An Economic Approach to Motor Vehicle Theft[1]

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Documentos de Trabajo del CPP No. 002/2011
Enero 2011

Motor vehicle theft costs dearly to the Australian economy. Conservative estimates have put the annual cost of this form of illegal activity at 654 million during 1996. A number of initiatives aimed at reducing the incidence and cost of car theft have been implemented in recent years, yet statistics indicate that car theft is on the increase. Several authors have proposed an integrated approach to the regulation of markets for stolen property. Understanding property crime as a market is central to identifying approaches to its control.

This paper discusses an industry model of crime and develops it on Australian data. Our model is an adaptation of one originally proposed by Vandeale (1978). It considers a production sector that uses inputs from a market of illegal labour to generate a supply of illegal goods that are traded in a product market. These sectors interact with each other and with a criminal justice sector. The model is applied to the analysis of car theft in Queensland.

JEL Classification: K40, K42
Keywords: Illegal Behavior, Illegal Markets, Rent Seeking

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[1] An earlier version of this paper was written while the author worked as a Senior Researcher at the Australian Institute of Criminology, Canberra.

1. Introduction

Motor vehicle theft is a common offence in Australia. Official statistics show that 130,406 motor vehicles were stolen in Australia during 1997 (Australian Bureau of Statistics, 1998). In a typical week in Australia around 2,500 motor vehicles were stolen during 1997. According to the same source, 12 per cent of all registered vehicles were stolen, affecting to 7 per cent of the total population. These thefts accounted for 11.9 per cent of all the recorded offences for which the Australian Bureau of Statistics published data during 1997[2].

The most recent data available put the cost of motor vehicle theft at $654 million in 1996. This form of crime contributed to 3.3 per cent of the total estimated cost of crime and justice in Australia (Walker, 1997). The NRMA however, estimated that car theft cost Australia $809 million in 1996 (NRMA, 1997). A stolen vehicle costs around $5,000 to the Australian community.

A number of measures have been adopted to prevent the incidence and to reduce the cost of motor vehicle theft in Australia. Following recommendation by the National Motor Vehicle Theft Task Force, the Governments and the Insurance Council of Australia had agreed to set up a National Motor Vehicle Theft Reduction Council which will pursue a five year plan to curb the crime. The National Motor Vehicle Theft Reduction Council is expected to put in place a number of strategies, one of which is the establishment of a national register of written-off vehicles as well as improved exchange of information between states and territories on stolen motor vehicles. Other strategies include parts labeling, enhanced vehicle security, and also a number of theft prevention strategies such as (NRMA, 1997 p. 16):

- urban planning to reduce opportunities for car theft;
- secure carpark schemes;
- reducing the risk of young people becoming involved in car theft and dealing with repeat offenders;
- introduction of best practice in community crime prevention;
- local problem-solving partnerships between communities and police;
- technical devices to make cars harder to steal; and
- public education and awareness of the factors involved in car theft.

Official statistics show that the incidence of car theft has remained relatively stable during recent years. This trend is the result of an observed decline in the rates of New South Wales and South Australia. For the other states however, car theft rates exhibit a steady increase over time (Mukherjee, Carcach and Higgins, 1997).

Despite all the efforts for its prevention and control, car theft continues to be a major problem in Australia. Data on costs suggest that car theft is a big industry in Australia,

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[2] The crime statistics published by the Australian Bureau of Statistics include the following offences: murder, attempted murder, manslaughter, driving causing death, assault, sexual assault, armed and unarmed robbery, blackmail/extortion, unlawful entry with intent, motor vehicle theft and other theft.

and no doubt a profitable one. As with other forms of property crime, there has been a tendency among criminologists towards dealing with car theft as a series of discrete and unrelated events, concentrating in individual offenders and overlooking the importance of the interactions between goods and people (Walsh and Chappel, 1974).

Frieberg (1997) views property crime as a market for goods and services, which is subject to the influences of supply and demand. The property crime market is conceived as a complex network of suppliers (offenders), distributors/retailers and consumers, a notion that facilitates understanding the many factors involved and provides better opportunities for prevention and control. Although conceptually attractive, this "marketing" approach is difficult to implement due to the lack of relevant data.

The economic aspect of crime has become a prominent area of research since the seminal paper by Becker (1968). The basic assumption on which an economic approach to crime rests is that irrespective of individual differences regarding crime prone factors, individuals decide to engage in unlawful activities by weighing their costs and benefits. Individuals measure benefits from crime by assessing potential earnings, while costs are assessed in terms of potential punishment. Individual attributes related with individual crime proneness are reflected by specific attitudes towards risk, which ultimately determine the effect that punishment has on crime.

Car theft, as well as other forms of property crime, can be studied from an economic perspective. This paper discusses an industry model of crime. The model is an adaptation of one originally proposed by Vandeale (1978). It considers a production sector that uses inputs from a market of illegal labour to generate a supply of illegal goods that are traded in a product market. These sectors interact with each other and with a criminal justice sector.

An economic analysis aims to explain human behaviour by examining the effect that factors suggested by theory have on the decisions made by economic agents. The industry model discussed in this paper is of an aggregate nature and as such it approaches car theft from the perspective of the decisions made by a collectivity of individuals. The analysis rests on the belief that offenders, as a group, respond to incentives in a way similar to those engaged in legitimate activities.

Our main concern has to do with whether the actions of the criminal justice system have any impact in reducing the rate of car theft. The analytic strategy ensures that other factors that have a potential impact on the prevalence of such a type of crime are controlled for.

The model discussed here is also useful to understand how market forces operate to determine the level of car theft in a community, and in this way extends the study of crime beyond the regulatory framework. Weatherburn (1996) has made the case that a purely regulatory approach to crime may result in crime prevention and control getting confounded within the broader "law and order debate". He argues that crime reduction strategies encompass many activities, only, some of which involve the criminal law.

Community policing, treatment for drug addicts and property marking certainly involve actors others than those strictly considered by the criminal law.

The empirical analysis of car theft presented in this paper is based on a model consisting of five-equations: the demand of stolen vehicles, the supply of stolen vehicles, the probability of arrest production function, the demand for police officers and the supply of police officers. The model is applied to the analysis of motor vehicle theft in Queensland. It is theoretically feasible to extend the model to at least include an insurance sector, however this was not possible due to data unavailability.

