THE HOUSEHOLD EXPENDITURE RESPONSE TO PRE-ANNOUNCED CONSUMPTION TAX CHANGES

by

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DEDICATION

This dissertation is dedicated to James, Mary, and Daniel Cashin for their unwavering support and frequent canine care throughout my career as a graduate student.

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Any errors found below are my own.

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ABSTRACT

The studies included in this dissertation examine the household expenditure response to pre-announced increases in national consumption tax rates. Several countries have changed their consumption tax rate in recent years in order to generate new revenue or stimulate demand. Consequently, it is important to understand the impact of these tax changes on household expenditure. In addition, pre-announced consumption tax changes provide predictable variation in prices, and as such, present an ideal environment to measure intertemporal substitution behavior.

The first and second chapters of this dissertation use the April 1997 increase in Japan's Value Added Tax (VAT) rate along with household-level expenditure data to measure intertemporal substitution behavior. Chapter 1 provides an estimate of the intertemporal elasticity of substitution in consumption (IES). Using an appropriate categorization of non-durables and an empirical specification that is robust to intratemporal substitution between durables and non-durables, we find that the IES is 0.21 and not significantly different from zero.

Chapter II builds on the work of Chapter I. First, it characterizes the sensitivity of household *consumption* and *expenditure* to the increase in Japan's VAT. Second, the study utilizes information on the durable and storable expenditure responses to the VAT increase to yield a more precise estimate of the IES. Matching the time path of expenditures generated by a dynamic structural model of household consumption to empirical estimates of the intertemporal substitution response to the VAT increase, I find that expenditure is sensitive to a change in the future price level due to accelerated purchases of durables and stockpiling of storables. However, consumption is relatively insensitive. The IES is 0.13, and is precisely estimated.

The final chapter uses durable and non-durable retail sales data to estimate the intertemporal substitution and income effects of three increases in New Zealand's Goods and Services Tax (GST) rate. The intertemporal substitution estimates are consistent with the results from Japan. I also find evidence that uncompensated tax rate increases reduce retail sales in proportion to the price increase.

The results presented in this dissertation suggest that policies that alter intertemporal prices will have a large, but short-lived impact on household expenditure.

CHAPTER I

Measuring Intertemporal Substitution in Consumption: Evidence from a VAT Increase in Japan

Abstract

We estimate the intertemporal elasticity of substitution in consumption (IES) using a pre-announced increase in Japan's Consumption Tax rate. Because Japan's Consumption Tax is highly comprehensive, the tax rate increase was announced prior to its implementation, and other factors that affect the real interest rate were constant, the tax rate increase presents an ideal natural experiment to estimate the IES. A Japanese monthly household survey is exploited to accurately categorize non-durables, and our empirical specification addresses intra-temporal substitution bias. We find that the IES is 0.21 and not significantly different from zero, but it is significantly less than one.

1. Introduction

In this paper, we estimate the intertemporal elasticity of substitution in consumption (IES) using a rate increase in the Japanese Consumption Tax as a natural experiment. The Consumption Tax, which is a Value Added Tax (VAT), increased from three to five percent in April 1997. Unlike VAT in many other countries, Japan has a single flat rate with a relatively small number of exemptions. As expected, the tax burden was borne fully by consumers in the form of higher prices. Because nominal interest rates and the inflation rate were constant around the implementation of the tax rate increase, it can be treated as an exogenous change in the real interest rate, which provides us with an ideal situation to estimate the IES.

Previous research on this topic (e.g. Hall, 1988; Attanasio and Weber, 1993, 1995; Ogaki and Reinhart, 1998) has relied on an instrumental variables approach to address the critical econometric problem that the real interest rate is endogenous in the standard log-linearized Euler equation for consumption. However, as Yogo (2004) notes, asset returns are notoriously difficult to predict, and as a result, the available instruments are weak. Weak instruments can lead to biased estimators and finite-sample distributions of test statistics that depart greatly from their limiting distributions. This paper avoids the problem of weak instruments by exploiting the natural experiment presented by the Consumption Tax rate increase.

In addition to the novel research design, our dataset plays an important role in estimating the IES. We use the Japanese Family Income and Expenditure Survey (JFIES), which is a monthly household-level panel dataset. Given our use of micro-data, our results are free from the aggregation bias discussed in Attanasio and Weber (1993, 1995). Its high frequency (monthly) panel structure allows us to adopt the conventional Euler equation approach, and to observe consumption expenditure immediately before and after implementation of the tax rate increase.

Moreover, because the JFIES is highly disaggregated by item-type, we can define "non-durables" appropriately. The definition of non-durables in previous studies included goods and services that exhibit some degree of storability and/or durability. For example, as Mankiw (1985) points out, footwear and clothing are usually considered to be non-durables, but they should be classified as durables. Attanasio and Weber (1993, 1995), which is the first to address this issue, exclude durables and semi-durables, but pay little attention to storability. Storable goods can be stockpiled during low price periods for consumption in high price periods. Failing to account for this behavior will bias the estimate of the IES upwards. To avoid these biases, we separate non-storable non-durable goods and services (e.g. eating out) from storable non-durable (e.g. laundry detergent) and durable (e.g. automobiles) goods and services.

With multiple goods, we explicitly consider intratemporal substitution between non-durables, storables and durables by constructing a model of consumer choice. As Ogaki and Reinhart (1998) demonstrate, failing to account for intratemporal substitution can induce a biased estimate of the IES when preferences over non-durables and durables are non-separable. In general, the service flow from durables becomes higher prior to a tax rate increase because the user cost of durables falls. With non-separable preferences, households substitute between non-durables and durables. If we do not control for this, the estimate of the IES will be biased, where the sign of the bias depends on the structure of intratemporal preferences. The empirical specification derived below, which is consistent with our model, is robust to the possibility of intratemporal substitution.

Exploiting these advantages, our point estimate of the IES is 0.21, which is significantly less than one, but not significantly different from zero. While the baseline regression uses the sample period between April 1992 and March 2002, the choice of sample period has little impact on our results. In addition, the results are robust to sample selection criteria. Point estimates from those robustness checks range between 0.17 and 0.36, which are comparable to those in previous studies using macro-data such as Hall (1988), Ogaki and Reinhart (1998), and Yogo (2004), but less than those using micro-data such as Attanasio and Weber (1993, 1995), Vissing-Jorgensen (2002), and Gruber (2006). We employ additional tests to check whether liquidity constraints or data quality are responsible for the small IES, but find no evidence to support these assertions.

To the extent that our finding of a small IES is applicable in other contexts, it suggests that policies that aim to dampen volatility in household consumption expenditure through changes in the real interest rate will not be effective. For the same reason, the deadweight loss from a pre-announced increase in a VAT and the taxation of interest income should be small.

The remainder of the paper is organized as follows. Section 2 provides background on Japan's April 1997 Consumption Tax rate increase and evidence for our assertion that the tax rate increase presents an ideal natural experiment to estimate the IES. Section 3 introduces a representative agent model of household consumption to make predictions about household consumption in the months following announcement of a consumption tax rate increase. We then present an empirical specification consistent with the model, and discuss identification of the IES. The data used in estimation and our results are presented in Section 4. Section 5 concludes.

2. The Consumption Tax Increase: An Ideal Natural Experiment to Estimate the IES

2.1. Japan's Consumption Tax and the April 1997 Tax Rate Increase

Japan's Consumption Tax is a Value Added Tax (VAT). Unlike VAT in many other countries, the Consumption Tax has a single flat rate with a relatively small number of exemptions.[1] In addition, as documented by Ishi (2001), the Japanese government made it

[1] Exemptions included transfer of lease or land, transfer of securities and transfer of means of payment, interest on loans and insurance premiums, transfer of postal and revenue stamps, fees for government services, international postal money orders, foreign exchange, medical care under the Medical Insurance Law, social welfare services specified by the Social Welfare Services Law, midwifery service, burial and crematory service,

clear that they expected the burden of the Consumption Tax would be borne fully by consumers.[2] Accordingly, changes in consumer prices should be proportional to changes in the Consumption Tax rate; in other words, given a nominal interest rate, an increase in the Consumption Tax rate lowers the real interest rate through a proportional price increase across goods and services.

The Consumption Tax was introduced in 1989 at a rate of three percent, and the rate was increased from three to five percent in April 1997. The 1997 tax rate increase was originally proposed as a part of the Murayama Tax Reform, which passed through the Japanese Diet in late 1994.[3] Because the primary purpose of the reform was to continue the shift from direct to indirect taxation, the Consumption Tax rate increase was coupled with immediate cuts in income tax rates. In that sense, the tax increase was compensated.

