New Zealand	9.6	7	9.4 - 9.6
4	Denmark	9.5	7	9.4 - 9.6
5	Singapore	9.4	9	9.2 - 9.5
6	Sweden	9.2	7	9.0 - 9.3
7	Switzerland	9.1	7	8.9 - 9.2
8	Norway	8.8	7	8.4 - 9.1
9	Australia	8.7	8	8.3 - 9.0
9	Netherlands	8.7	7	8.3 - 9.0
11	Austria	8.6	7	8.2 - 8.9
11	Luxembourg	8.6	6	8.1 - 9.0
11	United Kingdom	8.6	7	8.2 - 8.9
14	Canada	8.5	7	8.0 - 8.9
15	Hong Kong	8.3	9	7.7 - 8.8
16	Germany	8.0	7	7.8 - 8.4
17	Japan	7.6	9	7.0 - 8.1
18	France	7.4	7	6.7 - 7.8
18	Ireland	7.4	7	6.7 - 7.9
20	Belgium	7.3	7	6.6 - 7.9
20	Chile	7.3	7	6.6 - 7.6
20	USA	7.3	8	6.6 - 7.8
23	Spain	6.8	7	6.3 - 7.2
24	Barbados	6.7	4	6.0 - 7.2
24	Estonia	6.7	8	6.1 - 7.4
26	Macao	6.6	3	5.4 - 7.1

26	Portugal	6.6	7	5.9 - 7.3
28	Malta	6.4	4	5.4 - 7.3
28	Slovenia	6.4	8	5.7 - 7.0
28	Uruguay	6.4	5	5.9 - 7.0
31	United Arab Emirates	6.2	5	5.6 - 6.9
32	Bhutan	6.0	3	4.1 - 7.3
32	Qatar	6.0	5	5.6 - 6.5
34	Israel	5.9	7	5.2 - 6.5
34	Taiwan	5.9	9	5.6 - 6.2
36	Bahrain	5.7	5	5.3 - 6.2
37	Botswana	5.6	6	4.8 - 6.6
37	Cyprus	5.6	4	5.2 - 5.9
39	Oman	5.4	3	4.1 - 6.2
40	Jordan	5.3	7	4.5 - 5.7
41	Hungary	5.2	8	5.0 - 5.4
42	Mauritius	5.1	5	4.1 - 6.3
42	South Korea	5.1	9	4.7 - 5.5
44	Malaysia	5.0	9	4.5 - 5.5
45	Italy	4.9	7	4.4 - 5.4
46	Czech Republic	4.8	8	4.4 - 5.2
46	Kuwait	4.8	5	4.0 - 5.4
46	Lithuania	4.8	6	4.2 - 5.6
49	Latvia	4.7	6	4.0 - 5.5
49	Slovakia	4.7	8	4.3- 5.2
51	South Africa	4.6	8	4.1 - 5.1
51	Tunisia	4.6	5	3.9 - 5.6
53	Dominica	4.5	3	3.5 - 5.3
54	Greece	4.4	7	3.9 - 5.0
55	Costa Rica	4.1	5	3.3 - 4.8

55	Namibia	4.1	6	3.6 - 4.9
57	Bulgaria	4.0	7	3.4 - 4.8
57	El Salvador	4.0	5	3.2 - 4.8
59	Colombia	3.9	7	3.5 - 4.7
60	Turkey	3.8	7	3.3 - 4.2
61	Jamaica	3.7	5	3.4 - 4.0
61	Poland	3.7	8	3.2 - 4.4
63	Lebanon	3.6	3	3.2 - 3.8
63	Seychelles	3.6	3	3.2 - 3.8
63	Thailand	3.6	9	3.2 - 3.9
66	Belize	3.5	3	2.3 - 4.0
66	Cuba	3.5	3	1.8 - 4.7
66	Grenada	3.5	3	2.3 - 4.1
69	Croatia	3.4	7	3.1 - 3.7
70	Brazil	3.3	7	3.1 - 3.6
70	China	3.3	9	3.0 - 3.6
70	Egypt	3.3	6	3.0 - 3.7
70	Ghana	3.3	6	3.0 - 3.6
70	India	3.3	10	3.1 - 3.6
70	Mexico	3.3	7	3.1 - 3.4
70	Peru	3.3	5	2.8 - 3.8
70	Saudi Arabia	3.3	3	2.2 - 3.7
70	Senegal	3.3	5	2.8 - 3.7
79	Burkina Faso	3.2	5	2.8 - 3.6
79	Lesotho	3.2	5	2.9 - 3.6
79	Moldova	3.2	7	2.7 - 3.8
79	Morocco	3.2	6	2.8 - 3.5
79	Trinidad and Tobago	3.2	5	2.8 - 3.6
84	Algeria	3.1	5	2.7 - 3.6

