

Pricing the travel time of busy women

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1 Introduction

The changing role of women in recent decades explains much of the growth in hours travelled. Accurate valuation of the travel time of busy women is required to optimise investment decisions about transport infrastructure. If policy makers, planners and private sector providers use inaccurate estimates of the shadow price of the travel time of women, they will make incorrect investment decisions and / or will schedule infrastructure investment years too early or too late.

Women are the focus of this paper. In recent decades women have accounted for much of the growth in hours travelled, in public transport patronage and in vehicle kilometres travelled (Ironmonger and Norman, 2007).

For the purpose of this paper, busy women are considered to be *highly-skilled professionals in paid work who also care for dependents (double-shift)*. They tend to exhibit many of the behavioural patterns of workaholics.

This paper sets out a model developed by Cavagnoli (2008) to help transport professionals move away from stated preference surveys of the value of time based on tiny sample sizes, towards revealed preferences of hundreds of millions of trips captured by large scale statistical tools, including the emerging time use database for Melbourne produced by Ironmonger (2006; 2008). The Cavagnoli model explains the supply of female labour as an augmentation of the standard neo-classical economic model. It is an alternative to the approach (Becker, 1965) of the Chicago-based Nobel Prize Economist, Gary S. Becker.

This paper is divided into the following sections: section 2 presents data that show how Australians spend their time; section 3 discusses travel time trends, section 4 presents travel time outside working hours, section 5 reveals preferences of time use of highly skilled women, section 6 sets out a model of utility maximisation for women, section 7 tests our hypotheses against stylised facts; section 8 discusses the implication for building upon previous findings by Morris (1996), section 9 proposes a measure for valuing travel time for economic appraisal of transport projects, and section 10 is the conclusion.

2 Australians have busy and complex lives

In Australia, from 2001-07, evening, public holiday and week-end work increased steadily. In the period 2001 to 2007, 23% of employees worked both on weekdays and week-ends. Full-time workers, males and females, work between 41 to 50 hours per week, (excluding the self employed) (van Wanrooy *et al.*, 2007). Highly skilled workers, in particular, spend an average of 48.4 hours per week in paid employment.

These skilled workers are at the top-end of the earning distribution, and they represent a third of the total full-time working population (ABS, 2006a; van Wanrooy *et al.*, 2007). Within this group, the majority of employees extend their working hours to perform more work at home, such as unpaid overtime (about 6 hours each week), learning and career development activities (about 4 hours a week). Full-time and part-time women employees with dependent

care, in particular, devote on average, 9 hours per week in home chores/activities, 5 hours per week in childcare, 1 hour per week in eldercare, commuting to and from work (about 5.6 hours per week), in addition to doing extra unpaid work and career development activities.

Highly-skilled women spend more time per week caring for children, and have more demands at home. On average, 75.7 hours per week are allocated to work (paid or unpaid) and family activities. These women enjoy only about 11 hours per week in free leisure (Duxbury and Higgins, 2008). ABS (2006b) defines free leisure as *“the residual time a person has after they have attended to the necessities of life (e.g. work, family care, self care). During this time a person is free of obligation or duty, and free to choose the way in which the time is spent (i.e. what activities they undertake in that time)”*. Highly skilled women with dependent care (the Baby Boomer and Generation X) report the heaviest demands on their time.

Before investigating the travel time decisions of these busy women, it is important to note that in Australia, the proportion of leisure time to paid-work time has not remained constant over time (since the early 1960s). This “structural change” (later called ‘A’) affects the demands on women’s time, in addition to what is already required by their family and social responsibilities. During the period 1965-1981, the daily average leisure time was about 8 hours. Between 1992 and 1997 the average decreased to nearly 4 hours a day, with little difference between men and women (ABS, 1995-97). In 2008, however, Australian highly skilled women in particular, enjoy about 11 hours per week in free leisure, or 1.6 hours a day, to allocate as they please.

Generally, it is argued that preferences play a major role in the decision to work overtime (paid and unpaid). Preferences for working longer changed, as a consequence of positive economic outlook, education (Wooden and Drago, 2007; Tseng and Wooden, 2005; ABS, 2006; Bray *et al.*, 2005), and greater job opportunities and flexibility in working conditions (Burgess, 1998; Campbell, 2002). Working longer is argued to be desirable for an efficient life-consumption pattern, in a way that educated individuals achieve their preferred careers to retirement (Moen and Roehling, 2005). Consumerism is also a reason for working longer, especially given the variety of market goods available to individuals (Schor, 1999).

Whether it is for shopping reasons, career and wealthy retirement reasons, or simply for the satisfaction from work, high-income earners, in general and highly-skilled women in particular, work well above the 48 hours a week. These highly skilled workers enjoy a high degree of discretion (flexibility) in the choice of their working hours (Duxbury and Higgins, 2008), they prefer to work fewer hours (ABS, 2006a), but, for every increase in the wage rate, they cannot enjoy more time in free leisure. It is not clear what is preventing them from working fewer hours. Their choices reveal a discrepancy between what the theory holds and what their preferences state. Time in paid work is not decreasing, and in addition to paid work, women still bear most of home responsibilities, so that time for housework is not decreasing with income and technological change (market time-saving goods).

This paper argues that what prevents women high-income earners from choosing more leisure is addiction to work effort. Work effort affects the ratio of labour endowment to actual labour supply (the ratio between total hours of potential work and total hours of actual paid work), which in turn affects the fraction of total time allocated to travel time. It decreases the marginal disutility of work, but increases the marginal cost of time inputs. The measure of work effort is given by the ‘extra’ hours of total time allocated to work (Cavagnoli, 2008), and the measure of work effort (cost of time) for travel time is given by the marginal utility of work (shadow price of time) by the changed fraction of time to travel time (out of total leisure time).

3 Travel time trends

Travel time estimates for Melbourne show rising hours per week by women travellers (see Figure 1). Hours spent by women travelling for consumption purposes, e.g. social interaction, visitation, dining out, entertainment rose by 77 per cent in Melbourne from 1991-2006 (see Table 1).