Although the Murayama reform package set a target date of April 1997 for the Consumption Tax rate increase, it was unclear whether the increase would actually be implemented then. This is because the reform legislation also stated that the tax rate increase would be imposed only if the economy had sufficiently recovered from a prolonged recession (1991-1993) and subsequent years of feeble growth. Having judged the economy to have sufficiently recovered, the ruling Liberal Democratic Party (LDP) decided to raise the tax rate as scheduled. The bill to raise the Consumption Tax rate passed through the Upper House on June 25, 1996, and the tax rate increase was scheduled to become effective on April 1, 1997.

Even after this passage, it was not clear that the Consumption Tax rate increase would be implemented in April, as it was the central issue in October 1996 elections to the Lower House of the Diet, with the LDP promising to implement the tax rate increase as planned, while the opposition promised to shelve it. The LDP narrowly won the election, and on December 26, 1996, the government submitted the fiscal year 1997 budget, finally deciding to increase the Consumption Tax rate to five percent on April 1, 1997.

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transfer or lease of goods for physically handicapped persons, tuition, entrance fees, facilities fees, and examinations fees of schools designated by the Articles of the School Education Law, transfer of school textbooks, and the lease of housing units.

[2] When the Consumption Tax was introduced in 1989, the government took several steps to ensure this outcome. First, a Special Council on the Transition was formed to promote enforcement of the consumption tax across agencies. Second, the government carried out an extensive advertising campaign to allay the public's fear of price hikes and to restrain overcharging by traders. A telephone service was also set up so consumers could report complaints about prices. Finally, the Economic Planning Agency increased the budget for the price monitoring system. The situation was nearly identical in 1997.

[3] For the political process, see Ishi (2001) and Takahashi (1999).

2.2. The Consumption Tax Rate Increase as a Natural Experiment

To estimate the IES, variation in the real interest rate, which is the price of current consumption relative to future consumption, is necessary. Because the real interest rate is defined as the nominal interest rate minus the inflation rate, a change in the inflation rate will induce the necessary variation As a result, the April 1997 Consumption Tax rate increase, which represented an exogenous increase in the future price level during a period in which nominal interest rates were stable, presents an ideal natural experiment to estimate the IES, which we discuss below.

First of all, the tax rate increase can be regarded as an exogenous change in consumer prices. Not only is it the case that the tax system is exogenous to individual households, but it is also true that the impact of the tax rate increase is independent of consumer behavior. This is because the VAT by and large applies to expenditures regardless of the characteristics of the consumer, the point of purchase, or the type of goods purchased. Figure I.1 shows the seasonally-adjusted month-to-month percentage change in the consumer price index for non-storable non-durable goods and services, the component of consumption expenditure that we use to estimate the IES. While inflation was negligible in most months prior to and following implementation of the tax rate increase, the price level increased by just over two percent (2.39 percent) between March and April 1997, which is consistent with full forward shifting of the Consumption tax onto consumers at the time of implementation.[4] As a result, we can focus on a one-time price change and can rule out the influence of an additional factor (i.e. variation in pre-tax prices) that affects the real interest rate.

We can also rule out the influence of the nominal interest rate on the real interest rate. Figure I.2 presents the average contracted interest rates on short-term loans and discounts, which are the average interest rates applied to a contract of less than one year between a commercial bank and lender. The average interest rate fell precipitously throughout 1995, but remained relatively constant thereafter. This suggests that households would not change their nominal interest rate expectations in the months surrounding implementation of the Consumption Tax rate increase. In other words, households should not have expected any changes in nominal interest rates by the central bank that would offset or augment the intertemporal substitution incentives.

These facts imply that the tax rate increase can be regarded as an exogenous change in the real interest rate, which allows for consistent estimation of the intertemporal substitution

[4] Carroll et al. (2010) find that full forward shifting at the time of a consumption tax rate increase is the norm across most countries.

response using ordinary least squares (OLS). Previous studies of intertemporal substitution have relied on an instrumental variables approach to address the well-documented endogeneity between the real interest rate and consumption growth. The standard approach has been to instrument for the contemporaneous real interest rate with lagged interest rates. However, there are several potential issues with the instruments that have been employed. First, as Yogo (2004) notes, it is notoriously difficult to predict the real interest rate, and therefore, some of the previous studies in this literature (especially those using aggregate data) suffer from the weak instrument problem. Weak instruments lead to estimates of the IES biased in the direction of OLS, which itself is likely to suffer from a downward bias.[5, 6] Even if the weak instrument problem is overcome, there still exists the potential for correlation between the lagged interest rates and consumption growth, which is discussed by Gruber (2006). Furthermore, Attanasio and Weber (1993, 1995) show that studies using lagged instruments and aggregate non-durable expenditure data suffer from a downward bias in estimates of the IES known as aggregation bias.[7] This study avoids these issues by using an exogenous institutional price change.

While exogenous variation in the real interest rate is a necessary condition for estimating the IES, it must also be the case that households are aware of the change. While we cannot provide direct evidence on household awareness of the Consumption Tax rate increase, we can provide indirect evidence by examining news coverage prior to implementation. Figure I.3 reports the number of articles that mention the phrase "Consumption Tax" in the Nihon Keizai Shimbun, Japan's leading business newspaper with a circulation of over three million (in 2010), and the Yomiuri Shimbun, a leading non-business newspaper with a circulation of over 10 million (in 2010).[8] There was a steady upward trend that began just prior to enactment of the June 1996 legislation. Coverage peaked in the Yomiuri Shimbun in October 1996, which coincided with elections to the

[5] Two stage least squares (2SLS) estimators using weak instruments are biased in the direction of OLS for the following reason. Suppose the structural equation is given by $y_i = \beta x_i + \eta_i$, and the first stage equation by $x_i = \pi z_i + \xi_i$. If π is truly zero due to weak instruments, then any variation in the predicted value of x_i, $\hat{x}_i$, will come from ξ_i. It follows that the variation in $\hat{x}_i$ is no different from the variation in x_i, and the OLS and IV estimates are estimating the same quantity on average. For more information, see Pischke (2010).

[6] Using OLS, Gruber (2006) obtains an estimate of the IES of -0.55, which is significantly less than his estimates when instrumenting for the after-tax real interest rate. Vissing-Jorgensen (2002) finds that estimates of the IES converge towards zero as the number of instruments is increased. This is because the weak instrument problem is increasing in the degree of overidentification.

[7] Attanasio and Weber (2010) sum up aggregation bias as follows: "The aggregate consumption growth rate is computed by taking logs of the mean of individual consumption, whereas [the log-linearized Euler equation] implies that means of the logs should be taken instead…the difference between these two terms is highly serially correlated, thus invalidating lagged consumption growth as an instrument."

[8] Circulation numbers come from Japan's Audit Bureau of Circulations.

Lower House of the Diet. Overall coverage in both papers was consistently high in the months following the election but prior to the tax change, with nearly 300 articles in the Nihon Keizai Shimbun mentioning the Consumption Tax in March 1997. This suggests that households were aware of the tax rate increase and might therefore engage in intertemporal substitution behavior.

The news coverage also suggests that households may have been aware of the effects of the Murayama reform package as a whole. Figure I.3 shows that coverage initially peaked in September 1994, which coincided with the passage of the Murayama reform. Accordingly, households may have known the package was intended to be revenue neutral over the long-run. This in turn implies that the income effect associated with the tax rate increase would be small; and thus, we need not pay much attention to separate identification of the intertemporal substitution and income effects.[9]

Finally, the relative pre-tax price of goods and services did not change around the time of the Consumption Tax rate increase. Figure I.4 shows the price of durables and storable non-durables relative to non-storable non-durables around the time of the Consumption Tax rate increase. As the figure demonstrates, there was little change in the relative price of these goods. This fact allows us to make the simplifying assumption of constant relative pre-tax prices in the model presented in Section 3. As a result, we need only concern ourselves with the possibility of intratemporal substitution between durables and non-storable non-durables resulting from the reduction in the user cost of durables just prior to the Consumption Tax rate increase, which we discuss further in Section 3.1.

To summarize, we argue that the April 1997 Consumption Tax rate increase presents an ideal natural experiment to estimate the IES for the following reasons: the tax rate increase can be regarded as an exogenous change in the real interest rate; the real interest rate was relatively stable prior to and following implementation; the tax rate increase was predictable and consumer awareness was high; and relative pre-tax prices were constant.