84	Madagascar	3.1	5	2.3 - 3.7
84	Mauritania	3.1	4	2.1 - 3.7
84	Panama	3.1	5	2.8 - 3.3
84	Romania	3.1	8	3.0 - 3.2
84	Sri Lanka	3.1	6	2.7 - 3.5
90	Gabon	3.0	4	2.4 - 3.3
90	Serbia	3.0	7	2.7 - 3.3
90	Suriname	3.0	4	2.7 - 3.3
93	Argentina	2.9	7	2.7 - 3.2
93	Armenia	2.9	6	2.7 - 3.0
93	Bosnia and Herzgegovina	2.9	6	2.7 - 3.1
93	Eritrea	2.9	3	2.2 - 3.5
93	Syria	2.9	3	2.3 - 3.2
93	Tanzania	2.9	7	2.7 - 3.1
99	Dominican Republic	2.8	5	2.4 - 3.2
99	Georgia	2.8	6	2.5 - 3.0
99	Mali	2.8	7	2.5 - 3.3
99	Mongolia	2.8	5	2.3 - 3.4
99	Mozambique	2.8	7	2.5 - 3.0
99	Ukraine	2.8	6	2.5 - 3.0
105	Bolivia	2.7	6	2.4 - 3.0
105	Iran	2.7	3	2.3 - 3.1
105	Libya	2.7	3	2.4 - 3.2
105	Macedonia	2.7	6	2.6 - 2.9
105	Malawi	2.7	7	2.5 - 3.0
105	Uganda	2.7	7	2.4 - 3.0
111	Albania	2.6	5	2.4 - 2.7
111	Guatemala	2.6	5	2.3 - 3.0
111	Kazakhstan	2.6	6	2.3 - 2.8

111	Laos	2.6	4	2.0 - 3.1
111	Nicaragua	2.6	6	2.4 - 2.9
111	Paraguay	2.6	5	2.2 - 3.3
111	Timor-Leste	2.6	3	2.3 - 3.0
111	Viet Nam	2.6	8	2.4 - 2.9
111	Yemen	2.6	4	2.4 - 2.7
111	Zambia	2.6	6	2.1 - 3.0
121	Benin	2.5	6	2.1 - 2.9
121	Gambia	2.5	6	2.3 - 2.8
121	Guyana	2.5	5	2.2 - 2.6
121	Honduras	2.5	6	2.4 - 2.7
121	Nepal	2.5	5	2.3 - 2.9
121	Phillipines	2.5	9	2.3 - 2.8
121	Russia	2.5	8	2.3 - 2.7
121	Rwanda	2.5	3	2.3 - 2.6
121	Swaziland	2.5	3	2.2 - 2.7
130	Azerbaijan	2.4	7	2.2 - 2.6
130	Burundi	2.4	5	2.2 - 2.6
130	Central African Republic	2.4	3	2.2 - 2.5
130	Ethiopia	2.4	7	2.2 - 2.6
130	Indonesia	2.4	10	2.2 - 2.6
130	Papua New Guinea	2.4	4	2.3 - 2.6
130	Togo	2.4	3	1.9 - 2.6
130	Zimbabwe	2.4	7	2.0 - 2.8
138	Cameroon	2.3	7	2.1 - 2.5
138	Ecuador	2.3	5	2.2 - 2.5
138	Niger	2.3	5	2.1 - 2.6
138	Venezuela	2.3	7	2.2 - 2.4
142	Angola	2.2	5	1.9 - 2.4

