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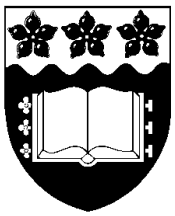

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Abstract

This paper quantifies the magnitude and duration of the GST effect on the quarterly growth rate of the eleven groups of the consumer price index (CPI) in Australia using the Box and Tiao intervention analysis. It was found that prices did not increase significantly before or after the introduction of GST beyond what could have been expected on the basis of the discernible systematic pattern of fluctuation in the data. Furthermore, the varying one-off effect of GST on prices was significant in seven out of eleven CPI groups, the effect was found insignificant for the other four CPI groups.

Keywords: Intervention Analysis; Goods and Services Tax; Australia.
JEL codes: C22; E31; H71; C22.

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I. INTRODUCTION

A New Tax System (ANTS) was implemented in July 2000 (the beginning of the third quarter 2000 or 2000q3), whereby "most goods and services became subject to GST [goods and services tax] equivalent to one-eleventh of the selling price, some goods and services were GST-free and some were input taxed" (Australian Competition and Consumer Commission, ACCC, 2003, p.2). The ANTS has had profound implications for social security systems, business tax, indirect tax, income tax, and Commonwealth-State financial relations. See Dawkins and Johnson (1998) for a general discussion on the interaction between the tax and social security systems. It is believed that this major tax reform has brought about the largest structural change to the Australian economy since World War II (Commonwealth Treasury, 2000). Presented below is a succinct review of the relevant literature prior to discussing the theoretical framework

Prior to the introduction of GST, Warren *et al.* (1999) and Johnson *et al*. (1999) thoroughly evaluated the revenue, efficiency and equity effects of the indirect tax changes associated with the government's tax package. They suggested that in the long run both reductions in personal income tax and increases in social security rates could sufficiently attenuate the average price rises among broad groups of households. Warren *et al.* (1999) examined the distributional impact of the implementation of the Government's ANTS tax package under various possible scenarios. According to this comprehensive study, with different sets of assumptions and depending on which scenario is taken into account, the effect of this tax reform on inflation was predicted to be between 0.8 per cent and 3.6 per cent in July 2000. The Commonwealth Treasury (2000, p.11) also estimated that GST can increase the overall CPI by 2.75 per cent.

Similar to the above studies, Queensland Treasury (2001, p.1) and New South Wales Treasury (2001, p.14) believed that the GST effect would result in a one-off price-perturbation. During the GST transition period the ACCC (2001, 2003) also conducted eight general surveys (December 1999–January 2000; March, May, August, and October 2000; and February and May 2001), in which prices for various goods and services were collected from about 10,000 retail outlets in 115 geographical locations (*i.e.* major capital cities, regional cities, towns etc in all states and territories). The Commission's retail price surveys do not represent an economy-wide measure of the effects of GST and therefore one cannot compare them directly to the CPI compiled by the Australian Bureau of Statistics (ABS). However, they provide a rough estimate of the impact of GST on inflation. According to the ACCC (2001, p.2), the effect of ANTS on inflation during third and fourth quarters of the year 2000 was initially expected to be around 4 per cent, with 3.7 per cent occurring in the September quarter 2000. As can be seen previous studies have not been very specific in relation to the duration of the GST effect.

More recently the ACCC (2003) in its final report on GST made 320,000 price comparisons between the survey in May 2000 (the pre-GST base period) and the May 2001 survey (post-GST period). The ACCC (2003, p.11) found that "the weighted average price change over the three months between the May and August 2000

surveys was +2.6 per cent. Weighted on the same basis, the Commission's estimate of the effects of the ANTS by the end of 2000 was an increase of 3 per cent. The weighted average price change over 12 months between the May 2000 and May 2001 surveys, by which time non-tax factors were generally determining prices outcomes, was +5.7 per cent." ACCC (2003) and Valadkhani and Layton (2004) conclude that price changes caused by the implementation of the ANTS were rather similar across geographical locations. Table 1 summarises these estimates.

Table 1: A summary of the previous estimates of the aggregate inflationary effect of GST/ANTS

Previous Studies	Effect on inflation (%)
Queensland Treasury (2001)	2.75
Commonwealth Treasury (2000)	2.75
ACCC (2001)	3.70-4.00
ACCC (2003)	3.00
Warren *et al.* (1999)	2.00
New South Wales Treasury (2001)	2.50-3.00
Valadkhani and Layton (2004)	2.80
Present study	2.90

With the passage of almost four years, it is now important to examine the extent to which the GST has impacted on various goods and services in Australia. As can be seen from the above brief review of the relevant literature, various studies and surveys have already examined the effect of the GST on inflation. However, the contribution of this paper to such an important issue is twofold. First, this paper uses a totally different approach to examine systematically the size and duration of the GST effects on inflation not only in Australia as a whole but also in the eleven groups of the CPI, namely, Food; Alcohol and tobacco; Clothing and footwear; Housing; Household furnishings, supplies and services; Health; Transportation; Communication; Recreation; Education; and Miscellaneous. Although previous studies and surveys (undertaken by the ACCC, the Commonwealth Treasury and various State Treasuries) have already analysed this issue, they adopted different approaches and/or different survey data. Enough disaggregated quarterly time series data are now available since the introduction of GST to enable a meaningful econometric analysis to be used to examine this issue for each group of the CPI in the Commonwealth.