3. A Consumption Tax Rate Increase and the Intertemporal Elasticity of Substitution

3.1. The Model

In this section, we construct a model to demonstrate the impact of a consumption tax rate increase on both household consumption and expenditure. A household consumes three

[9] That said, our empirical specification does attempt to identify the combined income and intertemporal substitution effects in the months immediately following announcement of the Consumption Tax rate increase.

types of goods and services: non-storable non-durables (N), storable non-durables (S), and durables (D). Household *i* maximizes its lifetime utility function, *U*, which is the discounted sum of the instantaneous utility, *u*. Suppose the utility function at time *s* is as follows:

$$U_s = \sum_{t=s}^{\infty} \beta^{t-s} \left(\frac{\sigma}{\sigma - 1}\right) \left[u_t^{\frac{\sigma-1}{\sigma}} - 1\right],$$

where β is the subjective discount factor; σ is the IES; and u_t is the instantaneous utility. Unlike previous studies, we use a deterministic setting because we focus on short-run dynamics around the time of the Consumption Tax rate increase.

Following Ogaki and Reinhart (1998), the intratemporal utility function is assumed to take the CES form for N, S, and D:[10]

$$u_t = u(C_t^N, C_t^S, D_t) = \left[aC_t^{N\frac{\epsilon-1}{\epsilon}} + bC_t^{S\frac{\epsilon-1}{\epsilon}} + D_t^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}$$

where C_t^N and C_t^S are consumption of N and S, respectively; D_t is the stock of D held at the end of period *t*; ϵ is the intratemporal elasticity of substitution; and *a* and *b* are some positive numbers that determine the weights attached to N and S.[11] It is worth noting that the utility function becomes additively separable in N, S, and D if $\sigma = \epsilon$.

In maximizing its lifetime utility, the household faces three constraints: the intertemporal budget constraint and laws of motion for the stock of S and D. The intertemporal budget constraint is given by

$$A_t = (1 + i_t - \pi_t)A_{t-1} + Y_t - C_t^N - p_t^S X_t^S - p_t^D\{X_t^D + \varphi(X_t^D)\} - \theta(S_t) \quad \text{for } t = s \cdots \infty,$$

where A_t is financial wealth held at the end of period *t*; i_t is the nominal interest rate; π_t is the inflation rate in terms of N; Y_t is income; p_t^S and p_t^D are the prices of S and D in relation to N, respectively; X_t^S and X_t^D are gross expenditures on S and D, respectively; and S_t is the stock of S held at the end of period *t*. The functions θ and φ represent costs associated with

[10] Pakos (2004) points out that preferences are in fact non-homothetic. In particular, durables are luxuries, while non-durables are necessities. However, given that we are focused on a short time period and a modest rate increase, it is plausible to assume that preferences over durables and non-durables are homothetic.

[11] Because we are focusing on short-run dynamics, our model ignores the labor/leisure choice, effectively assuming that labor supply is fixed during the period of interest. This is made more plausible by the fact that we restrict our sample to households that do not change jobs during their time in the sample. Crossley and Wakefield (2009), which investigates a VAT rate change in the UK, also ignored the labor supply decision.

the storage of S and purchase of D, which we discuss below. Finally, we take A_{s-1}, D_{s-1}, S_{s-1} as given.

As discussed in the previous section, it was expected that the Consumption Tax rate increase would be fully passed onto consumers in the form of higher prices at the time of implementation (hereafter, period *T*). In addition, the price of S and D relative to N were constant before and after the rate increase. Moreover, nominal interest rates and the pre-tax price level were stable around implementation. As a result, we can safely make the following two simplifications to the intertemporal budget constraint:

$$1)\ p_t^S = p^S \quad \text{and} \quad p_t^D = p^D$$

$$2)\ i_t - \pi_t \equiv r_t = \begin{cases} i - \tau & \text{in period } T-1 \\ i & \text{in other periods.} \end{cases}$$

where τ is the inflation rate due to the rate increase. In our case, τ = 0.0239 because the CPI for N increased by 2.39 percent from March to April 1997.

The function θ accounts for the cost of holding a level of stock, *S*.[12] This consists of costs from stock shortages as well as storage costs. For example, if a household runs out of storable non-durable goods such as toothpaste, there is a time cost associated with making a trip to the store to purchase an additional tube. Alternatively, stockpiling S requires the use of storage space that could be used for other purposes. These scenarios suggest that there exists a bliss point for the stock of *S*, S^*, which means that $\theta'(S_{i,t}) \leq 0$ if $S_{i,t} \leq S^*$ and $\theta'(S_{i,t}) > 0$ if $S_{i,t} > S^*$.

φ accounts for costs associated with the purchase of *D*. The purchase of a durable good is an infrequent event, and more effort is required than for a non-durable purchase. This may include collecting catalogues, identifying key specs, and shopping around to get a better price. Assuming that the opportunity cost of a household's time spent shopping is increasing, convex, and proportional to the amount spent on durable goods, it follows that φ_i is increasing and convex in its argument. That is, $\varphi' > 0$ and $\varphi'' > 0$.

Finally, the evolution of the stocks of *S* and *D* are given by

$$S_t = (1-\delta^s)S_{t-1} - C_t^S + X_t^S \qquad \text{for } t = s \cdots \infty,$$

[12] Previous studies have shown empirically that demand is affected by the storability of a good (e.g. Hendel and Nevo, 2004 & 2006). In particular, households weigh the benefits of purchasing storable goods at a lower price against the cost of holding additional inventory.

and

$$D_t = (1-\delta^D)D_{t-1} + X_t^D \qquad \text{for } t = s \cdots \infty$$

where δ^S and δ^D are the depreciation rates of *S* and *D*, respectively.[13]

3.2. Optimal Consumption Path and the Intertemporal Elasticity of Substitution

Solving the household's optimization problem, we obtain the following first order conditions:

$$\frac{\partial u/\partial C_{t+1}^N}{\partial u/\partial C_t^N} = \left(\frac{F_{t+1}}{F_t}\right)^{\frac{\sigma-\epsilon}{\sigma(\epsilon-1)}} \left(\frac{C_{t+1}^N}{C_t^N}\right)^{\frac{-1}{\sigma}} = \frac{1}{\beta(1+r_t)} \qquad (1)$$

$$C_t^S = C_t^N \left(\left(\frac{a}{b}\right) p^S\right)^{-\epsilon} \qquad (2)$$

$$\theta_i'(S_t) = \theta_i'\Big((1-\delta^S)S_{t-1} - C_t^S + X_t^S\Big) = -p^S \left\{\frac{r_t + \delta^S}{1+r_t}\right\} \qquad (3)$$

$$D_t = C_t^N \left(ap^D \left[\left(\frac{r_t+\delta^D}{1+r_t}\right) + \left\{\varphi'(X_t^D) - \frac{1-\delta^D}{1+r_t}\varphi'(X_{t+1}^D)\right\}\right]\right)^{-\epsilon} \qquad (4)$$

where

$$F_t = 1 + \left(\frac{b}{a}\right)\left(\frac{C_t^S}{C_t^N}\right)^{\frac{\epsilon-1}{\epsilon}} + \left(\frac{1}{a}\right)\left(\frac{D_t}{C_t^N}\right)^{\frac{\epsilon-1}{\epsilon}},$$

$\frac{C_t^S}{C_t^N}$ is a constant, as demonstrated in (2), and $\frac{D_t}{C_t^N}$ may vary as a result of the variation in r_t.

Equation (1) gives the standard Euler equation, which can be rewritten as

$$\frac{C_{t+1}^N}{C_t^N} = \beta^\sigma (1+r_t)^\sigma \left(\frac{F_t}{F_{t+1}}\right)^{\frac{-(\sigma-\epsilon)}{(\epsilon-1)}}.$$

Then, taking the logarithm of both sides and using the general approximation $\ln(1+x) \cong x$ for small x, the consumption changes can be denoted as

[13] In the case that δ^S and δ^D are equal to one, S and D effectively become nondurables.

$$\Delta\ln C_t^N = \sigma\ln\beta + \sigma\ln r_t + \frac{\sigma-\epsilon}{\epsilon-1}\Delta\ln F_t$$

$$= \begin{cases} \kappa - \sigma\tau + \left(\frac{\sigma-\epsilon}{\epsilon-1}\right)(\ln F_t - \ln F_{t-1}) & \mathrm{t} = T \\ \kappa \quad\quad + \left(\frac{\sigma-\epsilon}{\epsilon-1}\right)(\ln F_t - \ln F_{t-1}) & \mathrm{t} \neq T \end{cases} \quad (5)$$

where $\Delta\ln C_t^N = \ln C_{t+1}^N - \ln C_t^N$ and $\kappa = -\sigma\{\ln\beta + r\}$.

This shows that we can estimate the IES, σ, using the Japanese consumption tax rate increase as the source of identifying variation once we assume that preferences over N, S, and D are additively separable (i.e. $\sigma = \epsilon$). Because the third term in Equation (5) is zero, we simply divide the change in log-consumption growth of N at the time of implementation by the size of the tax rate increase, τ, in order to obtain the IES.