The paper contains 5 sections. Section 2 describes the economic model of car theft and discusses the hypotheses that derive from it. Section 3 presents an empirical analysis of motor vehicle theft in Queensland using annual data over the 1974-1997 period. Section 4 presents and discusses the results of the analysis, and Section 5 draws the main conclusions and policy implications.

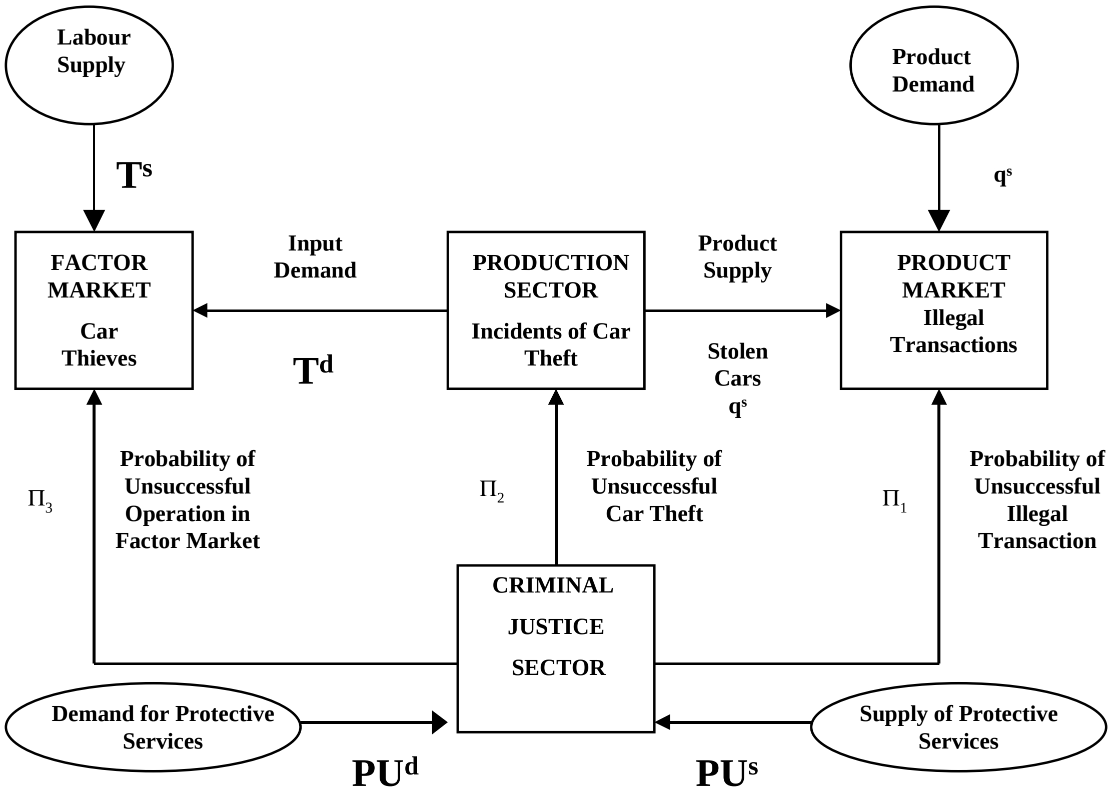
2. A Model of the Economics of Car Theft

This paper considers an extended industry model of the economics of car theft formulated in real terms and composed of four sectors:

- A production sector which transforms inputs into an illegal product;
- A factor market providing the production sector with labour and capital inputs;
- A product market where illegal goods are transacted; and
- A criminal justice sector, the actions of which will affect the interaction between supply and demand for illegal goods.

The illegal product under study is stolen cars. For simplicity it is assumed that the only input demanded by the production sector, and supplied by the factor market, is labour in the form of time allocated to car theft. Figure 1 shows a schematic representation of the referred system.

Figure 1: Diagrammatic Representation of the Car Theft Industry Model


Labour Supply
Product Demand
T^s
q^s
FACTOR MARKET
Car Thieves
Input Demand
T^d
PRODUCTION SECTOR
Incidents of Car Theft
Product Supply
Stolen Cars
q^s
PRODUCT MARKET
Illegal Transactions
Π_3
Probability of Unsuccessful Operation in Factor Market
Π_2
Probability of Unsuccessful Car Theft
Π_1
Probability of Unsuccessful Illegal Transaction
CRIMINAL JUSTICE SECTOR
Demand for Protective Services
Supply of Protective Services
PU^d
PU^s

2.1 The Market of Stolen Cars

Demand for Stolen Cars

An economic approach to crime, in particular property crimes such as car theft, rests on the presumption that demand illegal goods has many characteristics in common with the demand for legal goods. Therefore it is possible to apply standard demand theory to the study of car theft.

From this perspective, an individual can combine legal and illegal goods with his/her own consumption time and other inputs in a household production function as to produce a basic set of commodities. Consumers maximize utility derived from different combinations of commodities, subject to a budget constraint. Therefore, the demand for stolen cars will then depend on the real price of stolen cars (p), the real price of commodities closely related to stolen cars (p^c), and real income (y). Since stolen cars are illegal goods, it is reasonable to assume that demand will be affected by factors such as the probability of arrest, $\boldsymbol{\pi}_1$, and the probability of conviction given arrest, $\boldsymbol{\pi}^c{}_1$ from participation in illegal transactions. The demand equation for stolen cars in per capita terms for a specific individual i can be represented as

$$q_i^d = d_i(p,p^c,y_i,\pi_1,\pi^c{}_1) \tag{1}$$

Ceteris paribus, the price elasticity of demand should be negative. In addition, we consider the price of new cars, which is a substitute good for stolen cars, so we expect a positive cross-elasticity of demand[3]. The impact of income on demand is uncertain because it depends on whether stolen cars are a normal or an inferior good. If they were *normal goods,* then demand should be positively related with income. However, it might be argued that as income increases, the demand for stolen cars declines because consumption shifts toward new cars. In this case stolen cars would be *inferior goods*. Finally, consumption of stolen cars is expected to decline as the probabilities of arrest and conviction increase.