The relevant review of literature indicates that the various studies and surveys have provided slightly different estimates for the overall effect of GST (See Table 1). Under various assumptions and approaches, these estimates also vary through time (See various estimates of the ACCC in different surveys discussed above). It seems that with the passage of time these estimates have become more accurate and differences are now being narrowed, resulting in a consensus among analysts in relation to the effect of GST on inflation. However, it would be useful to know the magnitude of the GST effect on various goods and services in the CPI basket using a different technique.

The second contribution the paper makes is that almost all previous studies have indicated that the effect of GST on inflation was one-off and of transitory nature but they have not been very specific as to the duration of the effect on various goods and services included in the CPI basket. For instance, the ACCC (2001, p.2) has

estimated the overall effect of GST on inflation during third and fourth quarters of the year 2000 to be around 4 per cent, with 3.7 per cent occurring in the September quarter 2000. The Commonwealth Treasury (2000, p.11) expected that the ANTS would "add around 2¾ percentage points to the CPI through the year to the June quarter 2001". The present study uses quarterly data – with inflation defined as quarter-to-quarter log changes - and lends further empirical support to this view that the GST effect on inflation in all eleven groups of the CPI basket was either statistically significant only in the September quarter of 2000 or not significant at all, suggesting no noteworthy effect in any of the four preceding or subsequent quarters. To the best of author's knowledge the present study is the only independent (*i.e.* non-government) study which quantifies the size and duration of the GST effect on inflation at a disaggregated level and for various CPI groups.

The GST was an important component of the ANTS package. However, it should be noted that the ANTS package was a more comprehensive reform which encompassed the sequential adjustment and removal of the wholesales tax and changes to excise taxes as well as the introduction of the GST. It is important to recognise that it is very difficult to separate the GST effect from the effect associated with other components of the ANTS package through time. Time series data on the CPI groups reflect (simultaneously) all price changes associated with the ANTS package (including the GST effect) and thus the term "GST" is used as a generic term for the ANTS package. In this paper both "GST" and "ANTS" are employed interchangeably.

The remainder of the paper is structured as follows: Section II discusses briefly the theoretical framework of the Box and Tiao intervention analysis employed in the paper. Section III presents summary statistics of the data as well as the unit root test results. Section IV presents the empirical econometric results. Finally the last section offers some concluding comments.

II THE INTERVENTION MODEL

As the CPI data are collected over time in regularly spaced intervals (*i.e.* quarterly) and the timing of intervention (the introduction of GST) is also known, the Box and Tiao (1975) intervention analysis can be utilised to examine the impact of this policy change on prices of goods and services. In essence this approach uses the Box-Jenkins methodology in which an Autoregressive Integrated Moving Average (ARIMA) type model is augmented by dummy variables to evaluate the effects of unusual events. Since Box and Tiao introduced this useful technique in 1975, many economists have used it in a wide variety of applications. For instance, Ho and Wan (2002) employed intervention analysis to test for structural breaks following the 1997 Asian financial crisis, Liu and Yu (2002) investigated the role of Taiwan's stock stabilization fund in countering market declines associated with foreign policy changes. More recently, Valadkhani and Layton (2004) applied this technique to examine the magnitude and duration of the GST effect on the overall rate of inflation in Australia and its eight capital cities. In fact, the present study is an extension of the work by Valadkhani and Layton (2004) in that it investigates further the pre- and post-GST effects on prices of the 11 groups of goods and services included in the CPI basket.

The logarithmic transformation is used to facilitate the analysis and the interpretation of the empirical results. This enables one to (a) consider percentage changes rather than absolute shifts and (b) stabilizes the variance of the series. A general ARIMA process of order (k,d,q) is specified as follows:

$$\Phi_k(L)\Delta^{d=1}\Delta_r^s p_t = m + \Theta_q(L)e_t + b D_t \quad (1)$$

where $F_k(L)$ represents a k-order polynomial lag operator; D^d and D^s_r denote the ordinary difference and seasonal difference operators, respectively; d and s are the number of times these differences are applied (in this paper d was empirically determined to be 1); r is the seasonal lag term; $p=ln(P)$; P is a price index representing one of the CPI eleven groups; m is a constant, $Q_q(L)$ denotes a q-order polynomial lag operator; e is a white noise process; k is the number of autoregressive terms; q is the number of moving-average terms; D_t is the intervention (or dummy) variable.

It is not the objective of this paper to behaviourally explain the inflation process, the ARIMA model should nonetheless capture any underlying systematic time series patterns in the data (of which seasonality would be the most obvious). It is of paramount importance that such systematic time series patterns in the fluctuations in the data be accounted for so as to accurately gauge the impact of the intervention itself. The magnitude of b will represent the effect of the introduction of GST on the rate of inflation say in a particular CPI basket beyond what could have been expected on the basis of the discernible systematic pattern of fluctuation in the data.

Based on previous studies, it is widely believed that an intervention such as the introduction of the GST has had only a temporary impact on the rate of inflation in the quarter in which it was introduced. Such an immediate and temporary impact could be well captured by a variable such as D_{0t}, a dummy variable taking the value of zero everywhere except in the quarter in which the GST was introduced, *viz.* the September quarter, 2000.