However, as Ogaki and Reinhart (1998) point out, this approach could yield a biased estimator if preferences over N, S, and D are in fact non-separable. For example, suppose that $\sigma > \epsilon$, and $0 < \epsilon < 1$. F_t will vary in the months surrounding implementation of the Consumption Tax rate increase because the term F_t reflects intratemporal substitution between N and D resulting from variation in the real interest rate, r_t, which in turn affects the user cost of durables. Specifically, the value of F_t will be greater in the month of implementation than in the month prior to implementation. As a result, the third term in Equation (5) will be negative. If we do not account for intratemporal substitution between N and D, it follows that a regression of the change in log-consumption growth on τ will overstate the IES.[14] To address this issue, we will add terms to allow for non-separable preferences in the empirical specification described below.

3.3. Empirical Specification

To estimate the IES, we use an empirical specification that is consistent with the model and is able to separately identify the IES from intra-temporal substitution effects. According to the model presented above, the intra-temporal substitution effects, or changes inln F_t, will appear symmetrically in the months prior to and following implementation. On the other hand, the intertemporal substitution effect is present only at the time of implementation. This is key to identifying the IES.

[14] Conversely, if $1 > \epsilon > \sigma > 0$, a regression of the change in log-consumption growth on τ will understate the IES.

With this in mind, the following specification can identify the IES:

$$\Delta \ln C^N_{i,y,m} = c + \gamma_{1997,\mathrm{Apr}} D_{1997,\mathrm{Apr}} + \sum_{(y,m)\in I} \alpha^N_{y,m} \Delta D_{y,m}$$

where $\Delta \ln C^N_{i,y,m}$ is the log-difference of consumption of N for household type i in year y and month m; c is a constant; $D_{1997,\mathrm{Apr}}$ is a dummy for April 1997; and $\Delta D_{y,m}$ is the first difference of month dummies for the period I, during which the intra-temporal substitution effects are present. In the absence of durable adjustment costs (i.e. φ is always zero), the changes in $\ln F_t$ will be limited to the month prior to and the month of implementation. That is, the set I consists of one element, March 1997. With this specification, our main interest is $\gamma_{1997,\mathrm{Apr}}$, which is divided by τ to obtain the IES. On the other hand, the $\alpha^N_{y,m}$'s correspond to $\frac{\sigma-\epsilon}{\epsilon-1} \Delta \ln F_{y,m}$ for each month m.

In the actual estimation, we consider some additional factors affecting consumption that were excluded from the theoretical model, such as seasonality and demographics. The regression equation is:

$$\begin{aligned} \Delta \ln C^N_{i,y,m} = c + \Delta \boldsymbol{Z_m} \delta_m + \Delta \boldsymbol{X_{i,y,m}} \phi + \\ + \gamma_{1996,\mathrm{Oct}} D_{1996,\mathrm{Oct}} + \gamma_{1996,\mathrm{Nov}} D_{1996,\mathrm{Nov}} + \gamma_{1996,\mathrm{Dec}} D_{\mathrm{Dec}} \\ + \gamma_{1997,\mathrm{Apr}} D_{1997,\mathrm{Apr}} + \sum_{(y,m)\in I} \alpha^N_i \Delta D_{y,m} \qquad (6) \end{aligned}$$

where $\Delta \boldsymbol{Z_m}$ is the first difference of a vector of month dummies. Consequently, δ_m represents the seasonal effects. $\Delta \boldsymbol{X_{i,y,m}}$ is a vector of (potentially) time-varying household-specific characteristics, which includes the number of household members; the number of working household members; the number of household members under age 18; the number of household members above age 65; and interview dummies, which control for "survey fatigue", the tendency of households to report lower expenditure in later interviews. It is worth noting that household-specific fixed effects (or non-time-varying characteristics) are already controlled for by taking the first difference.

The dummies for October, November, and December 1996 (D_{Oct}, D_{Nov}, and D_{Dec}, respectively) are included to determine whether there was any effect on consumption associated with announcement of the tax rate increase. The effect is the sum of the income effect and the intertemporal substitution effect. As we discussed in Section 2, the announcement of the tax rate increase occurred sometime between October and December 1996; thus, it is preferable to include not a single month but all three month dummies. The sign of the coefficients associated with each dummy are, however, ambiguous. The income effect should be negative because the rate increase represents a negative income shock, while the intertemporal substitution effect should be positive, reflecting households' incentive to increase their consumption during the periods between announcement and implementation, when the price level was relatively low. As a result, the sign of the coefficients depends on which effect dominated the other.[15]

Figure I.5 provides a graphical depiction of our identification strategy when durables and non-durables are complements and there are no durable adjustment costs. In the top figure, the blue circles represent monthly expenditure on N in the absence of intra- and inter-temporal substitution effects. The red X's represent expenditure on N in the absence of intra-temporal substitution effects. And finally, the orange doughnuts represent observed expenditure on N. In this example, we assume that announcement occurs in October 1996; the announcement effects appear immediately upon announcement; the income effect dominates the positive intertemporal substitution effects; and intra-temporal substitution between durables and non-durables is confined to March and April 1997. When we take the first difference of expenditure on N, the coefficient associated with the dummy variable for October 1996 will capture the sum of the income (I) and positive intertemporal substitution effect (S_+), γ_{Oct}; the coefficient associated with the first-differenced March 1997 dummy variable will capture the (positive) intra-temporal substitution effect, α_{Mar} ; and the coefficient associated with the April 1997 dummy variable will capture the intertemporal substitution effect, γ_{Apr}, because we are able to control for the intra-temporal substitution effect in that month with the first-differenced March 1997 dummy.

[15] There is also a literature that suggests that the income effect associated with a tax change is absent until the tax change is implemented. See, for example, Watanabe et al. (2001) and Mertens and Ravn (2010). If this were the case, our estimate of the IES would be biased upwards, as the decline in expenditure from March to April would capture not only intertemporal substitution, but also the negative income effect..

4. Empirical Evidence

4.1. Data

We use data from the Japanese Family Income and Expenditure Survey (JFIES) to estimate the IES.[16] The JFIES is a rotating panel survey in which households are interviewed for six consecutive months and approximately 8,000 households are interviewed each month.[17]

Our estimates make use of JFIES data from the period between April 1992 and March 2002. We use a symmetric five year window around the April 1997 rate increase. We choose to exclude the "bubble" years before April 1992 because household expenditures prior to 1992 grew at a much faster pace than they did after the bursting of the economic "bubble" in 1991, while they remained more or less flat after that. Our sample period ends in March 2002, which coincided with the beginning of another boom.

We limit the sample to households who complete all six interviews, but nearly all households can be used as the response rate of the JFIES is quite high. Although data for agricultural households is available in the JFIES after 1999, we drop them to maintain consistency over the sample period. Also, we use male headed households and those whose head does not change his job because March is the end of fiscal year in Japan. As a result, we observe many job changes, which may cause systematic changes in consumption. The sample restrictions leave us with 646,900 observations from 129,380 households. Table I.1 presents summary statistics for our sample.

The JFIES expenditure data is highly disaggregated by item type, which allows us to accurately categorize goods and services. It is critical for our purpose to distinguish not only between taxable and tax-exempt goods and services, but also between N, S, and D.

To construct expenditure on N, we first exclude expenditures on goods and services that were not subject to the consumption tax. As shown in Table I.1, expenditure on taxed items comprised 70% of total expenditure, while most tax-exempt expenditure consists of rent for housing and education (e.g. tuitions for school), which would not respond to a rate increase in the short-run.

[16] See Stephens and Unayama (2011, 2012) for more information regarding the JFIES design and content.

[17] Until 2002, single-person and agricultural households were excluded from the JFIES. As of the 2009 JFIES, single-person households comprised 11.8 percent of the population and were responsible for 18.1 percent of expenditures, while agricultural households accounted for 2 percent of the population, and 2.1 percent of expenditures.