Hours per week

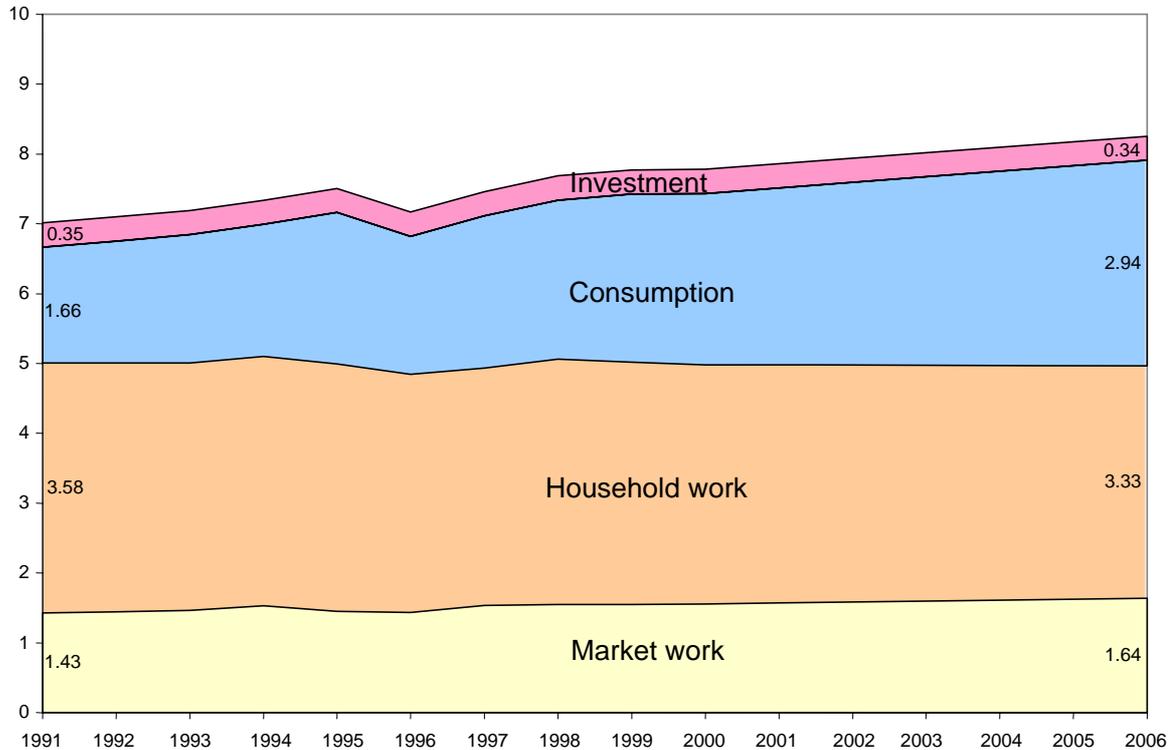


Figure 1 – Travel time by women in Melbourne, 1991-2006

Source: Ironmonger (2008)

Table 1 – Time spent travelling by women in Melbourne, 1991-2006

Purpose	Travel time (hours per week)		Change
	1991	2006	
Investment	0.35	0.34	-3%
Consumption	1.66	2.94	+77%
Household work	3.58	3.33	-7%
Market work	1.43	1.64	+15%
Total	7.02	8.25	+18%

Source: Ironmonger (2008)

Since 1991, travel time for the purpose of consumption activities, has increased significantly as a fraction of total time for travelling. In 1991, this fraction was 1.66 hours out of a total average of 7.02 hours per week (about 20%). In 2006, this increased to 2.94 hours per week, representing an increase of 1.28 hours per week, or 80%.

In 2006, the share of travelling time to total time in leisure has increased from 7.02 to 8.25 hours per week (about 18% increase since 1991). In 2006, the new share of travel time for consumption activities was of 36% (out of 8.25 hours travelling per week). This means that out of 18% increase in total travel time, travel time for consumption is responsible for 16% of this increase (20% out of 7.02 hours, 36% out of 8.25 hours).

The fraction of travel time for consumption activities was similar in 1991 to the fraction of travel time for work; both roughly corresponding to 45% of the time in travelling for house work purposes. In 2006, however, the purpose of travelling for consumption (2.94 hours) was 80% greater than the fraction of travel time for work (1.64 hours), and almost reaching, in magnitude, the share of time in travelling for house-work purposes (3.33 hours).

The activity of travelling increased its inputs of time by 18% (above the average of 7.02 hours per week) since 1991. Travel time for consumption activities, in particular, is responsible for 16% of this increase, but bearing a share of 36% in the total costs of time inputs for the activity of travelling. In this paper, the change in the (fraction of) inputs of total leisure time to travel time for consumption purposes (1.28 hours) is the coefficient used to adjust the shadow cost of travel time.

4 Travel time outside working hours

Generally, it is assumed that there is a positive relationship between the wage rate and consumption of social and recreational goods and services, and a negative relationship between the demand for leisure, including travel time, and the wage rate. This assumption implies that if leisure time, including travel time, is a normal good then for every increase in the wage rate, a lower share of income is allocated to them; because wealth increases overall (Becker, 1992; Becker and Murphy, 1992).

For high-income earners, in particular, if travel time is a normal good, the substitution effect should be lower than the income effect in absolute terms; that is, at greater income, they enjoy a greater amount of leisure and time for travel, with no extra costs incurred.

Given that the time allocated to paid and unpaid work has not decreased since the 1980s, and that highly-skilled women do not enjoy more free time than their counterparts of 30 years ago, then firstly, leisure time (including travel time), is not perceived to be a normal good; and secondly, the substitution between consumption and leisure is increasing over time. Both outcomes are contrary to the standard analysis of consumer's demand; in particular, it assumes that the elasticity of substitution between consumption and leisure, from period to period, is constant (Ashenfelter and Layard, 1986, ch.1; Becker and Murphy, 1988).

This paper proposes that the reason why leisure time is not perceived as a normal good is addiction to work effort (extra time to work). Work effort is an unrecognised drug. Generally overworkers (Peiperl and Jones, 2001), and workaholics (Harpaz and Snir, 2001) are, for different reasons, unhappy if not working, but satisfied when working (Porter, 1996; Robbins and Everitt, 1999; Azis and Zickar, 2006; Hamermesh and Slemrod, 2008). If addicted, individuals do not consider time allocated to work as a disutility. Within this framework, addiction, therefore, decreases the disutility of work, and decreases the marginal utility of non-labour income, rather than decreasing the marginal utility of labour income (as in Becker, 1985; Becker and Murphy, 1988).

Travel time, outside working hours, for all purposes, has increased since 1991, from 7 hours to 8.24 hours a week, in 2006. In particular, more time for travelling has been allocated for the purpose of consumption activities (not for work or family activities). If more time than the necessary has been allocated to activity 'travel' (for the purpose of consumption and not for work or family activities), then leisure time, is not perceived to be a normal good.

Preferences for leisure time change as addiction to work effort increases the subjective price of leisure time compared to other substitutes of time inputs (i.e. faster modes of travelling and other market time-saving goods). Therefore, substitution between leisure and consumption increases, as the ratio of travel time to total leisure (the average of travel time) increases. Since 1991, this ratio has increased by 1.28 hours.