On the other hand, there is the possibility that the effect of the intervention may persist before or after the introduction of GST. In the case of the GST this might occur if the initial impact on prices gave rise to some residual momentum of further price rises. This may arise from either subsequent nominal wage growth increasing cost pressures or simply a further round of price rises deriving from a belief on the part of price setters that they may be able to extract additional price rises from consumers as a result of the initial price rise confusion coming about from the introduction of the GST. It can also be argued that due to affected pricing behaviour in anticipation of the GST, consumer prices may have been influenced up to one year before the September quarter of 2000. In order to test the pre-GST effects, the GST is allowed to impact on prices in the model for four quarters prior to its implementation. Therefore, it is assumed that the pre-GST effect and the post-GST effect (if any) on the growth rate of the relevant CPI group would have started a year before and after the introduction of GST, respectively. In order to examine the pre- and post GST effects (as well as the third quarter 2000), in the estimated ARIMA models there were 9 pulse dummy variables which capture the pre- and post GST effects on inflation in 9 quarters separately starting from 1999:3 to 2001:3. We have allowed the GST to impact on various components of the CPI for up to four quarters prior to its introduction by including four pulse dummies (D_j where j=-1,-2,-3,-4) each with a non-zero value of 1 in only the relevant previous quarter: *i.e.* September 1999, December 1999, March 2000, June 2000. In order to test the post-GST effects on inflation, another four pulse dummies (D_j where j=1, 2, 3 , 4) were introduced to the model each with a non-zero value of 1 in only the relevant subsequent quarter: *i.e.* December 2000, March 2001, June 2001, September 2001. The last pulse dummy variable (D_0) captures the effect of GST on the growth rate of a particular CPI group on the third quarter of 2000. D_0 takes on the value of 1 in the third quarter of 2000 (when the GST was introduced) and zero otherwise. The duration of the GST effect

on inflation is then simply a matter of empirical investigation, which can be examined by testing for the statistical significance of these dummy variables in the intervention model.

As part of the modeling process one needs first to choose accurate values for *k*, *r* and *q* in the ARMA specification. While the identification of an appropriate ARMA model is not an exact science, the autocorrelation (AC) and partial autocorrelation (PAC) functions (*i.e.* the correlograms of the resulting residuals) as well as the Schwartz Information Criterion (SIC) have been used to determine *q* and *k*, respectively. It should be noted the selection of *q* and *k* were not very sensitive to the use of other information criteria such as the sequential modified LR test statistic, final prediction error; the Akaike information criterion, and the Hannan-Quinn information criterion. Three model-selection principles suggested in the Box-Jenkins model selection approach have also been adopted. These are the principle of parsimony (similar to the general-to-specific approach); stationarity and invertibility (*i.e.* the roots must not lie outside of the unit circle); and goodness of fit and diagnostic checking. By subjecting the estimated equations to a battery of diagnostic checks on the residuals, one can ensure that the model has properly accounted for all systematic variation in the time series. The estimated ARMA models should also capture any systematic underlying time series patterns in the data (including seasonality effects). This is important since systematic time series patterns in the fluctuations in the data need to be accounted for so as to accurately gauge the impact of the GST. In order to address this possibility, equation (1) is augmented by a seasonal autoregressive term (Box *et al.*, 1994). It is also important under ARMA theory that the series being modeled is stationary. As shown later in this paper, the unit root test results indicated that almost all of the variables employed in this analysis are stationary after first differencing. The intervention model specified for each CPI group is then as follows:

$$(1-\rho_1 L-\rho_2 L^2-\ldots\rho_k L^k)(1-\phi L^r)y_t=\mu_0+\Theta_q(L)\varepsilon_t+\sum_{j=-4}^{m=+4}\beta_j D_{jt}+\omega_t \qquad (2)$$

Where y_t is defined as the log difference of the CPI.

III THE DATA

As defined in ABS (2004), the CPI measures changes in the price of a basket of goods and services consumed by metropolitan households in the following eleven broad groups: Food; Alcohol and tobacco; Clothing and footwear; Housing; Household furnishings, supplies and services; Health; Transportation; Communication; Recreation; Education; and Miscellaneous. The base of each index is 1989-90=100 and each group is a weighted average of eight capital cities. Table 2 presents the summary statistics of the quarterly data employed for these eleven CPI groups as well as that of the aggregate CPI. It appears that Alcohol and tobacco and Education are the two groups within the CPI basket which increased in cost relatively more than the other nine CPI groups. On the other hand, Recreation and Communication have risen relatively less than the other CPI groups.

Based on the magnitude of the standard deviation, Communication and Education can be considered as the most volatile groups of the CPI. It should be noted that in the compilation of the CPI prices are usually collected once a quarter, however, “there are a few items where prices are changed at infrequent intervals, for example

education fees where prices are set once a year" (ABS, 2004, p.28). This phenomenon, which has contributed to a higher volatility of the rising cost of Education, can be observed in Figure 1. As seen from the next section this explains why the seasonal effect in the ARIMA intervention model for Education, or f (r=4), in Table 4 is highly significant.

Table 2: Summary statistics of the data employed: quarterly inflation rate Dln(Pt)

Groups	Data availability	Mean	Maximum	Minimum	Std. Dev.
Food	1972q4-2004q2	0.0161	0.0569	-0.0092	0.0135
Alcohol and tobacco	1972q4-2004q2	0.0198	0.1723	-0.0025	0.0226
Clothing and footwear	1972q4-2004q2	0.0133	0.0712	-0.0214	0.0184
Housing	1972q4-2004q2	0.0152	0.0601	-0.0335	0.0180
Household furnishings, supplies and services	1972q4-2004q2	0.0133	0.0696	-0.0099	0.0132
Health	1989q4-2004q2	0.0124	0.0611	-0.1026	0.0254
Transportation	1972q4-2004q2	0.0157	0.0783	-0.0469	0.0183
Communication	1972q4-2004q2	0.0093	0.3430	-0.0322	0.0377
Recreation	1989q4-2004q2	0.0048	0.0392	-0.0132	0.0104
Education	1982q3-2004q2	0.0185	0.1322	0.0000	0.0353
Miscellaneous	1989q4-2004q2	0.0107	0.0363	-0.0179	0.0090
All groups	1948q3-2004q2	0.0138	0.0704	-0.0087	0.0128

Source: Australian Bureau of Statistics (2004), *Consumer Price Index*, cat. 6401.0, Table 3B, Canberra.