As a second step, we divide goods and services that were subject to the tax into three sub-categories: D, S, and N. We define N as goods and services which are neither storable nor durable. That is, they depreciate relatively quickly over time when not in use, and when in use, are fully consumed. As a result, this category contains goods and services for which the timing of consumption and expenditure roughly coincide. For example, fresh fruit, if not eaten, will spoil, and is fully consumed with use. This category also includes services such as taxi service, which is consumed at the point of purchase. Second, we define S as those goods and services that depreciate slowly over time if not used and fully if used. It follows that these goods can be stockpiled for future consumption, and consequently, consumption and expenditure do not necessarily coincide. For example, laundry detergent can be stored for long periods of time with little to no effect on its ability to clean clothing, but once it is put into use, whatever amount was used has been fully consumed. This category also includes rail service, due to the fact that many Japanese households purchase passes which are good for train travel for several months. Thus, one might expect that a household would purchase a pass good for several months during a low price period, and use the pass during a relatively high price period. Finally, we define D as goods and services which depreciate relatively slowly over time if not used and do not depreciate fully with use. Consequently, consumption and expenditure do not coincide for durables. This category includes traditional durables such as refrigerators and automobiles, as well as goods such as clothing that are classified as semi-durables in the JFIES. In addition, we include a select group of services such as home repair and tailoring, which consumers derive benefits from long after the service is provided.[18]

We then deflate monthly expenditures on N, S, and D using tax-inclusive consumer price indices specific to our categories.[19] We are left with real monthly expenditures for Japanese households from April 1992 through March 2002. Table I.1 shows that more than half of taxable expenditure is on N, while expenditure on S and D are similar.

4.2. Empirical Results

Table I.2 presents our estimates for the entire sample based on the specification given in Equation (6). Regression (1) includes only a dummy for April 1997. In effect, it ignores announcement and intratemporal substitution effects. We find that expenditure on N fell significantly between March and April 1997. The 2.16 percent decline in expenditure implies

[18] See Appendix Table A.1 for our complete categorization of N, S, and D.

[19] In particular, we construct Laspeyres price indices for each of our four categories using item-specific price indices and expenditure shares in 1990 for each of these items as the weights.

that the intertemporal elasticity of substitution is 0.91. The estimate of the IES remains unchanged in Regression (2), which allows for announcement effects. However, these estimates ignore intratemporal substitution, and could be biased as a result.

Regression (3), our baseline specification, adds a first-differenced March 1997 dummy intended to capture intra-temporal substitution resulting from the fall in the user cost of durables in that month. Inclusion of this dummy reduces the coefficient associated with the April 1997 dummy from -2.16 to -0.51. The implied IES is 0.21, which is significantly less than one, but not significantly different from zero. The coefficient for the first-differenced March 1997 dummy is significantly different from zero, and therefore should, in fact, be included in the specification. To consider the possibility that the intra-temporal substitution effects persisted beyond March and April 1997 as a result of durable adjustment costs, Regression (4) includes additional first-differenced month dummies. Doing so, the estimate of the IES is slightly larger than in the baseline estimate (0.30), while we cannot reject the null that all first differenced month dummies are zero.

Table I.3 presents regression estimates intended to test the robustness of our results. Because seasonal effects may change over time, a longer sample period could yield an incorrect estimate of the IES. While we use the symmetric five year window from 1992 through 2002 in the baseline, Regression (1) uses a four year window (1993-2001) and Regression (2) a three year window (1994-2000). The resulting IES estimates (0.17 and 0.30, respectively) are similar to the baseline estimate. Regression (3) removes all sample selection criteria such as male-headed household, participated all six interviews, etc. The implied IES is the largest of all our regressions (0.36), but still small and significantly less than one.

Our results are comparable to the results in the previous studies using macro-data. Hall (1988) summarizes his results by saying that “the value may even be zero and is probably not above .2” (Hall, 1988; p.350); Ogaki and Reinhart (1998) conclude that the point estimates fall in a “range of 0.32 to 0.45” when allowing for non-separable preference (Ogaki and Reinhart, 1998; p.1095); and moreover, Yogo (2004) reports the 95% confidence intervals [-0.43, 0.56] (the negative sign is added for comparison with our estimates) using Japanese data between 1970 and 1998 (Yogo 2004; Table 3).

In contrast, studies based on survey data have found larger estimates of the IES. Attanasio and Weber (2010) summarize their results (Attanasio and Weber 1993, 1995) as follows: the lower IES based on the macro-data can be explained by aggregation bias; once this bias is taken into account, the IES estimate increases to approximately 0.8 (Attanasio and

Weber 2010, p.710). Similarly, Vissing-Jorgensen (2002) obtains point estimates of the IES in the range of 0.8-1 when accounting for limited asset market participation. Gruber (2006) obtains an even larger IES estimate of 2 when using cross-sectional variation in capital income tax rates as a source of identifying variation.

We believe that our estimates are preferable to previous estimates because we use micro-data, a natural experiment approach, an appropriate categorization of non-durables, and a specification that is robust to non-separable preferences between durables and non-durables. The use of micro-data implies that our result is free from aggregation bias. Exploiting a natural experiment allows us to avoid the problem of weak instruments and the potential for correlation between lagged instruments and contemporaneous consumption growth.[20] Restricting the analysis to non-storable non-durable goods and services mitigates the concern that we are capturing an expenditure elasticity rather than the intended consumption elasticity. Finally, as evidenced by the results from Regression (2) and (3) in Table I.2, allowing for non-separable preferences has a significant impact on our estimate of the IES.

It is possible that our small estimate of the IES is attributable to liquidity constraints. Because liquidity constrained consumers are less able to smooth consumption across periods, the estimated IES could be smaller if many households faced a binding constraint around the time of the consumption tax rate increase. To test for this possibility, we separate the sample into groups that are more likely to be liquidity constrained and groups that are relatively less likely to be constrained. First, we separate working and non-working households. While the non-working group includes unemployed households, most are retired.[21] Because retired households can expect little to no income growth, they are much less likely to be liquidity constrained. As Regression (1) and (2) in Table I.4 show, the difference in the estimated IES between working and non-working is small. A more conventional method to test for liquidity constraints is to divide households into higher and lower income groups. The results in Regressions (3) and (4) indicate that the IES is slightly larger for lower income households. Overall, the results in Table I.4 suggest that liquidity constraints are not responsible for our small IES estimate.

[20] As in this paper, Engelhardt and Kumar (2009) use micro-data and an approach that exploits a natural experiment to find the IES is 0.74. Unlike others papers (including this one), however, the IES is not derived from the Euler equation, and as a result, is difficult to compare to our estimates.

[21] More than 90 percent of non-working households are aged 60 or older.

Data quality is another possible explanation why consumption of N was insensitive to the tax rate increase. If households incorrectly report their expenditures every month, the real changes would be attenuated by measurement error, causing our estimate of the IES to be biased towards zero. To evaluate this, we regress the first difference of the logarithms of S and D on the same set of variables. Expenditures on S and D should change around implementation much more than expenditure on N. This is because S and D are subject not only to intertemporal substitution, but also 'arbitrage' effects. Regressions (2) and (3) in Table I.5 show that expenditures on S and D in March 1997 increased significantly. While it is difficult to interpret these coefficients, the results demonstrate that changes in expenditure are accurately reported; and thus, this suggests that data quality issues do not preclude us from finding a response to the Consumption Tax rate increase.

The coefficient on the first-differenced March 1997 dummy in our baseline specification is 1.66, which is significant at the five percent level. This result implies that durables and non-durables are strong complements, because the decline in the user cost of durables in March 1997 led to an increase in non-durable consumption. This result is consistent with those of Pakos (2004) and Cashin (2012), but conflicts with the results of Ogaki and Reinhart (1998), who find an elasticity of substitution between durables and non-durables that exceeds one.[22]

Finally, we consider the announcement effects. Specifically, we are interested in their sum. We find that the sum is slightly positive, but does not differ significantly from zero in all regressions presented in Tables I.2, I.3, and I.4. As discussed in subsection 3.3 above, this implies that the positive intertemporal substitution effect cancels out any negative income effect that may have resulted from announcement of the Consumption Tax rate increase.

5. Summary and Discussion

This study examines intertemporal substitution in consumption using a pre-announced increase in Japan's Consumption Tax rate from three to five percent. Because the Japanese Consumption Tax is highly comprehensive, the tax rate increase was announced prior to its implementation, and other factors that affect the real interest rate were constant, it presents an ideal natural experiment to estimate the IES. A Japanese monthly household survey is

[22] Pakos (2004) demonstrates that Ogaki and Reinhart's result may be biased due to the assumption of homothetic preferences. Given homothetic preferences where durables are luxuries and non-durables are necessities, growth in the durable consumption share over time that has accompanied a fall in durable prices is incorrectly attributed to the substitution effect rather than the income effect.

exploited to accurately categorize non-durables. Our research design and the use of micro-data allow us to avoid the problems of weak instruments and aggregation bias. Furthermore, our empirical specification is robust to intratemporal substitution between durables and non-durables. Given the exogenous change in the real interest rate, our detailed data, and flexible empirical specification, we find that the IES is small. The baseline point estimate is 0.21 and does not differ significantly from zero, but is significantly less than one. As Yogo (2004) notes, this finding is of economic interest because it implies that an investor's optimal consumption-wealth ratio is increasing in expected returns.