Supply of Stolen Cars

The model looks at the criminal act as a transformation curve that converts labour input (time devoted to illegal activities) into a final product (stolen cars)[4]. Consider a unique individual using his/her illegal labour time as input, $\boldsymbol{t}_j$, and designate his/her probability of arrest/conviction as π_2. Given similar levels of skills and technology, the probability of success in the illegal labour market would be lower for individuals with a criminal

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[3] Price of used cars is another substitute good. The demand equation can also include prices of complementary goods such as petrol. The cross-elasticity of demand for a complementary good is expected to be negative.

[4] A more rigorous treatment of supply decisions should consider capital services as additional input to the production function. Given the illegal nature of car theft, data on the amount of capital services used to produce a certain amount of stolen vehicles are not readily available, so this factor was excluded from the analysis.

record than for individuals who have not had formal contact with the criminal justice system.

Car theft operators are assumed to determine the rate at which they commit crimes of car theft as to maximize profit, so they face the following output supply function in real terms:

$$q_j^s = x_j(p,w,\pi_2,\pi^c{}_2) \qquad (2)$$

where, p is the real price of stolen cars, w is the real wage in the car theft labour market, and π_2 and $\pi^c{}_2$ represent the probabilities of detection and conviction respectively.

The model assumes that the market clears at an equilibrium price which in turn depends on population size, N. Letting Q^s and Q^d denote aggregate supply and aggregate demand respectively, equilibrium occurs when $Nq^d = Q^s$, which implies

$$q^s = Q^s /N = q^s = q(p,w,\pi_2,\pi^c{}_2,N)$$

Supply should increase as the real price of stolen cars increases, but it should decline when real illegal wages and probability of arrest/conviction increase. Any increase in wages or the probability of arrest/conviction causes cost of car theft to increase.

The Product Market Equations

The equations for the product market during a given period, *t*, are:

$$q^d{}_t = d_t(p_t,p^c{}_t,y_t,\pi_{1t},\pi^c{}_{1t}) \qquad \text{(Demand equation)}$$

$$q^s{}_t = q(p_t,w_t,\pi_{2t},\pi^c{}_{2t},N_t) \qquad \text{(Supply equation)}$$

$$q_t = q^d{}_t = q^s{}_t \qquad \text{(Equilibrium condition)}$$

2.2 Factor Market

The factor market is characterised as a standard competitive labour market of supply and derived demand. The demand for illegal time is given by equation (2), while the supply of illegal time us assumed to depend on the following factors:

- Real wage rate in the illegal labour market (w),
- Real wage rate in the legal labour market (w_l), and
- Probability of unsuccessful activities in the illegal labour market (π_3).

The aggregate illegal time supply equation, in real terms, can be expressed as

$$T^s = g(w, w_\ell, \pi_3) \qquad (3)$$

The real wage rate in the legal labour market is determined outside the system and therefore it is exogenous.

Other supply shifters such as unemployment rate for the legal sector, the age distribution of the population and participation rate can be included in equation (3).

It is postulated that illegal time supply should increase with increases in the illegal wage rate, but it should decrease with increases in the legal wage rate. Increases in the probability of arrest/conviction should cause the supply of illegal time to decrease.

The factor market is assumed to clear at the equilibrium illegal wage rate and the respective equations are as follow:

$$T^d_t = h_t(p_t, w_t, \pi_{2t}, \pi^c_{2t}) \qquad \text{(Demand equation)}$$

$$T^s_t = g_t(w_t, w_{\ell t}, \pi_{3t}, \pi^c_{3t}) \qquad \text{(Supply equation)}$$

$$T_t = T^d_t = T^s_t \qquad \text{(Equilibrium condition)}$$

2.3 Criminal Justice Sector

Individuals have a demand for protection services, which are assumed to be produced by the criminal justice sector using both labour and capital as factor inputs. There is also a probability of arrest and conviction linking the criminal justice and the product market sectors.

We make the simplifying assumption that protection services are provided only by police. An extension to the model might include private protection services and other types of security/protection measures adopted by the population such as insurance, security devices and engine immobilisers.

Demand for Police Officers

We assume that protection services are produced at minimum cost and that the majority rule decides the amount to be spent on public protection. For simplicity, we adopt the following constant-return-to-scale Cobb-Douglas production function:

$$T = \gamma \, PU^{\alpha} S^{1-\alpha} Z^{\beta}$$

where, T is the level of protective service, PU is the per capita number of police, S is the per capita level of capital services, and Z represents other variables affecting the level of protective services.

The demand for police officers, PU^d, is assumed to depend on the following variables:

- Real wage rate of police officers (w_p),
- Real factor price of capital services (w_s),
- The total crime rate (q^a), and
- Real income (y).

The equation of the demand for police officers is then given by

$$PU^d = f(w_p, w_s, q^a, y) \tag{4}$$

Demand should increase with increases in total crime and income, while it should decrease when police wages and capital price increase.

Supply of Police Officers

It is assumed that an individual enters the police force if the real return of police officers (*ie* wages and non-monetary returns) exceeds that from another occupation. The model needs to include income in order to account for the effect of income in labour force participation.

The supply of police officers, PU^s, is assumed to depend on the following variables:

- Real wage rate of police officers (w_p),
- Real wage rate in alternative occupations (w_ℓ),
- Real income (y), and
- Total crime rate (q^a).

The supply equation in real terms can be expressed as

$$PU^s = f(w_p, w_\ell, q^a, y) \tag{5}$$

An increase in the real police wage should result in an increased per capita supply of police officers. On the other hand, increases in the real wage of alternative occupations should decrease police officers supply. Increases in real income and increases in the crime rate should cause a downward movement in the supply function.

The Criminal Justice Sector Equations

The equations for the criminal justice sector during a given period, *t*, are:

$$PU^d_t = f(w_{pt}, w_{st}, q^a_t, y_t) \qquad \text{(Demand equation)}$$

$$PU^s_t = f(w_{pt}, w_{\ell t}, q^a_t, y_t) \qquad \text{(Supply equation)}$$

$$PU_t = PU^d_t = PU^s_t \qquad \text{(Equilibrium condition)}$$

2.4 Probability of Arrest Production Function

Assume that the number of arrests during a given period is generated according to the following production function:

$$A = PU^{\alpha} (q^a)^{\delta} N^{\gamma} \, exp(\eta Z)$$

where, PU represents the relative size of the police force, q^a is the crime rate, N is the population size and Z represents other variables which may affect the probability of arrest such as age structure or race composition of the population. Division of the above equation by the total number of crimes, Q, gives the probability of arrest, π.