Given that the time allocated to paid and unpaid work has not decreased since the 1980s, the extra 1.28 hours spent in travelling, are taken from the stock of free leisure time. These extra inputs of leisure time to travel time for consumption increase the share of the input costs (of time) to the total costs of travel time (and to the total cost of leisure time). Therefore, the shadow cost of travel time increases by the costs of these extra 1.28 hours.

In a study on overworkers, Peiperl and Jones (2001) emphasised that people who do choose to work longer, and more than the necessary, display a sense of guilt for their time away from the family; and because of guilt, they overspend in market goods to compensate their family (Pocock, 2003). Therefore, the extra time spent in travelling for consumption purposes, might be partly explained by this general increase in guilt amongst hard-working women.

Addictive behaviour, in this paper, is considered as a change in the technology of consumption. The change in technology reflects an increase in the elasticity of substitution between consumption and leisure within periods, but also between periods (and generations). Further investigation is required about the importance of the psychological motivation to work longer (whether in paid or unpaid work), as it reflects the natural desire to 'strive' in any activity, but also to be accepted and praised socially. Its determinants influence three issues:

- the subjective decision to allocate time,
- the shadow price of time, and
- the perpetuation of gender-based roles (and extra time) for family responsibilities.

5 Revealed preferences

The choice to allocate 'extra' hours of leisure to work reveals that people over-commit (over-allocate) their time at the expenses of free leisure. Commitment represents the individual's willingness to exchange time and the ability to control and plan the allocation of time. The commitment to work longer hours is affected by the characteristics of the job, the willingness of others to give up their time in order for the individual to consume more time at work, a high degree of job responsibility, and by the level of satisfaction obtained from work (Cavagnoli, 2008). These factors increase the demands of time for current consumption, while decreasing the quantity of leisure time available for future consumption.

The decision to work longer hours, therefore, is affected by more than the individual's opportunity cost of time in the market (wage). Women high income earners seem to prefer work to leisure but, in doing so, their marginal cost of time inputs increases further and faster than the increase in the market price of time.

If we take the current ratio of labour endowment to actual labour supply as a benchmark, women should allocate on average 40 hours a week in paid work, 30 hours in unpaid work, which includes: travel time, house work, dependent care, take home work, and career development; then 56 hours to sleep, and enjoy 42 hours a week, or 6 hours a day, of free leisure. To note that this ratio represents the rate of conversion of time to market time, and its value affects the difference between the compensated and uncompensated labour supply elasticities (and so, the net wage rate).

Given the institutional constraints on time of 24 hours a day, and the natural constraint of 8 hours for sleeping, then the remaining 16 hours of waking time must be allocated between work and the current needs of busy women. We know already, however, that women (full-time and part-time) allocate an average of 75.7 hours per week to work and family activities, which is 5.7 hours above the weekly average in the benchmark; and they enjoy only about 11 hours per week in leisure, which is 31 hours below the weekly average in the benchmark. When hours of paid work increase, more household tasks need to be done per unit of time, including time for travelling, as less time remains in leisure. The increased intensity of time augments the demand for units of time. Figure 2 shows the changes in the ‘subjective’ price of time. This price rises well above the price given by the market wage.

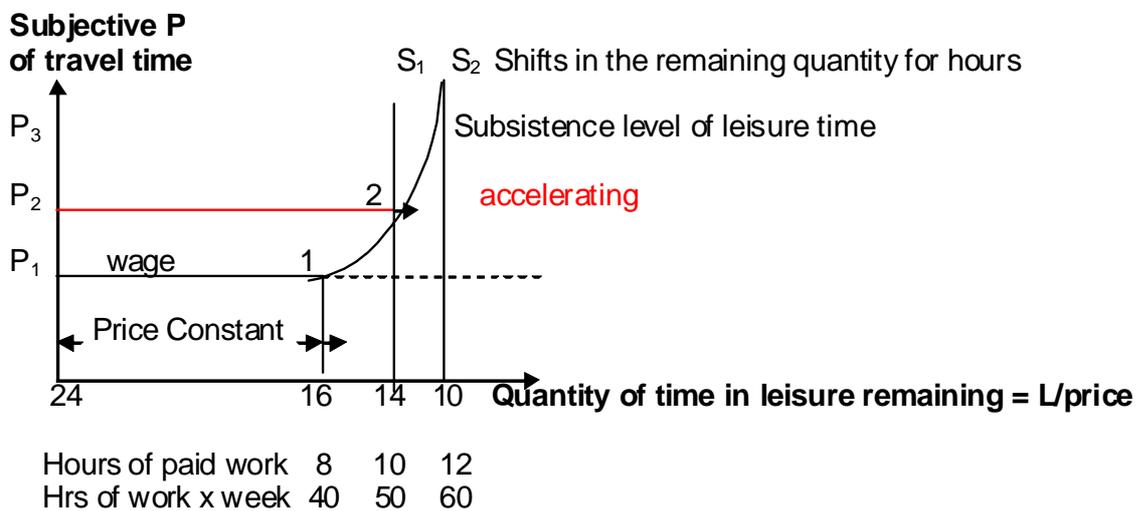


Figure 2 – Accelerating intensity of time use

Working women do not decrease time in paid or unpaid work in order to have more time for travelling and for leisure in general. They invest in cars in order to buy time for work or for travelling for consumption purposes. Salomon and Mokhtarian (1998) findings, for example, show that the choice of the mode that allows simultaneously to do other activities (in our case, shopping, dropping the kids off to school, work) is preferred to others, as it compensates for the negative marginal utility of travel-time increases.

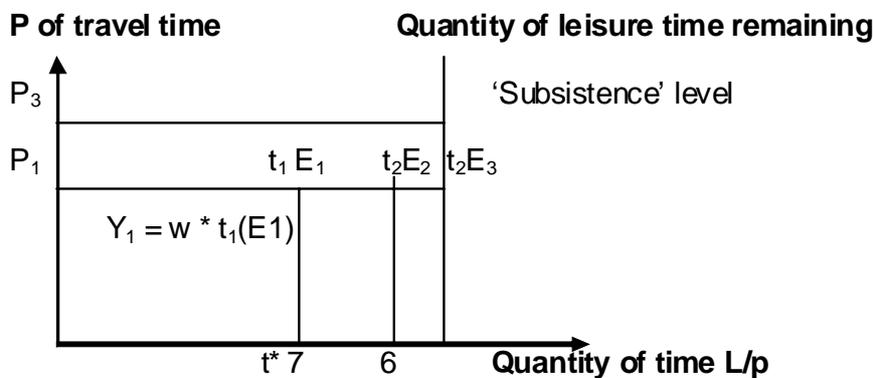
The evidence amongst Melbournians is a quasi ‘complete’ switch to driving mode, which could be argued to be an efficient response to the changes in relative prices of all the other modes of travelling (Lancaster, 1966). However, this could be the case only if total time spent travelling decreases, or if total time in travelling does not increase. Time for travel increases nevertheless (Ironmonger, 2006; 2008).