142	Congo, Republic	2.2	4	2.2 - 2.3
142	Kenya	2.2	7	2.0 - 2.4
142	Kyrgyzstan	2.2	6	2.0 - 2.6
142	Nigeria	2.2	7	2.0 - 2.3
142	Pakistan	2.2	6	2.0 - 2.4
142	Sierra Leone	2.2	3	2.2 - 2.3
142	Tajikistan	2.2	6	2.0 - 2.4
142	Turkmenistan	2.2	4	1.9 - 2.5
151	Belarus	2.1	4	1.9 - 2.2
151	Cambodia	2.1	6	1.9 - 2.4
151	Côte d´Ivoire	2.1	4	2.0 - 2.2
151	Equatorial Guinea	2.1	3	1.7 - 2.2
151	Uzbekistan	2.1	5	1.8 - 2.2
156	Bangladesh	2.0	6	1.7 - 2.2
156	Chad	2.0	6	1.8 - 2.3
156	Congo, Democratic Republic	2.0	4	1.8 - 2.2
156	Sudan	2.0	4	1.8 - 2.2
160	Guinea	1.9	3	1.7 - 2.1
160	Iraq	1.9	3	1.6 - 2.1
160	Myanmar	1.9	3	1.8 - 2.3
163	Haiti	1.8	3	1.7 - 1.8

Probit Regression Results:

```
. probit cpo age corrupt male wco fav inc1 inc2

Iteration 0:   log likelihood = -218.09258
Iteration 1:   log likelihood = -169.23346
Iteration 2:   log likelihood = -166.18468
Iteration 3:   log likelihood =  -165.9282
Iteration 4:   log likelihood = -165.92143
Iteration 5:   log likelihood = -165.92143

Probit regression                 Number of obs   =        343
                                  LR chi2(7)      =     104.34
                                  Prob > chi2     =     0.0000
Log likelihood = -165.92143       Pseudo R2       =     0.2392

------------------------------------------------------------------------------
         cpo |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |  -.0321917   .0208964    -1.54   0.123     -.073148    .0087645
      corrupt |   .8027376   .1900443     4.22   0.000     .4302576    1.175218
        male |   .7260705   .1784222     4.07   0.000     .3763694    1.075771
         wco |  -.2961216   .1660552    -1.78   0.075    -.6215838    .0293406
         fav |  -.2279179   .3508821    -0.65   0.516    -.9156341    .4597984
        inc1 |   .9995714   .3069974     3.26   0.001     .3978675    1.601275
        inc2 |   1.280155   .3282263     3.90   0.000     .6368429    1.923467
       _cons |  -.8914206   .7076776    -1.26   0.208    -2.278443    .4956021
------------------------------------------------------------------------------
CPO =  -0.891 -0.032age + 0.803corrupt + 0.726male -0.296wco -0.228fav +0.999inc1 +1.28inc2
          (0.708) (0.209)         (0.190)             (0.178)         (0.166)         (0.350)      (0.307)         (0.328
. mfx
```

Marginal effects after probit:

```
      y  = Pr(cpo) (predict)
         =   .2668975
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.      z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
     age |  -.0105824      .00664   -1.59   0.111  -.023588  .002423   24.9388
 corrupt*|   .2876698       .07039    4.09   0.000   .149701  .425639   .239067
    male*|   .2302075      .05356    4.30   0.000    .12523  .335185    .55102
     wco*|  -.0987354      .05594   -1.77   0.078  -.208367  .010896   .591837
     fav*|  -.0793477      .12834   -0.62   0.536  -.330885   .17219   .953353
    inc1*|   .3113181       .0878    3.55   0.000   .139237  .483399   .548105
    inc2*|   .4586808      .11295    4.06   0.000   .237302  .680059   .253644
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

Heteroscedasticity Test:

```
. probit cpo corrupt age male wco fav inc1 inc2, score(gres1)

Iteration 0:   log likelihood = -218.09258
Iteration 1:   log likelihood = -169.23346
Iteration 2:   log likelihood = -166.18468
Iteration 3:   log likelihood =  -165.9282
Iteration 4:   log likelihood = -165.92143
Iteration 5:   log likelihood = -165.92143

Probit regression                               Number of obs   =        343
                                                LR chi2(7)      =     104.34
                                                Prob > chi2     =     0.0000
Log likelihood = -165.92143                     Pseudo R2       =     0.2392

------------------------------------------------------------------------------
         cpo |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     corrupt |   .8027376   .1900443     4.22   0.000     .4302576    1.175218
         age |  -.0321917   .0208964    -1.54   0.123     -.073148    .0087645
        male |   .7260705   .1784222     4.07   0.000     .3763694    1.075771
         wco |  -.2961216   .1660552    -1.78   0.075    -.6215838    .0293406
         fav |  -.2279179   .3508821    -0.65   0.516    -.9156341    .4597984
        inc1 |   .9995714   .3069974     3.26   0.001     .3978675    1.601275
        inc2 |   1.280155   .3282263     3.90   0.000     .6368429    1.923467
       _cons |  -.8914206   .7076776    -1.26   0.208    -2.278443    .4956021
------------------------------------------------------------------------------