The probability of arrest should decline as the crime rate increases. It should also decline with an increase in population, as criminals become less visible in more densely populated areas. Changes in the size of the police force should increase the probability of arrest, provided that most of the police officers spend their time in crime control activities. If however, the time of police officers were distributed among a number of different activities, the impact of the relative size of the police force on the arrest probability would be ambiguous.

The equation for the probability of arrest during a given period, *t*, is given by

$$\pi_t = k(PU_t, q^a_t, N_t, Z_t) \qquad (6)$$

3 Empirical Analysis

Equations (1) to (6) together with the relevant equilibrium conditions specify the structural model of the economics of car theft. Using this model with real data requires dealing with the fact that some variables cannot be observed due to lack of data.

The number of motor vehicle thefts per 100,000 total population measures the demand for stolen cars. The true level of car theft is however unknown because not all the incidents are reported to the police. Car theft however is one crime for which reportability rates are very high due to the requirements of insurance companies. Therefore it seems reasonable to suppose that the per capita number of stolen cars available to the product market, q_t, is proportional to the reported crime index, r_t. The following relationship was assumed to hold between q_t and r_t:

$$log_e\, q_t = \beta_0 + \beta_1\, log_e\, r_t$$

There is evidence of an association between the rate of car theft and the average age of the car fleet (Carcach, 1998). Data published by the Australian Bureau of Statistics (1997) indicate that the median age of the car fleet has increased from 8.6 years during 1988 to 10.6 years during 1995. Inclusion of the average age of the car fleet in the above equation did not make a significant contribution to the fit of the model.

A second variable for which data are not available due to obvious reasons, is the price of stolen vehicles. The assumption was made that price of stolen vehicles was related to the price of new vehicles, according to the following equation:

$$log_e\, p_t = \gamma_0 + \gamma_1\, log_e\, p^c_t$$

Age of vehicle is a variable with a definite impact on the price of a vehicle, however its inclusion in the previous equation did not contribute to improve the fit of the market equations.

The third variable for which no data can be obtained is the wage rate in the illegal labour market. The factor market equations were used to derive an expression for the real illegal wage rate as a function of the price of stolen cars. This expression was substituted in the equation for the per capita number of stolen cars supplied to the market.

The following system of simultaneous equations was fitted to the data:

Demand for Stolen Cars

$$log_e\, q_t = a_0 + a_1\, log_e\, p_t + a_2\, log_e\, y_t + a_3\, log_e\, \pi_t + a_4\, log_e\, \pi^c_t \qquad (7a)$$

Supply of Stolen Cars

$$log_e\, q_t = b_0 + b_1\, log_e\, p_t + b_2\, log_e\, w_{\ell t} + b_3\, log_e\, \pi_t + b_4\, A_t \qquad (7b)$$

Probability of Arrest Production Function

$$log_e \pi_t = c_0 + c_1\, log_e PU_t + c_2\, log_e q^a_t + c_3\, log_e A_t + c_4\, log_e N_t \quad (7c)$$

Demand for Police Officers

$$log_e PU_t = d_0 + d_1\, log_e w_{pt} + d_2\, log_e y_t + d_3\, log_e q^a_t + d_4\, log_e A_t \quad (7d)$$

Supply of Police Officers

$$log_e PU_t = e_0 + e_1\, log_e w_{pt} + e_2\, log_e w_{\ell t} + e_3\, log_e y_t + e_4\, log_e q^a_t + e_5\, log_e UR_t \quad (7e)$$

where, *A* represents the proportion of males aged 15 to 24 years in the general population, and *UR* is the unemployment rate. All the other variables are as defined in previous sections.
The following variables are defined as e*ndogenous*:

- $log_e\, q$,
- $log_e\, p$,
- $log_e\, w$,
- $log_e\, \pi$, and
- $log_e\, PU_t$

These variables are determined within the system and therefore are affected by the interaction between supply and demand of stolen cars. The remaining variables are determined outside the market of stolen cars, therefore they are defined as exogenous.

The model defined by equations 7a to 7d was fitted to Queensland data for the period from 1974 to 1997, both years included. The data are shown in Table 1. Given the high correlations between the error terms of the different equations, the model was fitted as a system of seemingly unrelated regressions (SUR) (Zellner, 1962).

Table 1: QUEENSLAND, 1974-1997. Data Used to Model Motor Vehicle Theft

Financial Year	Rate of Motor Vehicle Theft per 100000 Population (1)	Aggregate Crime Index (2)	Aggregate Crime Index Excluding Motor Vehicle Theft (3)	% of Motor Vehicle Thefts Cleared by Arrest (4)	Total Imprison-ment Rate (5)	Imprison-ment Rate Motor Vehicle Theft (6)	Number of Police Officers, including Civilians per 1000 population (7)	Unemploy-ment Rate (8)	Average Weekly Earnings Police (9)
1974	233.1	91.9	56.3	27.4	105.5	11.8	582.1	4.6	114.6
1975	249.7	93.1	54.0	31.8	105.5	11.4	589.6	4.3	148.0
1976	236.6	95.4	62.6	30.0	107.5	11.4	584.1	5.0	168.4
1977	234.8	92.3	60.5	32.7	102.3	10.3	568.9	5.5	197.0
1978	258.6	94.0	64.4	29.1	106.5	10.8	566.8	6.7	221.1
1979	268.1	94.5	67.8	31.5	107.7	10.1	567.6	6.9	231.8
1980	261.1	95.9	72.7	29.4	105.5	10.0	563.7	6.6	253.5
1981	258.3	97.5	75.6	27.3	104.1	9.2	540.6	6.0	296.0
1982	270.9	102.0	81.2	28.9	105.5	9.9	558.0	6.0	335.1
1983	312.7	112.4	88.1	27.9	107.2	7.8	549.9	9.0	363.9
1984	318.6	120.0	98.6	28.1	114.6	10.7	538.6	9.7	382.6
1985	341.0	117.1	95.9	23.7	124.5	8.7	538.5	10.0	400.2
1986	359.7	127.1	107.3	26.9	132.1	11.6	538.7	9.2	427.9
1987	377.9	131.9	112.5	28.5	120.5	12.2	527.4	9.9	448.4
1988	367.5	135.0	121.0	27.1	122.1	10.4	538.8	9.2	470.0
1989	410.3	138.1	124.4	28.0	113.3	10.0	541.8	7.4	494.1
1990	491.1	157.8	146.2	21.2	106.4	8.9	524.9	7.1	522.3
1991	543.2	169.3	157.3	19.9	94.4	8.4	502.3	9.3	553.7
1992	543.7	177.3	168.2	21.3	89.4	6.7	483.2	10.1	594.6
1993	536.2	181.1	178.1	19.4	88.0	4.7	487.7	10.6	636.6
1994	560.1	174.8	172.4	21.5	104.0	5.1	515.5	10.1	655.2
1995	587.8	169.0	169.1	16.3	116.6	4.5	518.4	8.9	654.3
1996	584.7	183.2	189.1	22.8	139.6	6.6	521.2	9.3	645.1
1997	540.7	184.7	196.5	23.0	149.2	6.0	517.4	114.7	666.9