Women also intensify every trip by increasing the number of stops for every trip, as they try to avoid congestion and buy more time. However by doing so, the intensity of travel time increases, which impact on traffic delays, travel reliability, and the duration and extent of traffic congestion (BTRE, 2007). Not only the social economic costs of travelling increase, but there is a further re-allocation of total time (and total income) to travel time. Therefore,

even though women try to maintain their allocation of time to work (paid or unpaid) by increasing the elasticity of substitution between leisure and consumption, there is an inefficient private ‘over-compensation’ of their time to the market, which increases the private and the social cost of travelling time.

If 8 hours of work is considered a fixed resource of time, at $t^* = 16$, the cost of travelling increases at an exponential rate when the quantity demanded is above t^* . Intensity increases work effort, which in turn increases the quantity of leisure time demanded for travelling, thereby decreasing the quantity of time for other activities, and increasing the marginal cost of inputs.

The cost of travelling equals the generalised costs of the mode (i.e. driving) when the time spent in travelling and the average working hours remain constant; but, as this average has not remained constant over time, the marginal cost of travel time cannot be absorbed by the average costs in the long term; therefore, for every extra time spent travelling, the cost of travelling increases at an exponential rate. It inflates the subjective price of time, and increases the shadow price of travel time. This is important to estimate the ratio of the marginal utility of travel and the total cost.



At $P_1 t^* = 8$ hours of work; 1 hour of travelling; 8 of sleep; E_1

Figure 3 – The price of travel time

Figure 3 shows that the greater the hours devoted to paid work, and the more productive individuals are, with education and experience, the greater are the opportunities to produce output and *potential output* (more time in leisure and more time for travelling). Education and experience, however, also increase the willingness to work longer, and to become addicted to work effort, which increases the intensity of tasks per unit of time, and hours at work.

The real output of hours remaining in leisure decreases. Each increase in the demand for leisure time (t_1 to t_3) for travel time increases the intensity of travel time (E_1 to E_3). A decreased quantity of leisure time, and an increased intensity of time, lead to a greater substitution between leisure time for travelling time, and to a greater substitution for modes that permit many stops in one trip (to save time).

The wage and the ‘shadow wage’ cannot compensate for the extra hours lost in leisure. The ‘subjective’ price of consumption of time for travelling is affected by the decreased base of leisure time, as well as by the increased intensity of travel time. Individuals do not decrease paid work time for travelling. There is addiction. They decrease leisure time. The shadow price of time is increased by the amount of over-consumption of time at work and by the intensity of time.

The proposition here is that the demand for travelling time, for example, is not contingent on the choice of destinations, but by the characteristics associated with the mode of travelling and the use of modes that maximise the benefits from travelling, per unit of time. 'Time pressure' increases the complexities of time and of tasks. Complexities and lack of leisure time increase the demands on travelling time. Time pressure and lack of leisure are a characteristic of high income earning women.

The data suggests that even though more tasks are accomplished within the same trip and per unit of time; time spent in travelling increases. If the mode of travelling is the car, and if the road chosen leads to many destinations (location of jobs, schools, as well as shops, as well as leisure activities), then the number of tasks achieved, while travelling, satisfy more needs within the same trip. However, the new equilibrium in the use of modes is inefficient, as more time is consumed on the roads, leading to congestion.

6 Utility

The conventional approach to estimating the value of travel time saved involves calculating the marginal rate of substitution between travel-time and travel-cost, holding income (as utility) constant (Becker, 1965; Oort, 1969; De Serpa, 1971; Truong and Hensher, 1985).

Individuals are assumed to derive utility from both the consumption of market goods and time they allocate to different activities, such as time for travelling. The utility function includes both market and non-market goods consumed per activity and time as inputs. The constraints are the total amount of time and wealth available.

Within this framework, utility is maximised when individuals minimise the costs of travelling.

Generally it is accepted that utility is maximized where the marginal utility of travel time gives the additional utility received from consuming an extra hour of travel time, and this 'extra hour' costs 'w' (wage) dollars; therefore, maximization occurs when the last dollar spent on travel time activities gives the same utility as the last dollar spent on consumption goods. That is, that the marginal utility of travel time is equal to the marginal utility of consumption. The ratio equals the wage rate, or the marginal rate of substitution between travel time and consumption.

However, the phenomenon of long hours of work reveals that, amongst women high income earners, the marginal utility of consumption is greater than the marginal utility of travel time.

Individuals do not minimise travel costs. This paper argues that leisure time, including travel time, is not perceived as a normal good, which is a fundamental assumption underlying the validity of the marginal rate of substitution between leisure time and time for work.

According to the theory, the difference between a normal and an inferior good rests in the size and the sign of the income and the substitution effect. A normal good always displays a negative substitution effect and a positive income effect. However, when the income effect is negative and greater than the substitution effect, or when the substitution effect is greater than the income effect, the good in question is inferior.

In the aggregate, the net effect of an increase in wages is that more market goods and services are bought (Hamermesh and Slemrod, 2008). However, the motivation to consume more might be to decrease the time spent in travelling. The increased expenditures on fast cars, child-care services, home-time-saving appliances, for example, as well as the increase in the average working week, reveal that people are prepared to trade off time in non-paid activities for more time in paid work.

If travel time is a normal good, and its demand is downward sloping, the ratio between the change in the demand for travel time with respect to a change in its price, should equal the ratio of the change in demand for travel time with respect to a change in its rental price (shadow wage). This ratio should be positive.

However, the above statistics imply a negative ratio between the change in demand for travel time and the change in its price (shadow wage); but also that the marginal utility of consumption (the substitution effect) is greater than the marginal utility of income. Income is decreased by the 'subjective' price effect, while substitution is increased by the increased intensity of time (addiction to work effort). One of the two prices, the market (shadow) wage or the subjective price of travel time, differs in the degree of change, which is not captured by the current theory.