Using all available data published by the ABS, Figure 1 plots the rate of inflation, defined as $Dln(P_t)$, in the above eleven CPI groups plus the weighed average rate of inflation for Australia as a whole. A cursory inspection of these graphs clearly shows an abnormal positive spike (see the corresponding dashed line in each graph) in the third quarter of 2000 in the following eight CPI groups: Food; Alcohol and tobacco; Clothing and footwear; Housing; Household furnishings, supplies and services; Communication; Recreation and Australia as a whole (all groups). In other words, on the basis of the visual inspection of data, it seems that the introduction of GST did not generate a conspicuous spike in the cost of Health; Transportation; Education; and Miscellaneous. This finding is not counterintuitive as Health, Transportation and Education are sectors where the government is a big player. The other possible explanation relates to the fact that reductions in personal income tax and increases in social security rates sufficiently attenuated the average price rises in the economy including some of the-above sectors (Johnson, Freebairn and Scutella, 1999). The dotted line in the last panel of Figure 1, where the overall rate of inflation is considered, shows the obvious effect of GST on inflation only in 2000q3. However, one needs to use a more formal technique to properly evaluate the magnitude and duration of the GST effect on various goods and services.

The Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, have been used to examine the stationarity, or otherwise, of the time series data. Table 3 presents the results of applying the ADF and KPSS

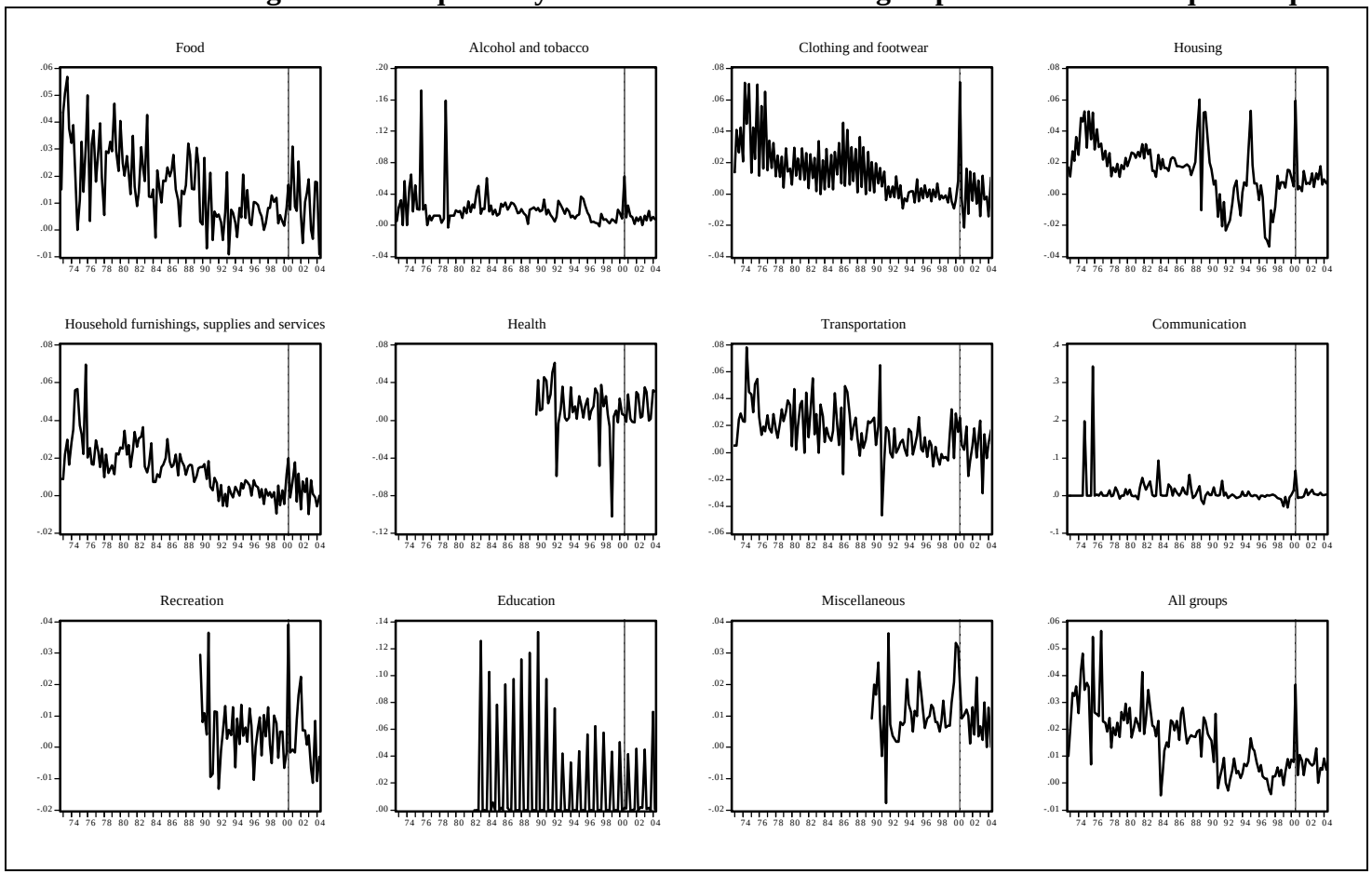
tests to the data. On the basis of these results, all the variables are I(1), with the only exception being Education, where the ADF and KPSS test results are contradictory. It is thus concluded that all of the variables become stationary after first differencing and this assumption is also backed by the visual inspection of the graphs of the data employed.