Table 1: *Continued*

Financial Year	Males Aged 15-24 as % of Total Population (10)	Consumer Price Index, Brisbane, (1989-90=100) (11)	Average Male Weekly Earnings – Manufacturing (12)	Price of New Sedan (13)	Per Capita Gross State Product (14)
1974	19.4	23.7	172.1	3580	7092
1975	19.4	27.4	187.2	3798	8768
1976	19.5	31.0	188.7	4336	10444
1977	19.6	35.4	194.5	6337	12100
1978	19.7	38.7	224.6	6513	13245
1979	19.7	41.9	267.7	7200	15364
1980	19.6	45.9	311.2	7900	17234
1981	19.5	50.2	341.7	9066	19806
1982	19.4	55.6	352.9	10633	23173
1983	19.2	61.7	369.1	11452	25228
1984	19.0	66.1	414.8	11152	28523
1985	19.0	69.2	479.9	13011	31564
1986	19.0	74.8	510.6	15869	34556
1987	18.8	81.2	489.2	16391	37930
1988	18.5	86.9	517.4	18631	42493
1989	18.4	93.0	599.3	20554	49902
1990	18.2	100.0	567.6	22213	55766
1991	18.0	104.9	522.6	23982	56739
1992	17.8	107.0	580.2	24560	60022
1993	17.6	108.5	586.7	26300	65015
1994	17.3	110.6	635.4	27040	69625
1995	17.1	114.7	669.8	28890	74984
1996	16.7	119.1	633.5	29610	78211
1997	16.5	121.0	634.2	29760	82794

Sources: (1) Australian Institute of Criminology, Crimes Reported
(2) Australian Institute of Criminology, Crimes Reported. Calculated as the geometric mean of number of crimes per 100,000 population for the following crimes: Homicide, assault, robbery, sexual assault, break and enter, motor vehicle theft, fraud and stealing.
(3) Australian Institute of Criminology, Crimes Reported. Calculated as the geometric mean of number of crimes per 100,000 population for the following crimes: Homicide, assault, robbery, sexual assault, break and enter, fraud and stealing.
(4) (7) Queensland Police Service, Annual Reports
(5) (6) Australian Institute of Criminology and Australian Bureau of Statistics, National Prison Census, Prison Trends and Correctional Statistics.
(8) (14) Australian Bureau of Statistics, Labour Force Survey
(9) Queensland Police Service, Annual Reports, Calculated from figures on expenditure on salaries.
(10) Australian Bureau of Statistics, Population Estimates at 30 June
(11) (12) Australian Bureau of Statistics
(13) Federal Chamber of Automotive Industries, 1998 Black and White Book
(14) Queensland Government Statistician's Office

4. Results and Discussion

Table 2 shows the final estimates of the parameters in equations 7a to 7e. \

Table 2: Estimated Parameters of the Model of Motor Vehicle Theft

Variable	Parameter Estimate
Demand for Stolen Cars	
Intercept	- 1.882
Logarithm of Real Price of Stolen Cars	0.412*
Logarithm of Real Income	0.572***
Logarithm of Probability of Arrest	- 0.779***
Logarithm of Probability of Imprisonment	0.035
Supply of Stolen Cars	
Intercept	3.146
Logarithm of Real Price of Stolen Cars	0.691***
Logarithm of Real Wage Rate Manufacturing	0.004
Logarithm of Probability of Arrest	- 0.670***
Proportion of Males Aged 15-24 Years in Total Population	- 0.104***
Probability of Arrest	
Intercept	2.653
Logarithm of Police Officers per 1000 Population	0.496
Logarithm of Aggregate Total Crime Index	- 0.522***
Demand for Police Officers	
Intercept	9.371
Logarithm of Real Wage Rate Police	- 0.241***
Logarithm of Real Income	0.120*
Logarithm of Aggregate Total Crime Index	- 0.368***
Logarithm of Proportion of Males Aged 15-24 Years in Total Population	- 0.364***
Supply of Police Officers	
Intercept	7.978
Logarithm of Real Wage Rate Police	0.276***
Logarithm of Real Wage Rate Manufacturing	- 0.003
Logarithm of Real Income	- 0.157*
Logarithm of Aggregate Total Crime Index	- 0.334***
Logarithm of Unemployment Rate	0.004

Demand for Stolen Cars

The probability of arrest has a significant negative effect on the demand for stolen cars. An increase of 1 per cent in the probability of arrest causes the demand for stolen cars to decline by 22 per cent.

The positive coefficient of price suggests that demand for stolen cars is more sensitive to changes in the price of new vehicles than to the price of stolen vehicles. The price elasticity of demand is a combination of the own price elasticity of stolen cars and the elasticity to price of new cars, a result consistent with the notion that new cars and stolen cars are substitute goods[5]. This result although unexpected has significant policy implications, which will be discussed, in the next section.

The positive sign of real income in the demand equation is consistent with expectations and suggests that stolen cars are normal goods. Keeping the effect of the other variables in the equation constant, a 1 per cent increase in income induces a 41 per cent increase in the demand for stolen cars. Note that the true effect of real income on demand depends on the magnitude and direction of both income and substitution effects.