The following model of utility refers to a two-period utility from a Beckerian perspective, which accounts for addiction, so for a change in the subjective price of time. However, as work effort is an unrecognised addictive substance, its effect on behaviour cannot be fully explained within this model. An alternative is needed.

$$u^1(y_1, r_1)$$

$$r_1 = \text{recreation} \quad / \text{travel} \quad / \text{sleep}$$

$$y_1 = \text{income}$$

$$s = \text{overtime} = 0$$

Budget :

$$y_1 = (24 - r_1)w_1$$

$$w_1 = \text{wage} = (\$/\text{hour})$$

$$u^2(y_2, r_2, s)$$

$$s = (24 - r_1)$$

$$r_2 = \text{leisure} \quad t_2$$

Budget :

$$y_2 = (24 - r_2)w_2$$

$$w_2 = w_1 + f(24 - r_1) + (-)A,$$

$$A = \text{negative} \quad (\text{if}) \text{addicted}$$

$$s = (24 - r_1)$$

$$u^1(y_1, r_1) + \delta u^2(y_2, r_2, s)$$

$$\delta = \text{discount}$$

$$y_1 = (24 - r_1)w_1$$

$$y_2 = (24 - r_2)w_2$$

$$s = 24 - r_1$$

$$w_2 = w_1 + f(24 - r_1) + A$$

A refers to an autonomous increase in the wage rate in period 2 (or new generation of high income earners). It is assumed that A represents a structural change in the ratio of labour endowment to actual labour supply (and so, in the ratio of leisure time to travel time). As such, A 'inflates' the price of the real wage. For every increase in the wage, there is an income effect that works in the opposite direction to the standard income effect. It decreases the budget (leisure) constraint. In the second period of utility maximisation, the effect of a change in A on utility is in addition to the income and substitution effect given by a decrease in the real wage.

The Beckerian assumption is that recreation (r), for 2 cohorts of women (periods 1 and 2), is the difference between total time and time at work, $r_1 = (24 - w_1)$, and $r_2 = (24 - w_2)$, where time at work is a positive function (f) of the wage rate in each period. The value of the initial stock of time is the reservation wage, which equals the marginal rate of substitution between hours of work and consumption. Addiction (s) is given by an initial (internal) subjective price of time, which, for bad addictions (and low income earners), is assumed to be higher than the rate of interest, in the first period.

To maximise utility in period 2, the first condition is that the ratio between the marginal utility of consumption (work time) and the marginal utility of leisure (hours), equals the wage rate in period 2, or $u_2^2/u_1^2 = w_2$. The wage rate is equal to the marginal rate of substitution between leisure (recreation) and consumption, and the reservation wage in period 2.

The second condition is that the marginal rate of substitution between the ratio of marginal utility of leisure time and consumption in period 1, u_2^1/u_1^1 , equals i) the wage rate in period 1, plus ii) the discounted marginal rate of substitution between the marginal utility of consumption in period 2, $u_1^2(24 - r_2)f'$, and the marginal utility of consumption in period 1, u_1^1 , plus iii) the marginal utility of addiction in period 2, u_3^2 , the marginal utility of the 'bad' addiction, on the wage rate, $u_3^2 < 0$, which decreases the marginal utility of leisure (non-labour income) in period 2. It represents preferences for high leisure in period 1 (an income effect), which decreases in period 2.

Generally, the theory explains that there are 'bad' and 'good' addictions, so that the variable A can take a positive or a negative sign (Becker and Murphy, 1988). Addictive goods however, as defined by the theory, do not include the satisfaction from 'high-intrinsic effort'. This is a 'good' addictive good as it leads to greater earnings (utility increases), but it also leads to a 'negative' outcome on leisure time. It decreases the disutility of work, thereby increasing the inputs of time to work, which in turn increase the marginal cost of time at work.

In 2006, more time than the expected has been allocated to the activity of travelling. That is the difference between $r_1 = (24 - w_1)$, and $r_2 = (24 - w_2)$ when discounted, can still be positive, but r_2 can be lower than r_1 . However, this represents a discrepancy as the condition for long-term equilibrium, assumes that peoples' expectations about future prices do not change overtime (i.e. internal rate of return to capital (r) equals the interest rate (i), in the long-term). If addiction is 'good' in period 1, then the internal rate of return to capital $r > i$ (the highest present value is preferred). If addiction is 'bad' in period 1, then the internal rate of return to capital, $r < i$.

Therefore, the stock of addiction, for standard (bad) addictive goods (s) equals the wage rate in period 1, $s = w_1$. Standard (bad) addictive goods, such as alcohol and cigarettes, are

assumed to bring about lower wages, and more work in period 2. The marginal utility of 'bad' addiction decreases with time, $\partial u^2 / \partial s < 0$, so that more work is done in period 2.

If leisure is a normal good, and if leisure time, travel time and hours of work are substitutes, the cross-price elasticity of demand for time in leisure (including travelling for consumption) must be positive. That is, the individual's own-price elasticity of hours must be lower than the own-price elasticity of goods and services (i.e. modes of travelling).

If the cross-price elasticity of demand for goods and services (modes of travelling) is negative then either leisure time (including travel time) is not a normal good, or hours spent in leisure, travel, and at work are not substitutes. As leisure time must be a normal good, then hours in leisure, travel and at work are not substitutes; and this is the reason why the substitution effect in period 2 overwhelms the income effect, and is much greater in period 2 than what it was in period 1. In both cases there is a misspecification in the theory.

Studies on the elasticities for public transports suggest an increase from 1980 to 1990, with a mean elasticity from 50 studies of -0.41 and a mean elasticity for petrol consumption of -0.48, from 120 studies. In another situation, the traffic decreased at a level implying a toll elasticity of -0.40 (Taplin *et al.*, 1997; Hensher and Louviere, 1998). These are cross-price elasticity of demand for public transports and modes of travelling. This not only suggests that this individual would be willing to pay for increases in travel time, but also that their income elasticity of demand for goods and services is negative.

If more time than the expected has been allocated to the activity of travelling in period 2, and time at work does not decrease, then the own-price elasticity of time (hours) is greater than the own-price elasticity of goods and services (modes of travelling), w_2 is less than w_1 by a change in the subjective price of time in period 2 (rather than in period 1 as currently assumed). This leads to an increase in the shadow price of time by the same proportion, as more inputs of time, than expected in period 2, are required for travelling.

Therefore, leisure time, r_2 , in 2006 is lower than what it was in 1991, r_1 , by A , which in this paper is 1.28 hours. It increases the fraction of travel time to total travel time by 1.28 hours.

An optimal equilibrium quantity of hours consumed in paid work exists; past which, the 'extra' time consumed in 'high intrinsic effort' affects the willingness to exchange time for money. Leisure time becomes inferior as addiction to work increases the demand for paid work (decreases total utility, increases total costs). The price elasticity of demand for hours in paid work, as for addicted goods, becomes inelastic, and the income elasticity of demand for time (effort) is negative. It reflects an over-compensation of women's work effort (hours) to the market sector. This leads women to allocate more than expected hours to travel time and work. These choices create a vicious cycle of consumption patterns that are not efficient, even though they are necessary in order to adapt to an unacknowledged (and so uncompensated by the market) constraint on leisure time.