From a policy standpoint, two implications emerge from our result. First, recent work by Correia et al. (2010) demonstrates that when nominal interest rates are at the zero lower bound, a reduction in the VAT can be used to mimic an interest rate cut. However, our result suggests that the stimulus provided by such a policy may be relatively limited.[23]

Second, previous authors (e.g. Kaplow, 2008; Auerbach and Kotlikoff, 1983, 1987) have raised concerns over the efficiency costs of pre-announced increases in consumption tax rates. They posit that the longer the length of time between announcement and implementation of a consumption tax rate increase, the larger will be the welfare losses due to the acceleration of consumption in the period prior to implementation. However, our result suggests that the welfare losses of pre-announcement are small.[24]

While we find that *consumption* is insensitive to the real interest rate, the same is not necessarily true for *expenditure*. Durability and storability allow households to change the timing of their expenditure without changing the timing of consumption. Our future work will examine these effects associated with Japan's consumption tax rate increase. In doing so, we will be able to fully characterize the consumption and expenditure response to a change in the real interest rate.

[23] For a borrowing constrained household, consumption should increase throughout the entire period of the rate decrease. Crossley et al. (2009) point out that the fraction of constrained households likely increases during downturns. If this is true, a rate decrease may provide stimulus not because of the intertemporal substitution effects, but rather income effects for constrained households.

[24] This finding is further reinforced by the results in Cashin (2011), which examines the intertemporal substitution and arbitrage effects of three separate increases in the Goods and Services Tax rate in New Zealand. In all three cases, the length of time between announcement and implementation differed, but in all three cases, the expenditure response was confined to the month prior to implementation, which indicates the response was driven by largely unavoidable arbitrage effects rather than intertemporal substitution in consumption.

TABLE I.1. SUMMARY STATISTICS

Variable	Mean	Std.	Min	Max
Age of head	51.5	13.7	17	99
Number of household members	3.38	1.24	2	11
Number of household members under age 15	0.68	0.98	0	7
Number of household members aged 65+	0.47	0.75	0	4
Number of working members	1.52	0.95	0	7
Yearly income (1,000 yen)	7,113	4,652	0	97,043
Total expenditure (1,000 yen)	317	266	20	14,346
Exculuding Tax Exempted items (1,000 yen)	221	195	15	9,255
Nonstorable non-durables (N) (1,000 yen)	120	78	7	5,523
Storable non-durables (S) (1,000 yen)	52	32	.58	3,790
Durables (D) (1,000 yen)	47	138	0	7,678
Number of Observations	646,900			
Number of Households	129,380			

Note: Yearly household income and monthly household expenditures are listed in thousands of yen, with 2005 serving as the base year.

TABLE I.2. ESTIMATES OF THE INTERTEMPORAL ELASTICITY OF SUBSTITUTION (IES)

	Dependent Variable: Non-storable non-durable (multiplied by 100)							
	(1)		(2)		(3)		(4)	
	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error
First Difference of Month dummies								
$\Delta \boldsymbol{D}_{\text{Feb,1997}}$							-1.10	0.78
$\Delta \boldsymbol{D}_{\text{Mar,1997}}$					1.66**	0.82	0.56	0.91
$\Delta \boldsymbol{D}_{\text{Apr,1997}}$							-0.89	0.94
$\Delta \boldsymbol{D}_{\text{May,1997}}$							-1.54*	0.90
$\Delta \boldsymbol{D}_{\text{Jun,1997}}$							0.06	0.78
p-value for F-test for All $\Delta \boldsymbol{D}$ =0	n.a.		n.a.		0.042**		0.139	
Month Dummies								
$\boldsymbol{D}_{\text{Oct,1996}}$ (a)			-0.93	0.78	-0.93	0.78	-0.93	0.78
$\boldsymbol{D}_{\text{Nov,1996}}$ (b)			1.21	0.76	1.21	0.76	1.21	0.76
$\boldsymbol{D}_{\text{Dec,1996}}$ (c)			-0.05	0.79	-0.05	0.79	-0.05	0.79
$\boldsymbol{D}_{\text{Apr,1997}}$ (d)	-2.16***	0.78	-2.16***	0.78	-0.51	0.84	-0.71	1.15
(a)+(b)+(c) (p-value for F-test)	n.a.		0.23 (0.80)		0.23 (0.80)		0.23 (0.65)	
Implied IES (=(d) divided by 2.39) [95% Conf. Interval]	-0.91 [-1.55, -0.27]		-0.91 [-1.55, - 0.27]		-0.21 [-0.90, 0.48]		-0.30 [-1.24, 0.65]	
Sample Period	1992-2002							
Sample Restriction	Yes							
Observations	646,900							

Note: This table presents estimates from a regression based on Equation (6). The dependent variable is the first difference of the logarithm of monthly household expenditures. Standard errors are robust to serial correlation within households over time. All columns report OLS regressions, which include, in addition to variables in the table, the first difference of month dummies, age of household head the first differences of the following variables: indicators for each interview; the number of household members, working members, members under age 18, and members over the age of 65. *, **, and *** represent significance at the 10, 5, and 1 percent level, respectively.

TABLE I.3. ROBUSTNESS CHECKS

	Dependent Variable: Non-storable non-durable (multiplied by 100)					
	(1)		(2)		(3)	
	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error
First Difference of Month dummies						
$\Delta \boldsymbol{D}_{\text{March,1997}}$	1.75**	0.83	1.54*	0.85	1.79**	0.74
Month Dummies						
$\boldsymbol{D}_{\text{Oct,1996}}$ (a)	-1.03	0.79	-0.38	0.81	-0.94	0.73
$\boldsymbol{D}_{\text{Nov,1996}}$ (b)	1.60**	0.78	1.33*	0.79	1.60**	0.71
$\boldsymbol{D}_{\text{Dec,1996}}$ (c)	0.03	0.80	0.13	0.82	0.10	0.72
$\boldsymbol{D}_{\text{Apr,1997}}$ (d)	-0.41	0.86	-0.71	0.88	-0.86	0.78
(a)+(b)+(c) (p-value for F-test)	0.59 (.407)		1.08 (0.266)		0.42 (.650)	
Implied IES (=(d) divided by 2.39) [95% Conf. Interval]	-0.17 [-0.87, 0.53]		-0.30 [-1.03, 0.43]		-0.36 [-0.99, 0.27]	
Sample Period	1993-2001		1994-2000		1992-2002	
Sample Restriction	Yes		Yes		No	
Observations	526,612		394,673		764,895	

Note: This table presents estimates from a regression based on Equation (6). The dependent variable is the first difference of the logarithm of monthly household expenditures. Standard errors are robust to serial correlation within households over time. All columns report OLS regressions, which include, in addition to variables in the table, the first difference of month dummies, age of household head the first differences of the following variables: indicators for each interview; the number of household members, working members, members under age 18, and members over the age of 65. *, **, and *** represent significance at the 10, 5, and 1 percent level, respectively.

TABLE I.4. HETEROGENEITY IN THE IES ESTIMATE ACROSS HOUSEHOLD TYPES

	Dependent Variable: Non-storable non-durable (multiplied by 100)							
	(1)		(2)		(3)		(4)	
	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error
First Difference of Month dummies								
$\Delta \boldsymbol{D}_{\text{Mar,1997}}$	1.19	0.89	3.95**	2.00	1.48	1.11	1.70	1.21
Month Dummies								
$\boldsymbol{D}_{\text{Oct,1996}}$ (a)	-0.82	0.85	-1.37	2.00	-1.88	1.10	0.25	1.09
$\boldsymbol{D}_{\text{Nov,1996}}$ (b)	0.99	0.81	2.28	2.22	1.18	1.06	1.28	1.10
$\boldsymbol{D}_{\text{Dec,1996}}$ (c)	-0.13	0.86	-0.27	2.05	0.39	1.10	-0.74	1.13
$\boldsymbol{D}_{\text{Apr,1997}}$ (d)	-0.57	0.93	-0.36	1.94	-0.36	1.17	-0.80	1.22
(a)+(b)+(c) (p-value for F-test)	0.04 (0.97)		0.36 (0.62)		0.23 (0.81)		0.23 (0.55)	
Implied IES (=(d) divided by 2.39) [95% Conf. Interval]	-0.24 [-1.01, 0.53]		-0.15 [-1.75, 1.45]		-0.15 [-1.11, 0.81]		-0.34 [-1.34, 0.67]	
Sample Period	1992-2002		1992-2002		1992-2002		1992-2002	
Sample Group	Working		No Job		Higher Income		Lower Income	
Observations	539,073		107,827		311,837		335,063	

Note: This table presents estimates from a regression based on Equation (6). The dependent variable is the first difference of the logarithm of monthly household expenditures. Standard errors are robust to serial correlation within households over time. All columns report OLS regressions, which include, in addition to variables in the table, the first difference of month dummies, age of household head the first differences of the following variables: indicators for each interview; the number of household members, working members, members under age 18, and members over the age of 65. *, **, and *** represent significance at the 10, 5, and 1 percent level, respectively.