Table 3: ADF and KPSS test results

Variable	ADF test		KPSS Statistics
	ADF statistics	Optimum lag	
Ln(P_t):			
Food	-2.04	3	0.345*
Alcohol and tobacco	-1.12	0	0.336*
Clothing and footwear	-2.97	4	0.337*
Housing	-2.30	2	0.333*
Household furnishings, supplies and services	-2.09	2	0.349*
Health	-2.45	0	0.204*
Transportation	-0.95	1	0.350*
Communication	-2.73	4	0.313*
Recreation	-1.89	0	0.054
Education	-1.88	4	0.301*
Miscellaneous	-2.54	2	0.166*
All groups	-2.17	5	0.346*
Dln(P_t):			
Food	-4.52*	2	0.016
Alcohol and tobacco	-12.27*	0	0.028
Clothing and footwear	-3.45*	3	0.100
Housing	-4.06*	1	0.073
Household furnishings, supplies and services	-5.55*	1	0.068
Health	-7.16*	0	0.128
Transportation	-11.72*	0	0.056
Communication	-11.79*	0	0.045
Recreation	-8.48*	0	0.076
Education	-1.46	3	0.085
Miscellaneous	-4.10*	2	0.095
All groups	-4.42*	4	0.105

Notes: a) *P* denotes the consumer price index. b) * indicates that the corresponding null hypothesis is rejected at the 1 or 5% significance level. c) The Akaike Information Criterion has been used as a guide to determine the optimal lag length.

Figure 1: The quarterly inflation rates of various groups of the CPI- 1972q4-2004q2



Notes: a) the dotted line coincides with the third quarter of 2000 when the GST was introduced. b) The quarterly inflation rate has been calculated by $Dln(P_t)$.
Source: Australian Bureau of Statistics (2004), *Consumer Price Index*, cat. 6401.0, Table 3B, Canberra.

IV EMPIRICAL RESULTS

The aim of this section is to provide convincing answers to the following two questions: (a) as a result of the introduction of the GST, how much did the cost of living rise in terms of each CPI group; (b) for how long did the GST affect the growth rate of each CPI group? In other words, was additional inflation resulting from the introduction of GST confined to only 2000q3 as a one-off phenomenon or did prices of various goods and services increase before or after this quarter? As was mentioned in Section I, many previous studies and surveys have already tried to provide answers to these important questions, but this paper uses a totally different technique to systematically undertake a consistency check on the results obtained previously and also shed some further light on the size and duration of the GST effect on inflation at a disaggregated level.

Equation (2) was estimated for the eleven CPI groups as well as the average CPI (all groups) and the estimation results are presented in Table 4. As can be seen, the estimated ARIMA intervention models pass the reported diagnostic tests. The estimated Ljung and Box (1978) *Q*-statistics (up to 36 lags) and the *LM* (Lagrange Multiplier test for serial autocorrelation up to 4 lags) in Table 4 and the correlograms of the resulting residuals for the estimated equations clearly indicate that the ARIMA intervention models are statistically quite acceptable. The correlograms of the resulting residuals are not reported but they are available from the author upon request. All estimated coefficients for f, r and q are highly significant and the inverted AR and MA roots have modulus less than unity, suggesting that the estimated ARIMA models are stationary (the inverted AR and MA roots have not been reported here but they are available from the author upon request).

Among the estimated coefficients for b_j, only b_0 is positive and statistically significant in the following seven CPI groups: Food (1.2%); Alcohol and tobacco (4.6%); Clothing and footwear (7.6%); Housing (5.4%); Household furnishings, supplies and services (1.9%); Communication (5.9%); Recreation (3.3%) and the overall CPI (3%). In other words, according to the empirical results presented in Table 4, the introduction of GST would appear to have increased the price indices associated with the above seven CPI groups only in the September quarter of 2000. One should note that b_0 was not statistically significant in the following four CPI groups: Health; Transportation; Education; and Miscellaneous. It is useful to note that these results are consistent with the observations made earlier based on the visual inspection of data presented in Figure 1.

Given that none of the estimated coefficients for b_{-4} to b_{+4} were statistically significant in Table 4, we excluded these dummy variables (*i.e.*, D_{-4} to D_4) from the model and re-estimated these equations. Table 5 shows the estimated coefficients for b_0 for all of the eleven CPI groups (plus the overall CPI) when the insignificant pulse dummy variables have been excluded from the estimated model. In order to make comparison easier, we have also reported the earlier estimates of b_0 (already presented in Table 4) in the second column of Table 5. A pairwise comparison between the magnitude of these two estimates for b_0 and their corresponding probability values across all the major CPI groups shows that these coefficients are robust and have not changed considerably.