Finally, note that the coefficient for the probability of imprisonment is not significantly different from zero. This suggests that individuals who engage in buying stolen vehicles are more sensitive to arrest than to imprisonment, so they are risk preferrers (Becker, 1968).

Supply of Stolen Cars

The supply of stolen cars is highly sensitive to the probability of arrest. The results in Table 2 suggest that an increase of 1 per cent in the probability of arrest causes a decline of 33 per cent in the supply of stolen vehicles.

Supply is positively associated with price. A reduction of 1 per cent in the price causes, according to the model, a reduction of 69 per cent in the rate of motor vehicle theft.

Note that the coefficient for the proportion of males aged 15 to 24 years is positive and highly significant. According to the figures in Table 2, as young males reduce their participation in the population, the rate of motor vehicle theft tends to increase. This result suggests that the type of motor vehicle theft known as "joyriding" which is attributed to the youth, is less of a serious problem than professional motor vehicle theft.

The supply of stolen cars is not sensitive to changes in legal wages. The positive but small coefficient for the rate of legal wage is contrary to expectations. This is a result requiring more research.

Probability of Arrest

The negative coefficient for the aggregate crime index is consistent with the notion that as total per capita crime increases the probability of arrest decreases. Note that this regression coefficient is significantly different from minus 1, which implies that the aggregate crime rate is not superfluous in the arrest production function and the resulting probability of arrest.

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[5] The actual expression for the price coefficient in equation (7a) contains two terms. The first term measures demand responses to changes in the price of stolen cars, while the second measures the impact of changes in the price of new cars. A positive sign for price in equation (7a) means that demand is more responsive to changes in the price of new cars than to changes in the price of stolen cars.

The coefficient for the relative size of the police force in the probability of arrest equation was not significantly different from zero, which may be due to the fact that arrest is only one part of the very diversified output of a police service.

Demand for Police Officers

The demand for police officers declines when the real wage rate of police officers increases, and it increases with increased real income. These results are consistent with expectations.

The coefficient of the aggregate crime index is significant but it does not have the expected algebraic sign. The negative relationship between aggregate crime and demand for police officers may reflect the significant expansion of the private protection sector in recent years. In the case of car theft, this result may be due to the fact that car insurance is relatively high, so the general population does not see police involvement as relevant to the recovery of lost property.

A reduction in the proportion of males aged 15 to 24 years in the general population results in increased demand for police officers. A likely explanation to this result is that arresting young people requires less effort than arresting older people, therefore as the average age of the general population increases, the time required to process alleged offenders increases due to the possibility of having to deal with lawyers representing these people.

Supply of Police Officers

Supply of police officers increases with commensurate increases in the real wage rate of police and with declines in real income. These results are consistent with theoretical expectations.

Note that as the total crime rate increases the supply of police officers declines. The crime rate was included in the equation as a proxy for the relative taste factor of an alternative occupation versus a police job. This variable had the expected algebraic sign.

The coefficient for the real wage in manufacturing was not significant.

Assessing the Model

An assessment was made of how well the model followed the actual values of the endogenous variables. Ideally, an appropriate simulation model follows the historical data very closely, or at least captures the overall trends.

Figure 1: Logarithm of the Rate of Motor Vehicle Theft, 1974-1997
Actual and Simulated Values

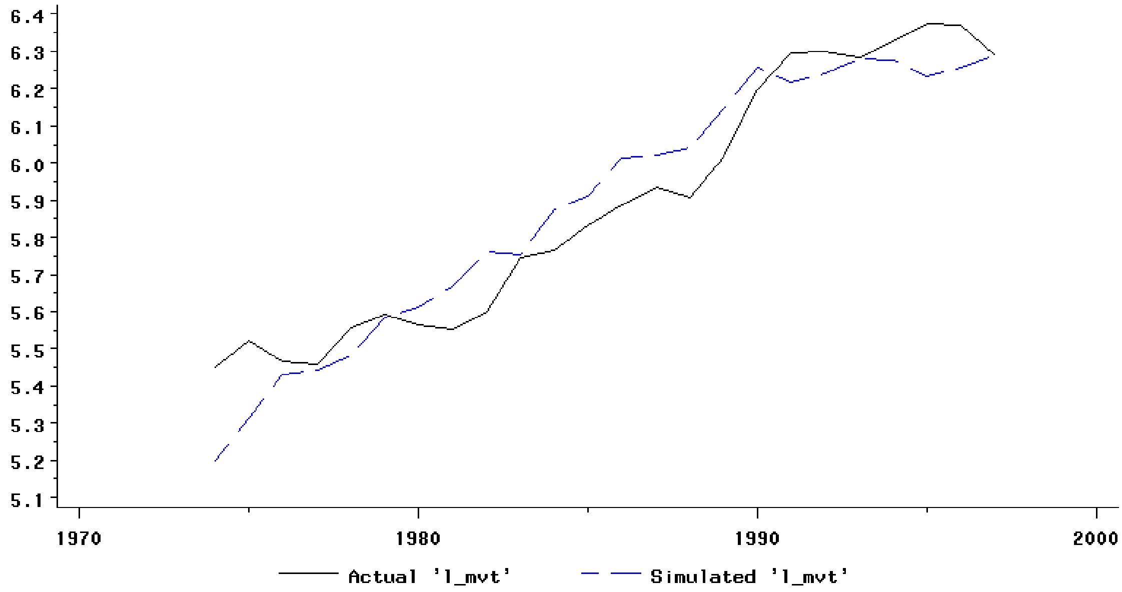


Figure 2: Logarithm of the Real Price of Stolen Vehicles, 1974-1997
Actual and Simulated Values