7 Hypothesis versus stylised facts

The motivation to strive requires activities to be categorised according to priorities. While the importance of categorising activities has been recognised (Mincer, 1962; Ironmonger, 1972; 1996), the input of effort (time) has not yet been recognised as an input in itself. Activities need to be categorised by purpose, but also by their degree of complexity (intensity).

In the possibility that “an individual may be capable of offering more than one kind of labour” a more complicated description of the model is required (Arrow, 1983:161). “If two factors are always used together and always in the same proportion, that are not produced goods but natural resources available in equal quantity, there is a problem with the classification of these two goods, whether they are free goods or scarce” (Arrow, 1983:209).

This thesis clarifies the concept of effort (time) in terms of income, and proposes a distinction between activities that are ‘goods’, or that produce positive characteristics of time, and activities that are essentially ‘bads’, such as paid work, which decreases the benefits from effort.

There are activities that have no complexity (sleep), others that have low complexity (routine activities), and high complexity (high cognitive demands jobs). Activities are also free or paid for. Effort time, as an input consumed in these activities, produces different types of characteristics, and so, of learning that affects preferences. The output of time has different characteristics.

The greater the complexity, the greater is the ‘high intrinsic effort’ produced and the motivation to strive, and the greater the substitution of time for activities that are complex; but the greater the amount of time in complex activities the faster a saturation point is achieved between rewards; after this point, preferences for the use of effort time (and income) change. Behaviour becomes addictive and activities in leisure become inferior ‘goods’ (as currently revealed by the Australian high income earners).

Effort time as an output affects the individual and the social level of tolerance (preference) both about the quantity of time to be consumed in one type of activity, and about the types of activities that should be prioritised (and are socially accepted). Greater effort time leads to a greater consumption of time, and so to less supply of the resource ‘leisure time’. The diminished supply is given by an increased tolerance for satisfying the greater demands placed on time.

Education, experience and social demands affect the length of working hours; fertility rates; congestion time, habits of choice, norms of behaviour. Behaviour is primarily driven by the motivation to strive. The motivation to strive responds to non-pecuniary rewards and to a non-instrumental type of rationality. In this paper ‘overtime’ is assumed to be a proxy to measure the motivation to strive (effort).

7.1 Proposal

Cavagnoli's (2008) model proposes that:

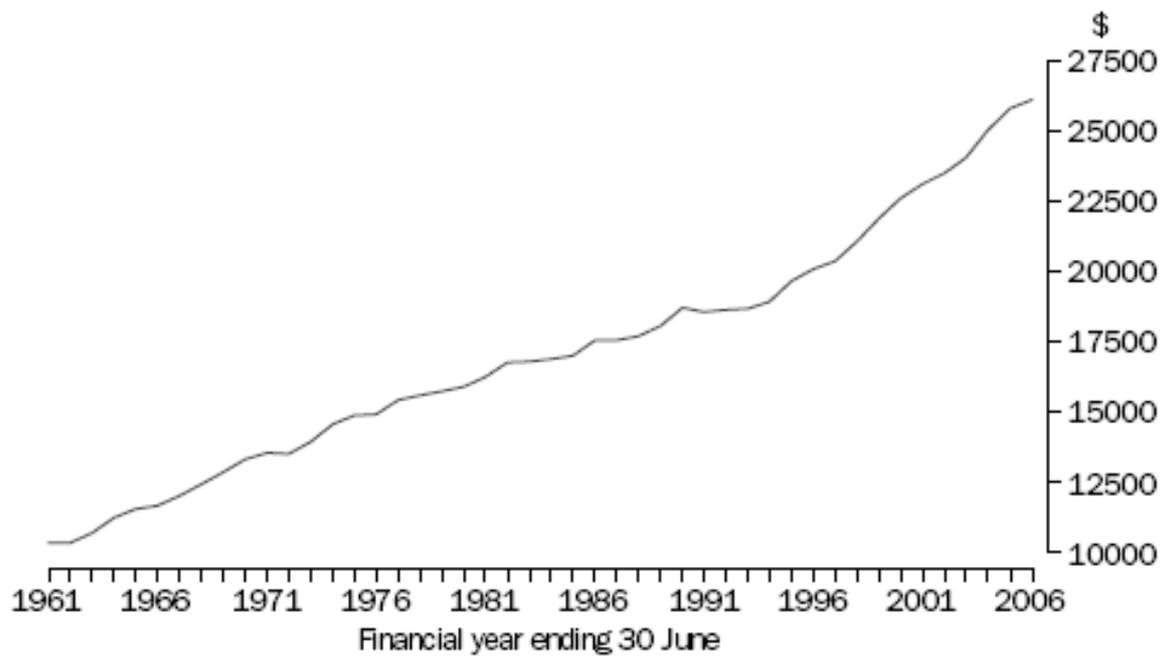
- Time is indivisible with learning between activities (Lancaster, 1966).
- Learning experiences differ between activities in terms of complexity (Arrow, 1962).
- Effort is measured in terms of time (Cavagnoli, 2008) rather than skills (Becker, 1992)
 - Effort time increases with time (wage) (Becker, 1992) and learning but it increases further in complex activities (intensity),
 - Effort time decreases with time (wage) (Currie and Steedman, 1993) but it decreases further in complex activities (intensity).
- Education generally leads to an elastic price elasticity of demand for time for complex work, and hence to increases substitution.
- Effort time in complex activities leads to an inelastic price elasticity of demand for time (Income elasticity = -1).
- Options in mode of travelling (and of work given the nature of work organised around tasks rather than time) increase opportunities for substitution. This gives a flatter average cost curve and flatter demand for (leisure) time in the long term. However, there is less supply remaining of leisure time.
- Behaviour is homogeneous in terms of the motivation to strive (Maslow, 1954; Hirschman, 1984; Bowles and Park, 2005). Behaviour is prone to addiction, to seek complexity. Behaviour is prone to increase the rate of substitution; given opportunities, general learning, experiences and habits.
- Expenditures reflect the consumption of resources.
- Investments are not expenditures, so that sleep time, for example, is not an investment.
- Effort, the motivation to strive, does not respond to pecuniary incentives nor does it reflect an instrumental rationality (Sen, 1977; Hirschman, 1984). Its demand is independent of the quantity of market goods and services consumed. Effort is constrained by the amount of time labour is engaged in complex activities. There are only 24 hours a day and effort needs to be renewed in non complex time (i.e. sleep or personal care).