Table 4: Estimated coefficients for the intervention model, $\mathrm{D}\ln(P_{it})$-continued

Estimated coefficients/statistics	Food		Alcohol and tobacco		Clothing and footwear		Housing		Household furnishings		Health	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
m_0	-0.0005	0.968	0.0175	0.000	0.0017	0.925	0.0137	0.530	0.0060	0.234	0.0089	0.018
b_0	**0.0116**	**0.000**	**0.0457**	**0.013**	**0.0760**	**0.000**	**0.0539**	**0.000**	**0.0192**	**0.014**	-0.0148	0.583
b_{-4}	-0.0013	0.494	0.0014	0.935	0.0003	0.968	0.0106	0.361	-0.0026	0.740	-0.0139	0.614
b_{-3}	-0.0037	0.052	0.0177	0.286	-0.0146	0.061	0.0093	0.470	-0.0015	0.848	-0.0151	0.562
b_{-2}	-0.0019	0.364	0.0047	0.777	0.0011	0.892	0.0058	0.674	-0.0027	0.728	0.0012	0.963
b_{-1}	-0.0011	0.783	-0.0078	0.639	0.0019	0.817	-0.0012	0.931	0.0085	0.284	0.0148	0.572
b_1	0.0068	0.236	-0.0068	0.697	-0.0117	0.150	-0.0037	0.796	-0.0042	0.595	-0.0166	0.526
b_2	0.0147	0.167	0.0126	0.468	-0.0167	0.045	-0.0012	0.931	0.0077	0.332	0.0166	0.527
b_3	-0.0004	0.930	0.0019	0.912	0.0064	0.407	-0.0049	0.704	0.0117	0.133	0.0122	0.646
b_4	0.0085	0.173	-0.0020	0.916	-0.0078	0.314	0.0086	0.458	-0.0038	0.623	-0.0192	0.467
r_1	0.6109	0.000			-0.0081	0.744			-0.0632	0.074		
r_2					0.9713	0.000	0.9417	0.000	0.9321	0.000		
r_3	0.3629	0.000										
r_4			-0.4362	0.000							0.6132	0.000
r_{12}			0.36945	0.000								
f (r=3)												
f (r=4)												
f (r=5)									0.2224	0.028		
q_1	-0.5777	0.000			0.1504	0.091	0.5776	0.000	0.2633	0.001		
q_2					-0.4956	0.000	-0.3903	0.000	-0.6689	0.000		
q_3												
q_4	-0.4054	0.000	0.7573								-0.9208	0.000
F-statistic	7.95	0.000	5.95	0.000	41.09	0.000	14.75	0.000	16.98	0.000	1.60	0.164
$\overline{R}^2$	0.424		0.343		0.808		0.571		0.653		0.093	
DW	1.873		2.1503		1.819		2.034		1.842		1.986	
AIC	-6.280		-5.065		-6.678		-5.929		-6.751		-4.372	
SC	-5.961		-4.754		-6.362		-5.635		-6.402		-3.934	
Q-statistic (36 lags)	20.582	0.94	27.381	0.743	36.406	0.271	35.816	0.338	37.195	0.205	15.399	0.854
LM (4 lags)	0.727	0.575	1.951	0.108	0.915	0.436	0.435	0.783	1.885	0.119	1.386	0.257

Notes: (1) *P*-values show the corresponding probabilities or significance levels; (2) If *P*-value is around 10% or less, the corresponding coefficient is assumed to be statistically significant.

Table 4: (continued) Estimated coefficients for the intervention model, $\mathrm{D}\ln(P_{it})$

Estimated coefficients/statistics	Transportation		Communication		Recreation		Education		Miscellaneous		All groups	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
m_0	-0.0119	0.562	0.0098	0.079	0.0039	0.243	0.0069	0.683	0.0090	0.000	0.0130	0.000
b_0	0.0226	0.1641	**0.0588**	**0.129**	**0.0325**	**0.000**	0.0003	0.973	0.0078	0.297	**0.0299**	**0.006**
b_{-4}	0.0288	0.0714	-0.0350	0.335	0.0021	0.764	-0.0005	0.943	0.0054	0.465	0.0056	0.496
b_{-3}	-0.0060	0.7078	-0.0069	0.847	-0.0035	0.613	0.0004	0.927	0.0132	0.077	0.0014	0.872
b_{-2}	0.0231	0.1492	0.0084	0.815	-0.0158	0.037	0.0071	0.145	0.0219	0.005	0.0043	0.644
b_{-1}	0.0115	0.4762	0.0088	0.807	-0.0061	0.428	0.0001	0.976	0.0245	0.002	0.0010	0.917
b_1	0.0022	0.8931	-0.0166	0.643	-0.0140	0.069	0.0010	0.843	0.0016	0.829	-0.0048	0.635
b_2	0.0005	0.9743	-0.0059	0.869	-0.0171	0.023	0.0016	0.764	-0.0012	0.867	0.0022	0.812
b_3	0.0156	0.3281	-0.0129	0.718	-0.0123	0.080	0.0001	0.987	0.0058	0.432	0.0000	0.998
b_4	-0.0228	0.1552	-0.0128	0.724	-0.0028	0.691	-0.0019	0.790	-0.0001	0.992	-0.0056	0.491
r_1	0.7648	0							-0.9096	0.000		
r_2					-0.2576	0.120					0.7592	0.000
r_3	0.2199	0.0179										
r_4			0.4016	0.000	0.5266	0.000						
r_{12}							-0.5406	0.000				
f (r=3)					0.3359	0.024						
f (r=4)							0.9539	0.000	-0.2431	0.087		
f (r=5)											-0.1396	0.079
q_1	-0.8659	0							0.7546	0.000	0.4164	0.000
q_2					0.6085	0.001					-0.3133	0.002
q_3											0.2234	0.004
q_4	-0.1245	0.1163					0.3755	0.021			0.2149	0.004
F-statistic	4.86	0.000	2.59	0.007	3.79	0.001	124.54	0.000	3.55	0.001	21.46	0.000
$\overline{R}^2$	0.290		0.115		0.415		0.954		0.366		0.588	
DW	2.083		2.002		1.822		2.054		1.902		1.976	
AIC	-5.389		-3.725		-6.881		-6.901		-6.825		-6.695	
SC	-5.071		-3.474		-6.356		-6.493		-6.347		-6.445	
Q-statistic (36 lags)	35.811	0.294	13.657	1	11.63	0.928	11.425	0.999	10.118	0.977	22.297	0.843
LM (4 lags)	0.653	0.626	0.777	0.542	0.269	0.896	0.182	0.947	1.705	0.170	1.853	0.120