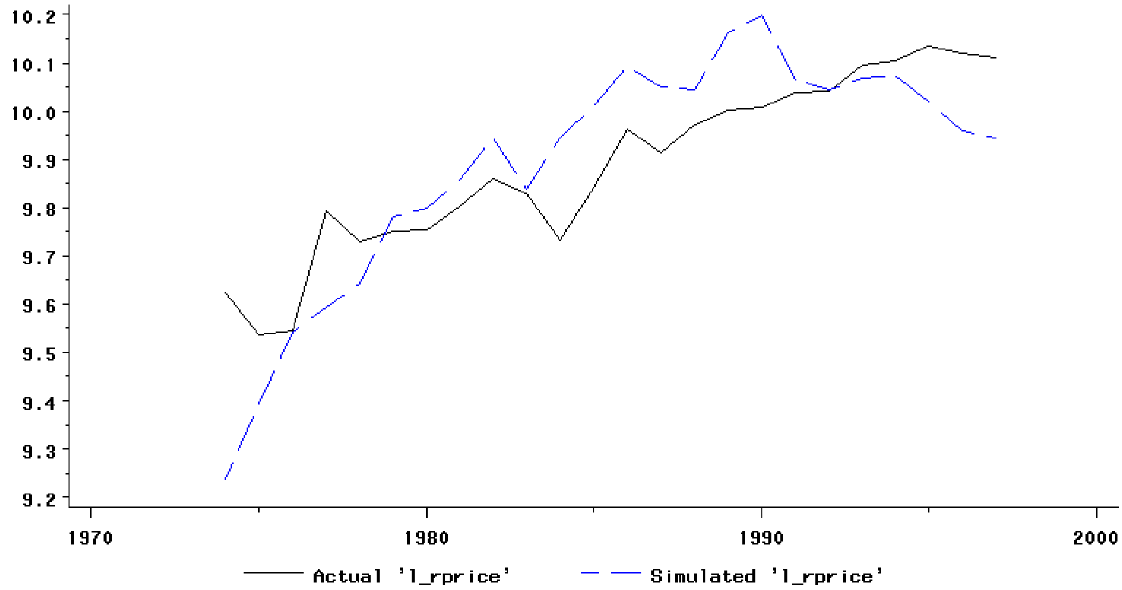


Figure 3: Logarithm of the Clearance Rate of Motor Vehicle Theft, 1974-1997
Actual and Simulated Values

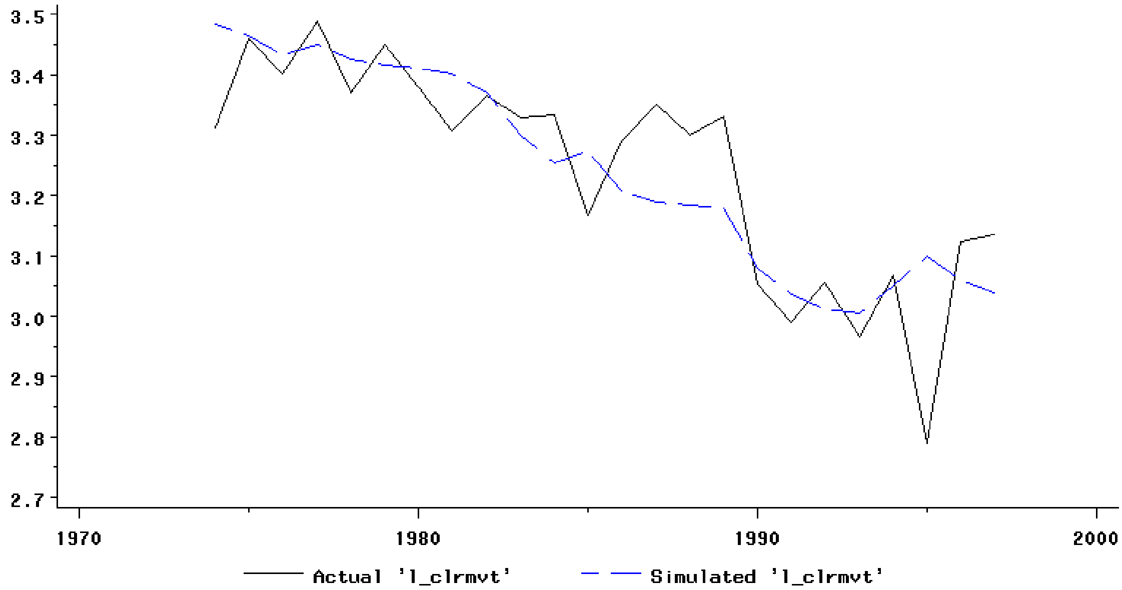


Figure 4: Logarithm of the Number of Police Officers per 100,000 Population, 1974-1997
Actual and Simulated Values