. generate const=1

. generate g1=gres1*corrupt
(1 missing value generated)

. generate g2=gres2*age
gres2 not found
r(111);

. generate g2=gres1*age
(1 missing value generated)

. generate g3=gres1*male
(1 missing value generated)

. generate g4=gres1*wco
(1 missing value generated)
```

```
. generate g5=gres1*fav
(1 missing value generated)

. generate g6=gres1*inc1
(1 missing value generated)

. generate g7=gres1*inc2
(1 missing value generated)

. predict xb
(option p assumed; Pr(cpo))
(1 missing value generated)

. generate ghet1=gres1*xb*male
(1 missing value generated)

. regress const gres g1 g2 g3 g4 g5 g6 g7 ghet1, noconst

      Source |       SS       df       MS              Number of obs =     343
-------------+------------------------------           F(  9,   334) =    0.54
       Model |  4.96305494     9  .551450549            Prob > F      =  0.8413
    Residual |  338.036945   334  1.01208666            R-squared     =  0.0145
-------------+------------------------------           Adj R-squared = -0.0121
       Total |       343   343          1              Root MSE      =   1.006

------------------------------------------------------------------------------
       const |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gres1 |   .3315316   .8379304     0.40   0.693    -1.316755    1.979818
          g1 |   .5967133    .331348     1.80   0.073    -.0550788    1.248505
          g2 |  -.0297313   .0354523    -0.84   0.402    -.0994692    .0400065
          g3 |    1.46154   .6841392     2.14   0.033     .1157756    2.807305
          g4 |  -.3720167   .2397357    -1.55   0.122    -.8435987    .0995654
          g5 |  -.4708156   .3709441    -1.27   0.205    -1.200497    .2588654
          g6 |   .7981583   .4666084     1.71   0.088    -.1197033     1.71602
          g7 |   .9773135   .5506877     1.77   0.077    -.1059398    2.060567
       ghet1 |  -2.927227   1.321876    -2.21   0.027    -5.527479   -.3269754
------------------------------------------------------------------------------
```

Normality Test:

```
. generate gnorm2=gres*xb^2
(1 missing value generated)

. generate gnorm3=gres*xb^3
(1 missing value generated)

. regress const gres g1 g2 g3 g4 g5 g6 g7 gnorm2 gnorm3, noconst

      Source |       SS       df       MS              Number of obs =     343
-------------+------------------------------           F( 10,   333) =    1.47
       Model |  14.5225955    10  1.45225955            Prob > F      =  0.1482
    Residual |  328.477404   333  .986418632           R-squared     =  0.0423
-------------+------------------------------           Adj R-squared =  0.0136
       Total |         343   343           1           Root MSE      =  .99319

------------------------------------------------------------------------------
       const |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       gres1 |   1.770321   .9456661     1.87   0.062     -.089912    3.630553
          g1 |   3.036553   .8139614     3.73   0.000     1.435399    4.637708
          g2 |  -.1216736    .045599    -2.67   0.008     -.211372   -.0319753
          g3 |   2.684264   .7388814     3.63   0.000     1.230801    4.137728
          g4 |  -1.327893   .3859796    -3.44   0.001    -2.087159   -.5686272
          g5 |  -1.433668   .4801669    -2.99   0.003    -2.378211   -.4891258
          g6 |   3.487024    .95899     3.64   0.000     1.600582    5.373466
          g7 |    4.66412   1.271021     3.67   0.000     2.163877    7.164363
      gnorm2 |  -27.03535   8.066089    -3.35   0.001    -42.90226   -11.16844
      gnorm3 |   19.50458   6.873168     2.84   0.005     5.984278    33.02488
------------------------------------------------------------------------------
```

Likelihood Ratio Test for equality of coefficients inc1 and inc2:

```
. probit cpo corrupt age male wco fav inc

Iteration 0:   log likelihood = -218.09258
Iteration 1:   log likelihood = -170.42279
Iteration 2:   log likelihood = -167.36954
Iteration 3:   log likelihood = -167.09307
Iteration 4:   log likelihood = -167.08514
Iteration 5:   log likelihood = -167.08513