Notes: (1) *P*-values show the corresponding probabilities or significance levels; (2) If *P*-value is around 10% or less, the corresponding coefficient is assumed to be statistically significant.

Table 5: Estimated effects of GST on the CPI groups (b_0) in 2000q3

CPI groups	$b_j \neq 0$	$b_j = 0$
	Where $j=-1,-2,..-4, 1, 2,\ldots 4$	
Food	0.012	0.013
P-value	0.000	0.000
Alcohol and tobacco	0.046	0.046
P-value	0.013	0.003
Clothing and footwear	0.076	0.081
P-value	0.000	0.000
Housing	0.054	0.053
P-value	0.000	0.000
Household furnishings, supplies and services	0.019	0.019
P-value	0.014	0.011
Health	-0.015	-0.017
P-value	0.583	0.496
Transportation	0.023	0.018
P-value	0.164	0.254
Communication	0.059	0.076
P-value	0.129	0.022
Recreation	0.033	0.042
P-value	0.000	0.000
Education	0.000	0.002
P-value	0.973	0.676
Miscellaneous	0.008	0.012
P-value	0.297	0.259
All groups	**0.030**	**0.029**
P-value	0.006	0.000

Notes: (1) *P*-values show the corresponding probabilities or significance levels; (2) If *P*-value is around 10% or less, the corresponding coefficient is assumed to be statistically significant.

As mentioned earlier, one may also argue that due to affected pricing behaviour in anticipation of the introduction of the GST, measured CPI indices may have been impacted prior to the September quarter of 2000. In order to test this interesting possibility we have allowed the GST to impact on various goods and services for four quarters before its implementation by including four separate pulse dummies (each with a non-zero value of 1 in only the relevant previous quarter: *i.e.* September 1999, December 1999, March 2000, June 2000). It is thus hypothesized that the pre-GST effect (if any) on the growth rate of the relevant CPI group would have started a year before the introduction of GST, *i.e.* the September quarter of 1999. Table 6 presents the Wald test statistics which lend some empirical support to the fact that in eleven (including the CPI all groups) out of twelve cases the GST did not significantly impact on prices of goods and services before or after its introduction. Therefore, one may conclude that the duration of the GST effect was very much confined to the September quarter of 2000 and these findings are consistent with both the relevant graphs presented in Figure 1 and the earlier studies briefly outlined in Section I.

V CONCLUDING REMARKS

This study presents an analysis of the magnitude and duration of the GST effects on prices of various goods and services included in the CPI basket. These goods and services are broadly defined by the ABS in the following eleven CPI groups: Food; Alcohol and tobacco; Clothing and footwear; Housing; Household furnishings, supplies and services; Health; Transportation; Communication; Recreation;

Education; and Miscellaneous. The data employed consist of quarterly indices for as far back as the data were available.

The Box and Tiao intervention analysis based on autoregressive integrated moving average (ARIMA) models augmented with dummy variables are used to evaluate the pre- and post-GST effects. To the best of the author's knowledge no one has estimated the impact of the GST in this way. This analysis provides a further valuable consistency check of others' estimates of the GST inflation impact derived from alternative approaches. It has the great advantage of properly, in a statistical sense, allowing for any discernible systematic variation existing in the underlying inflation process, and distilling out from that variation the impact of the GST introduction. The contribution of the paper also lies in determining the extent of differences among various goods and services in impact.

Table 6: Testing the pre- and post GST effects on various CPI groups

CPI groups	Pre-GST effect		Post-GST effect	
	F-statistic Ho: b_j=0 where *j*=-1,-2,-3,-4	*P*-value	*F*-statistic Ho: b_j=0 where *j*=1,2,3,4	*P*-value
Food	*F*(4,110)=1.59	0.183	*F*(4,110)=1.110	0.354
Alcohol and tobacco	*F*(4,102)=0.366	0.832	*F*(4,102)=0.178	0.949
Clothing and footwear	*F*(4,111)=1.130	0.344	*F*(4,111)=2.173	0.097
Housing	*F*(4,112)=0.330	0.860	*F*(4,112)=0.317	0.866
Household furnishings, supplies and services	*F*(4,105)=0.430	0.789	*F*(4,105)=1.120	0.351
Health	*F*(4,43)=0.257	0.904	*F*(4,43)=0.427	0.789
Transportation	*F*(4,110)=1.480	0.215	*F*(4,110)=0.772	0.546
Communication	*F*(4,112)=0.270	0.894	*F*(4,112)=0.123	0.974
Recreation	*F*(4,38)=1.750	0.158	*F*(4,38)=2.783	0.040
Education	*F*(4,60)=0.550	0.701	*F*(4,60)=0.051	0.995
Miscellaneous	*F*(4,41)=6.730	0.000	*F*(4,41)=0.163	0.956
All groups	*F*(4,200)=0.160	0.958	*F*(4,200)=0.261	0.902