7.2 Methodology

High skilled workers today behave homogeneously and have tolerance for less leisure like the experienced workers 'baby boomers'. Both groups are high income earners. Both groups experience 'time pressure'.

It is expected that distribution of revealed preferences for fast modes of travelling would be skewed for high income earners, so that revealed preferences are segmented by income groups. The elasticities of demands for consumption of market goods and services are required as parameters for a discrete choice model.

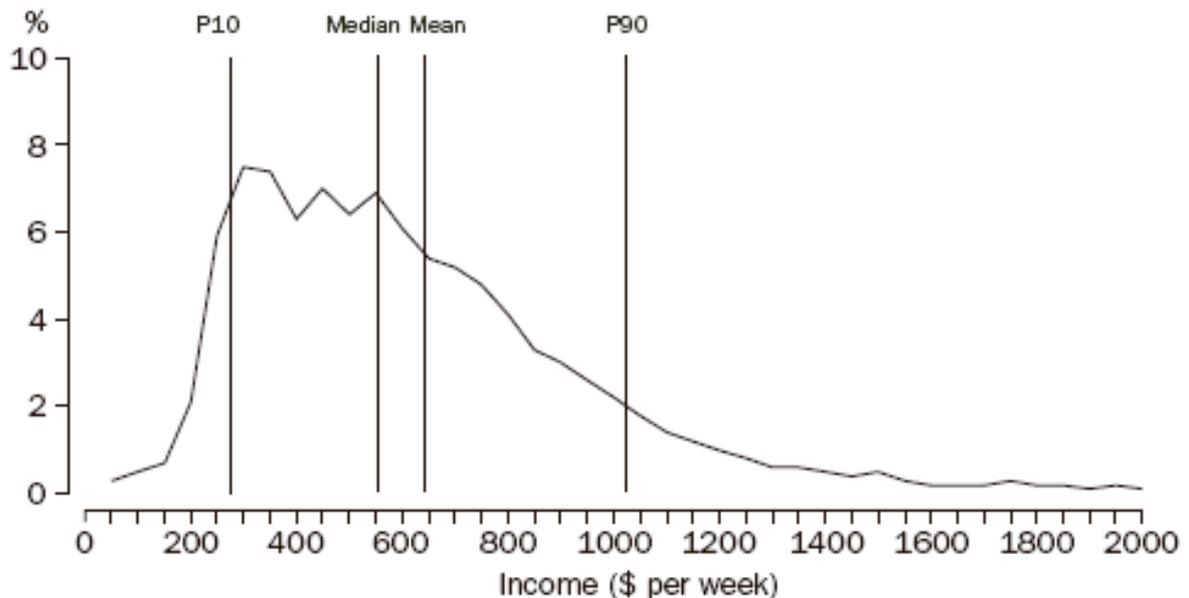
Figure 4 shows that from about 1993 there has been an overshooting in consumption patterns of Australians; we would expect a parallel increase in the average distribution of income per person. However, Figure 5 shows instead a persistent unequal distribution of income. This suggests that Australians are over-consuming and over-spending. The increase in consumption is not matched by an equal increase in income. Addiction to work effort leads to this disparity.



(a) Chain volume measure with the reference year being 2004–05.

Source: 2005–06 Australian System of National Accounts (ABS cat. no. 5204.0); Australian Historical Population Statistics, 2006 (ABS cat. no. 3105.0.65.001); Australian Demographic Statistics, September 2006 (ABS cat. no. 3101.0).

Figure 4 – Real consumption per capita in Australia is overshooting its long term trend.



Note: Persons with an income between \$25 and \$2,025 are shown in \$50 ranges on the graph

Figure 5 – Distribution of equivalised disposable household income, 2005-06.

Source: ABS (2006c)

7.3 Shadow price of travel time

The quantity of time at work is a function of the wage (24-r) and the reservation price. Taking the first derivative:

$$\partial U / \partial r_2 = -u_1^2 w_2 + u_2^2$$

$$\partial U / \partial r_2 = u_2^2 = u_1^2 w_2$$

The first derivative of utility with respect to recreation, tells us that in period 2 the shadow cost of time is lower than the wage rate by the marginal utility of consumption (money income) in period 2, which is supposed to be lower than period 1.

But if the marginal utility of time (hours in leisure) in period 2, as for busy women, is lower than the marginal utility of consumption, then the shadow cost of time is lower than the cost of money income in period 2, $u_2^2 < u_1^2$, then, u_2^2 / u_1^2 , the marginal rate of substitution (MRS) is lower than w_2 .

The MRS u_2^2 / u_1^2 changes in the sign of u_1^2 the marginal utility of consumption in period 2, by a change in the subjective price of time. Addiction affects the discount rate so that it is higher rather than lower or equal to 1, in period 2. A change in the subjective price of time decreases the real wage.

This change can only be explained if the ratio of time at work to total time has increased since period 1 (holding the wage constant). Within this framework, the quantity of travel time for consumption purposes is a function of a change in the quantity of total non-work time. In period 2, the difference (we call A) between $[(24 - r_2) > 0] - [(24 - r_1) > 0]$, is negative. Figure 1 shows that this negative difference grew by 1.28 hours from 1991 to 2006.

The price of travel time is a function of A , If negative, the elasticity of substitution between leisure and consumption has increased from 1991 to 2006, so that the demand for work effort to travel time increases in proportion to the change in A ($= D_{\text{effort}} = 1.28$ of the wage rate); but which means that, contrary to the mainstream theory, the current generation of busy women is worse off compared to their counterparts of 30 years ago.

The quantity of D_{effort} shows how much consumers need to be compensated for a decrease in their non-work time (non-labour income), or in their shadow cost of time.

8 Comparison to Morris *et al.* (1996)

The framework of analysis presented in this paper supports the findings of Morris *et al.* (1996). They showed a contradiction in terms of the expected implications of the theory of consumer demand when applied to travel demand.

Three generations of women (women, young and old), nowadays prefer the mode 'driving' to any other mode of travelling. They found that two generations (women and young) in particular, changed their demands compared to the elderly. While their expected role for house-work responsibilities (and carers) has never quite changed, but only postponed, their role as 'bread-winners' did, thereby placing additional demands on their time. Both generations have come to prefer the mode 'driving' in order to buy time to fulfil (or to adapt to) their expected social roles.