Probit regression                                 Number of obs   =        343
                                                  LR chi2(6)      =     102.01
                                                  Prob > chi2     =     0.0000
```

```
Log likelihood = -167.08513                     Pseudo R2       =     0.2339

------------------------------------------------------------------------------
         cpo |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     corrupt |   .7954717   .1887644     4.21   0.000     .4255003    1.165443
         age |  -.0352233   .0211029    -1.67   0.095    -.0765843    .0061377
        male |   .7791347   .1748182     4.46   0.000     .4364973    1.121772
         wco |  -.2575673   .1634099    -1.58   0.115    -.5778448    .0627102
         fav |    -.25388   .345868    -0.73   0.463    -.9317688    .4240088
         inc |   1.085397   .3024702     3.59   0.000     .4925662    1.678227
       _cons |  -.8442083   .7109546    -1.19   0.235    -2.237654     .549237
------------------------------------------------------------------------------

. est store A

. probit cpo corrupt age male wco fav inc1 inc2

Iteration 0:   log likelihood = -218.09258
Iteration 1:   log likelihood = -169.23346
Iteration 2:   log likelihood = -166.18468
Iteration 3:   log likelihood =  -165.9282
Iteration 4:   log likelihood = -165.92143
Iteration 5:   log likelihood = -165.92143

Probit regression                               Number of obs   =        343
                                                LR chi2(7)      =     104.34
                                                Prob > chi2     =     0.0000
Log likelihood = -165.92143                     Pseudo R2       =     0.2392

------------------------------------------------------------------------------
         cpo |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     corrupt |   .8027376   .1900443     4.22   0.000     .4302576    1.175218
         age |  -.0321917   .0208964    -1.54   0.123     -.073148    .0087645
        male |   .7260705   .1784222     4.07   0.000     .3763694    1.075771
         wco |  -.2961216   .1660552    -1.78   0.075    -.6215838    .0293406
         fav |  -.2279179   .3508821    -0.65   0.516    -.9156341    .4597984
        inc1 |   .9995714   .3069974     3.26   0.001     .3978675    1.601275
        inc2 |   1.280155   .3282263     3.90   0.000     .6368429    1.923467
       _cons |  -.8914206   .7076776    -1.26   0.208    -2.278443    .4956021
------------------------------------------------------------------------------

. est store C

. lrtest A
```

```
Likelihood-ratio test                          LR chi2(1)  =      2.33
(Assumption: A nested in C)                    Prob > chi2 =    0.1271

. . generate inc=inc1+inc2

. probit cpo corrupt male age fav wco inc

Iteration 0:   log likelihood = -218.09258
Iteration 1:   log likelihood = -170.42279
Iteration 2:   log likelihood = -167.36954
Iteration 3:   log likelihood = -167.09307
Iteration 4:   log likelihood = -167.08514
Iteration 5:   log likelihood = -167.08513

Probit regression                              Number of obs   =        343
                                               LR chi2(6)      =     102.01
                                               Prob > chi2     =     0.0000
Log likelihood = -167.08513                    Pseudo R2       =     0.2339

------------------------------------------------------------------------------
         cpo |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     corrupt |   .7954717   .1887644     4.21   0.000     .4255003    1.165443
        male |   .7791347   .1748182     4.46   0.000     .4364973    1.121772
         age |  -.0352233   .0211029    -1.67   0.095    -.0765843    .0061377
         fav |    -.25388   .345868    -0.73   0.463    -.9317688    .4240088
         wco |  -.2575673   .1634099    -1.58   0.115    -.5778448    .0627102
         inc |   1.085397   .3024702     3.59   0.000     .4925662    1.678227
       _cons |  -.8442083   .7109546    -1.19   0.235    -2.237654     .549237
------------------------------------------------------------------------------
. mfx
Marginal effects after probit
      y  = Pr(cpo) (predict)
         =  .26519757
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
 corrupt*|   .2843829      .06981    4.07   0.000    .14755  .421216   .239067
    male*|   .2453454       .0521    4.71   0.000   .143232  .347459    .55102
     age |  -.0115415     .00665   -1.74   0.083  -.024571  .001488   24.9388
     fav*|  -.0886517      .12744   -0.70   0.487  -.338422  .161119   .953353
     wco*|  -.0854841      .05473   -1.56   0.118  -.192758   .02179   .591837
     inc*|   .2729721     .05518    4.95   0.000   .164816  .381129   .801749
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```