TABLE I.5. ARBITRAGE EFFECTS FOR STORABLES AND DURABLES

	Non-storable non-durable (multiplied by 100)		Storable non-durable (multiplied by 100)		Durables (multiplied by 100)	
	(1) (Regression (3) in Table 2)		(2)		(3)	
	Coef.	Standard error	Coef.	Standard error	Coef.	Standard error
First Difference of Month dummies						
$\Delta\boldsymbol{D}_{\text{Feb,1997}}$	-1.10	0.78	0.01	0.87	7.16	3.40
$\Delta\boldsymbol{D}_{\text{Mar,1997}}$	0.56	0.91	10.06***	0.97	21.89***	3.71
$\Delta\boldsymbol{D}_{\text{Apr,1997}}$	-0.89	0.94	-3.80***	1.01	-0.35	3.72
$\Delta\boldsymbol{D}_{\text{May,1997}}$	-1.54*	0.90	-0.73	0.91	2.07	3.24
$\Delta\boldsymbol{D}_{\text{Jun,1997}}$	0.06	0.78	1.21	0.83	6.93**	2.94
p-value for F-test for All $\Delta\boldsymbol{D}$ =0	0.139		0.00***		0.00***	
Month Dummies						
$\boldsymbol{D}_{\text{Oct,1996}}$ (a)	-0.93	0.78	1.13	0.85	0.78	3.13
$\boldsymbol{D}_{\text{Nov,1996}}$ (b)	1.21	0.76	-1.91**	0.88	-4.02	2.95
$\boldsymbol{D}_{\text{Dec,1996}}$ (c)	-0.05	0.79	1.58*	0.94	3.41	3.03
$\boldsymbol{D}_{\text{Apr,1997}}$	-0.71	1.15	-2.43*	1.28	-8.13*	4.72
Sample Period	1992-2002		1992-2002		1992-2002	
Sample Restriction	Yes		Yes		Yes	
Observations	646,900		646,900		646,900	

Note: This table presents estimates from a regression based on Equation (6). The dependent variable is the first difference of the logarithm of monthly household expenditures. Standard errors are robust to serial correlation within households over time. All columns report OLS regressions, which include, in addition to variables in the table, the first difference of month dummies, age of household head the first differences of the following variables: indicators for each interview; the number of household members, working members, members under age 18, and members over the age of 65. *, **, and *** represent significance at the 10, 5, and 1 percent level, respectively.

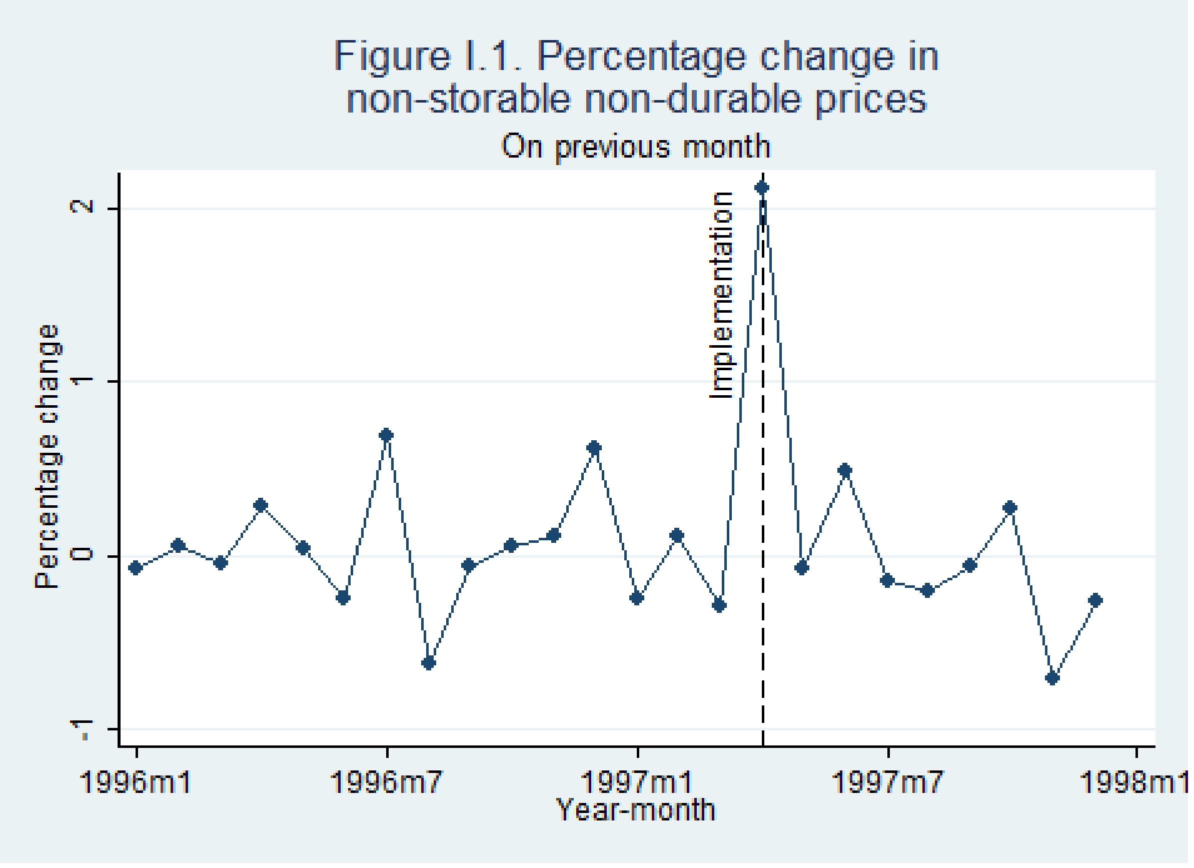


Figure I.1 presents the month on month percentage change in seasonally-adjusted non-storable non-durable prices. To remove seasonality, we regress the consumer price index for non-storable non-durable goods and services on month dummies. The residuals are added to the constant in the regression to obtain a seasonally-adjusted price index. We then calculate the percentage change from one month to the next in the seasonally-adjusted price index. The dashed vertical line in the figure is April 1997, the month of implementation.