Note: In the estimated ARIMA models there were 9 pulse dummy variables which capture the pre- and post GST effect on inflation in 9 quarters separately starting from 1999:3 to 2001:3. We have allowed the GST to impact on various components of the CPI for four quarters prior to its introduction by including four pulse dummies (where j=-1,-2,-3,-4) each with a non-zero value of 1 in only the relevant previous quarter: *i.e.* September 1999, December 1999, March 2000, June 2000. In order to test the post-GST effects on inflation, we introduced four pulse dummies (where j=1,2,3,4) each with a non-zero value of 1 in only the relevant subsequent quarter: *i.e*. December 2000, March 2001, June 2001, September 2001. The last dummy variable captures the effect of GST on inflation on the third quarter of 2000. The above Wald test statistics clearly indicate that the pre- and post GST effects on inflation were not significant with the only exceptions being Miscellaneous and Recreation which somehow were affected before and after the introduction of the GST, respectively. Thus most goods and services did not increase significantly from its underlying systematic pattern prior to and after the introduction of GST. It is also found that the b_0 coefficients are not excessively sensitive to different sample periods as well as to various specifications by including or excluding autoregressive and moving average error terms. The sensitivity results have not been reported here but they are also available from the author on request.

The most important findings of this study are as follows: (a) consistent with a recent but an aggregate study undertaken by Valadkhani and Layton (2004), the overall effect was a one-off lift in inflation of approximately 3 per cent in 2000q3; (b)

the GST effect (if any) was mainly confined to the third quarter of 2000 when the GST was implemented. As concluded by previous studies or surveys, prices thus did not increase significantly before or after the introduction of the GST beyond what could have been expected on the basis of the discernible systematic pattern of fluctuation in the data. More specifically, in ten out of eleven CPI groups there was no statistically significant evidence to suggest any residual impact before or after the quarter of introduction with the only exceptions being Miscellaneous and Recreation which somehow were affected before and after the introduction of GST, respectively; and (c) as far as differences were concerned, the GST effect varies across different goods and services within the CPI basket. The estimated temporary GST effect ranged from a minimum of 1.3 per cent (Food) to a maximum of 8 per cent (Clothing and footwear). In seven out of eleven CPI groups (*i.e.* Food, Alcohol and tobacco, Clothing and footwear, Housing, Household furnishings, supplies and services, Communication, and Recreation) the one-off GST effect was significant. However, in the other four CPI groups (Health, Transportation, Education, and Miscellaneous) the GST did not have any statistically significant effect on the corresponding price indices.

REFERENCES

Australian Bureau of Statistics (2004), *Consumer Price Index*, cat. 6401.0, ABS, Canberra.

Australian Competition and Consumer Commission (2001), *Report to the Minister Under Section 75AZ of the Trade Practices Act 1974*, Australian Competition and Consumer Commission, Canberra.

Australian Competition and Consumer Commission (2003), *GST Final Report: ACCC Oversight of Pricing Responses to the Introduction of the New Tax System*, Australian Competition and Consumer Commission, Canberra.

Box, G.E.P. and Tiao, G.C. (1975), 'Intervention Analysis with Applications to Economic and Environmental Problems', *Journal of American Statistical Association*, **70**, 70-9.

Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994), *Time Series Analysis Forecasting and Control*, Prentice-Hall, Upper Saddle River, New Jersey.

Commonwealth Treasury (2000), *Budget Speech 2000-01*, Delivered on 9 May 2000 on the Second Reading of the Appropriation Bill (no.1) 2000-01 by the Honourable Peter Costello, The Commonwealth of Australia, Canberra.

Dawkins, P. Johnson, D. (1998), 'The Interaction of Tax and Social Security: Introduction and Overview', *Australian Economic Review*, **31**, 258-62.

Ho, A.K.F. and Wan, A.T.K. (2002), 'Testing for Covariance Stationarity of Stock Returns in the Presence of Structural Breaks: An Intervention Analysis', *Applied Economics Letters*, **9**(7), 441-447.

Johnson, D.T, Freebairn, J. and Scutella, R. (1999), *Evaluation of the Government's Tax Package*, Melbourne Institute of Applied Economic and Social Research, University of Melbourne, Melbourne.

Liu, Y.J. and Yu, C.H. (2002), 'On the Effect of Stock Stabilisation Fund: A Case of Taiwan', *Review of Pacific Basin Financial Markets and Policies*, **5**(1), 93-109.

Ljung, G. and Box, G. (1979), 'On a Measure of Lack of Fit in Time Series Models', *Biometrika*, **66**, 265-270.

New South Wales Treasury (2001), *2000-01 Half Yearly Budget Review*, NSW Treasury, Sydney.

Queensland Treasury (2001), *CPI Exclusive of GST Effects: June Quarter 2001* (a briefing note), Office of Economic and Statistical Research, Queensland Treasury, Brisbane.

Valadkhani, A. Layton, A.P. (2004), 'Quantifying the Effect of GST on Inflation in Australia's Capital Cities: An Intervention Analysis', *Australian Economic Review*, **37**(2), 125-38.

Warren, N. Harding, A. Robinson, M. Lambert, S. and Beer, G. (1999), *Distributional Impact of Possible Tax Reform Packages*, Report to Senate Select Committee on a New Tax System, National Centre for Social and Economic Modelling (NATSEM), University of Canberra, Canberra.