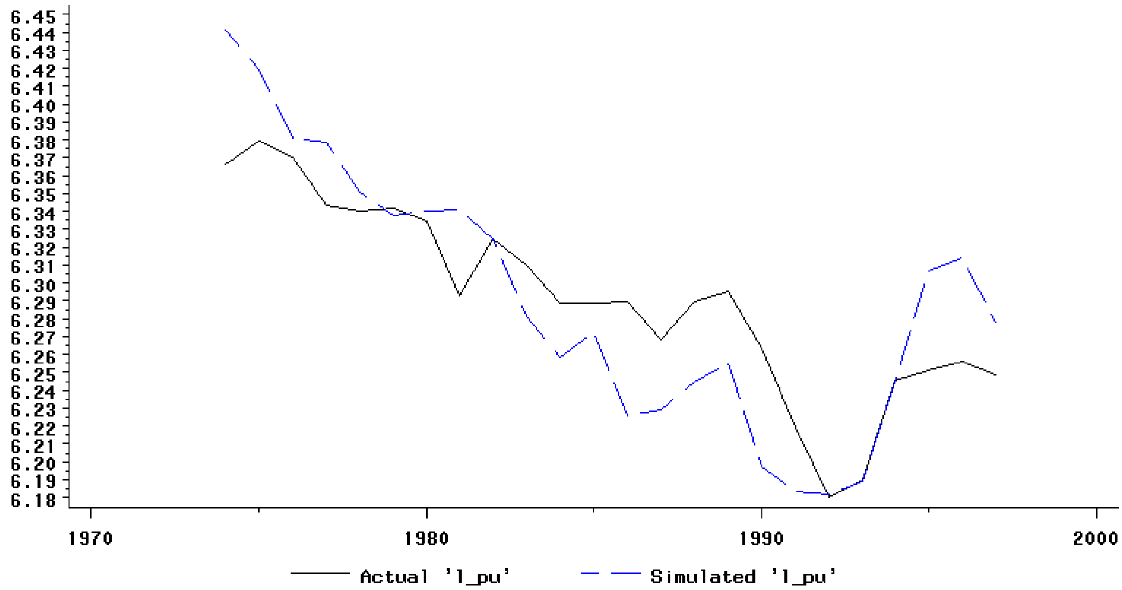
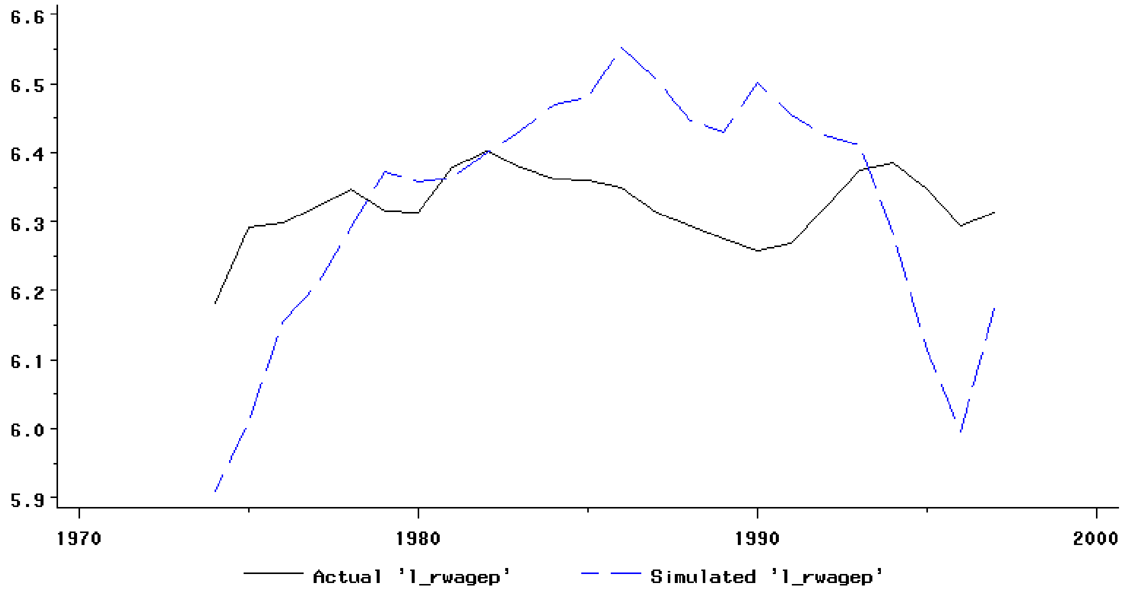


Figure 5: Logarithm of the Real Wage of Police Officers, 1974-1997
Actual and Simulated Values



The graphs in Figures 1 to 5 indicate that with the exception of the equation for the real wage of police officers, the remaining equations are adequate as models of the respective endogenous variables.

As shown by Table 3, with the exception of the police wage equation, the simulated values have approximately the same variability than the actual values. Note that the correlations between simulated and actual values are high for all the endogenous variables but the real wage of police officers. Finally, the relative mean square errors of prediction are acceptable.

Table 3: Forecast Error Statistics

	Actual		Simulated		Relative Mean Square Error	Actual-Simulated Values Correlation
	Mean	Standard Deviation	Mean	Standard Deviation		
Logarithm of Rate of Motor Vehicle Theft	5.89	0.34	5.89	0.35	0.108	0.949
Logarithm of Real Price of Stolen Vehicles	9.89	0.18	9.89	0.25	0.141	0.815
Logarithm of Clearance Rate of Motor Vehicle Theft	3.24	0.18	3.24	0.17	0.102	0.824
Logarithm of Police Officers per 100,000 Population	6.29	0.05	6.29	0.07	0.038	0.859
Logarithm of the Real Wage of Police Officers	6.32	0.05	6.32	0.18	0.138	0.401

5. Conclusions and Policy Implications

The model developed in this paper has a good potential to explain the main aspects of the economics of car theft in Queensland. Our results indicate that market forces, which explicitly operate to determine an optimal level of this form of crime in per capita terms, drive car theft.

The number of car thefts per 100,000 total population is more responsive to changes in the factors affecting demand than to those in factors affecting supply. In particular, the price of new cars has a major impact on the demand for stolen cars. The positive relationship between real income and demand suggests that any initiative aimed at preventing and controlling car theft must include improvements in new car affordability as one of its elements.

More affordable new cars would drive both demand for and supply of stolen vehicles down. In addition, as the age of cars on registry comes down, so does the demand for used parts. The demand for used parts has been suggested as one factors associated with the stealing of older vehicles.

The probability of arrest appears as a crucial factor in explaining demand and supply in the stolen car market. An increased probability of arrest is not necessarily related with increases in the size of the police force, but with the creation of conditions aimed reducing anonimity of car thieves, especially in densely populated areas.

Imprisonment on the other hand, did not appear as a relevant factor in affecting car theft rates. This suggests that individuals engaging in this form of criminal activity have risk preference, so their real income would be lower, marginally, than the income they could receive in less risky legal activities. A direct implication from this result is that car thieves should tend to offend at a relatively high frequency in order to compensate for this income disparity.

Car theft as an industry is dominated by the actions of professional criminals rather by opportunistic thieves or "joy riders". Therefore, car theft is no doubt a highly organised criminal activity with the potential to overcome any prevention measure of the type of those suggested by the National Motor Vehicle Theft Reduction Council. These measures will certainly result in a decrease of motor vehicle theft in the short term, however in the long term, the car theft industry will no doubt develop the necessary technology to get around measures such as parts labeling or enhancements to vehicle security.

The prevention and control of car theft are activities transcending the criminal justice system. Insurance companies, the car parking industry, local governments, and the private security industry are all heavily involved with car theft and its consequences. Our model reflects this as the demand for police officers is inversely related to the level of crime.

Comprehensive insurance does not cover the whole car fleet in a country. However, the perception that comprehensive insurance is a must seems to prevail among some sectors in the community. If this is also a dominant perception among members of police services, the owners of uninsured stolen cars will be penalized twice. They do not only experience the lost of their property, but their cases also may not receive proper treatment from the police, as they may deal with car theft under the assumption that all stolen cars must be covered by insurance.

The model developed here is not intended to serve as a forecasting tool. Its main purpose is to explain some of the many intricacies of car theft. The model can certainly be improved by considering a private protection sector which may include insurance and security measures among its components. Dividing the market sector into final consumption and distribution sectors can also expand the model.

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