Their roles, nowadays, are more complex than 30 years ago, given that paid work and dependent care are further constraints on their time, in addition to house-work, and given that this double-shift occurs at a later stage in life. While it is warranted for society to respond to those changed needs (i.e. greater accessibility to all modes of transports), it is also important to consider that this 'extra' constraints of their time (and lives) are at the expenses of two important factors: i) their free leisure, a necessary time for the psychological survival of human beings, and for their autonomy; and ii) the greater social costs, that extra time in travelling brings about, such as congestion, pollution, and other risks related to travelling.

The current generation of busy women is considered to be worse off compared to their counterparts of 30 years ago. They and society need to be compensated.

9 Valuing travel time for economic appraisal of transport projects

The authors acknowledge the world leadership of Prof. David Hensher in this specialised field and his emerging interest in bankable values of travel time – changing the focus from hypothetical willingness to pay to the actual money which will be handed over to toll road and mass transit operators (Hensher, 2008).

An extensive literature search uncovered only a few citations about the value of travel time by gender. In suburban Montreal in 1994, women stated that their travel preferences were somewhat less time sensitive than men. Modelling estimated that if there were a 10 minute increase in one-way commuting time, the effect would be to multiply the odds of choosing the slower option for men by .7 and for women by .78 (Patterson *et al.*, 2005).

Analysis of the American Housing Survey by Crane (2007) shows the gender gap between mean commuting times has widened from 1985 to 2005 (see Table 2). Crane asks if US women have tighter time budgets than men, and are they thus more willing to change residential or work locations to save time, even if this means lengthening work trip distance?

Table 2 – Average commute duration by sex and year in the USA

Year	Average commute duration (minutes)		Difference, ♂ - ♀ (minutes)
	Male, ♂	Female, ♀	
1985	21.4	19.4	2.0
2005	23.5	21.1	2.4

Source: Crane (2007)

In Australia, reductions in millions of dollars in travel time typically represent about 70% of the economic benefits of a transport project, so the official Austroads (2008) unit price of \$11.49 per hour, say \$12, for unpaid private travel time (May 2007) is a crucial component of every cost benefit appraisal for Federal funding using the ATC (2006) National Guidelines. This has been set at 40% of seasonally adjusted full time average weekly earnings, assuming a 38 hour week, since 1996.

Table 3 summarises the value of travel time savings by mode of travel. The Cavagnoli model implies an hourly value of travel time of \$38.40, being 3.2 times the Austroads value of \$12. Busy women would need to fly, as this is the only mode in the meta-analysis showing a value of travel time greater than wage rate (Zamparini and Reggiani, 2007).

Table 3 – Value of travel time savings (% of wage rate)

	<i>Travel mode</i>	<i>% of wage</i>
Meta-analysis	Airplane	146%
Cavagnoli and Norman	Busy Australian women	128%
Meta-analysis	Car	82%
Meta-analysis	Train	77%
Meta-analysis	Bus	57%
Meta-analysis	Average	83%

The authors conclude that with more women being busy since 1991, it is time for an upwards review of the 40 per cent of wage rate currently being used in official studies in Australia.

10 Conclusion

This paper investigated how highly-skilled women allocate time to travel, and their choices of modes of travelling. The purpose of this paper is to propose an alternative measure to value their price of travel time.

These statistics presented show that there has been a significant change in the way women rank their preferences for allocating leisure time to travel time. Since 1991, travel time (outside working hours), for the purpose of work and house work, has remained fairly constant (+21 minutes and -25 minutes, respectively), which shows that women's purpose for allocating time according to their social roles (for families' and paid work's responsibilities) remained constant over time.

However, the purpose of travel for consumption activities has become more important than any other purpose over time. This change in the allocation of time reveals that, firstly, the desire, or the willingness, to spend money for consumption activities is greater than the willingness to save money in travel time, and secondly that, whatever drives this choice (i.e. social status, psychological needs, or others) needs further investigation. The motivation, driving the willingness to allocate more time to travel time for consumption purposes, has increased the elasticity of substitution between consumption and leisure time, since 1991.

This change represents a fundamental discrepancy in the theory of consumer demand. It means that the value of the shadow price of travel time is not constant over time, and the marginal utility of time for work has increased. Innovative micro-economic theory and the emerging statistical database of time use in Melbourne suggest busy women highly value each hour. This paper argues that the marginal utility of time for work and the shadow price of travel time have increased relatively to the increased fraction of total time to travel time.

The greater than expected shadow cost of travel time is reflected in the cross-price elasticity of demand for travel. It is inelastic. It reflects an over-compensation of women's work effort (hours) to the market sector. The consumption technology of time changes with education, experience and intensity of tasks, and affects the marginal utility of consumption of time. It becomes greater than the marginal utility of income, which is greater than the wage rate.

This leads them to allocate more than the expected hours to paid work and to travel time. These choices create a vicious cycle of consumption patterns that are inefficient, even though they are necessary in order to adapt to an unacknowledged (and so uncompensated by the market) constraint on leisure time.

The increased fraction of total time to travel time is the result of an increased fraction of women's labour endowment to actual labour supply. This ratio has not remained constant, and it represents a further constraint on time and income, but is yet to be acknowledged.

This paper proposes that, if leisure time is a normal good, then time and effort (scarce resources) have to be proportionally divided between market and non-market activities according to a constant ratio of labour endowment to actual labour supply (and so a constant ratio between leisure time and travel time). A change in this ratio endogenises the elasticity of substitution between consumption goods and leisure, which affects the difference between the compensated and the uncompensated demand for goods and services, including the demand for modes of travelling.

If this ratio is not included in the value of travel time, then the shadow cost of time cannot compensate women for the extra inputs of hours (increased marginal cost) allocated to travel time. Women demonstrate an inelastic cross-price elasticity of demand for travel. The reverse represents a negative income elasticity of demand for time. It means that the greater the income, the more are the opportunities to substitute leisure time with market-time-saving goods. However, this increased substitution decreases the total time available for leisure, down to a subsistence where the productivity of their time falls, and where they are 'trapped' in having to buy time (further substitution between leisure and consumption is needed) to live up to their expected roles (and needs).

By including the ratio of travel time to total time for travelling, then

- i) the substitution of (women) labour inputs between market and non-market activities would be limited,
- ii) earnings per unit of time (real wage) would increase, and
- iii) the expected (stronger) income effect in the second period of their hard-working lives would be achieved.

Studies on travel demand have overlooked the importance of both the ratio of labour endowment to actual labour supply, and the ratio of leisure time to travel time, when valuing the shadow cost of travel time.

This paper concludes that the price of travel time of busy women in Melbourne exceeds their wage rates by an increased (since 1991) ratio of leisure time to travel time of 1.28 hours, which implies an hourly value of travel time of \$38.40.

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