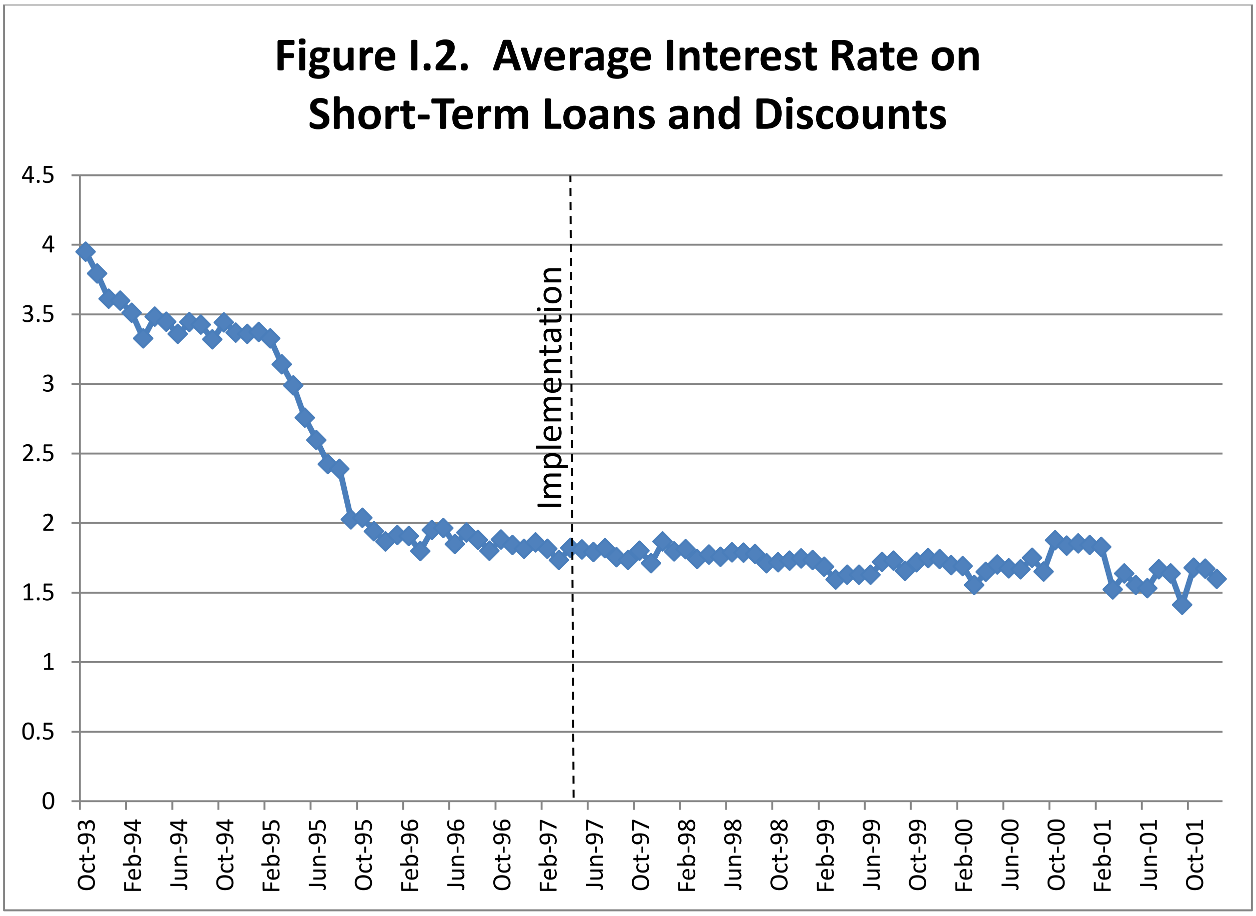
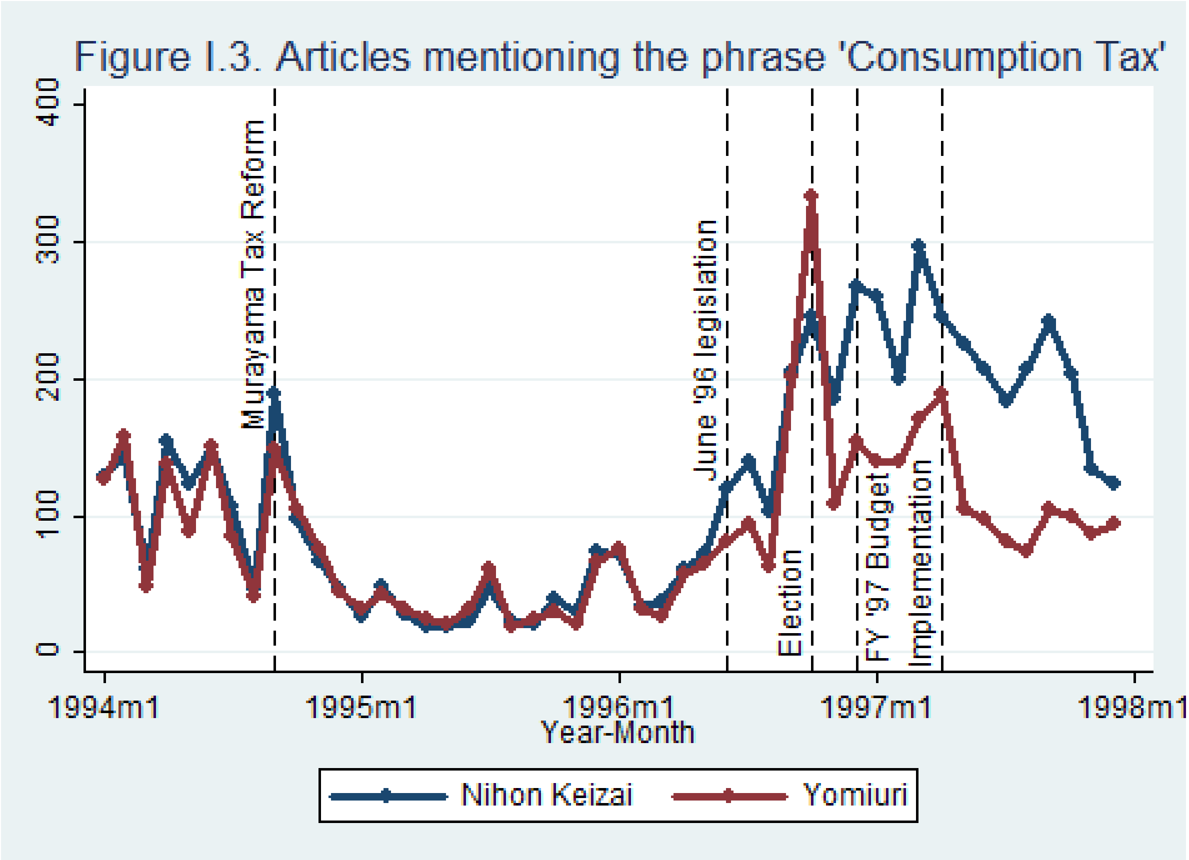


Figure I.2 presents the average contracted interest rate on short-term loans and discounts. These are the average interest rates applied to a contract of less than one year between commercial banks and lenders. The data comes from the Bank of Japan.



Source: Authors' calculations. Circulation numbers come from Japan's Audit Bureau of Circulations.

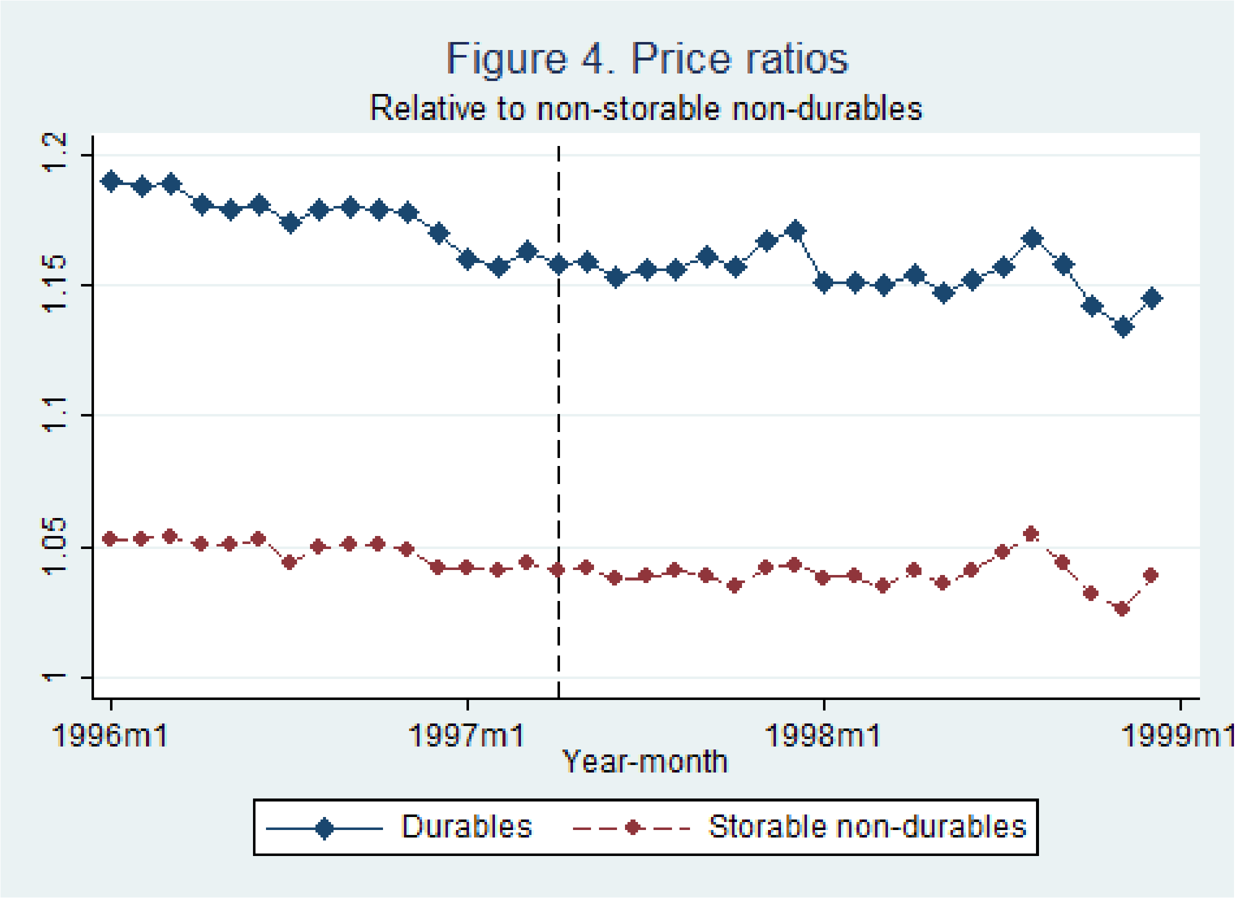
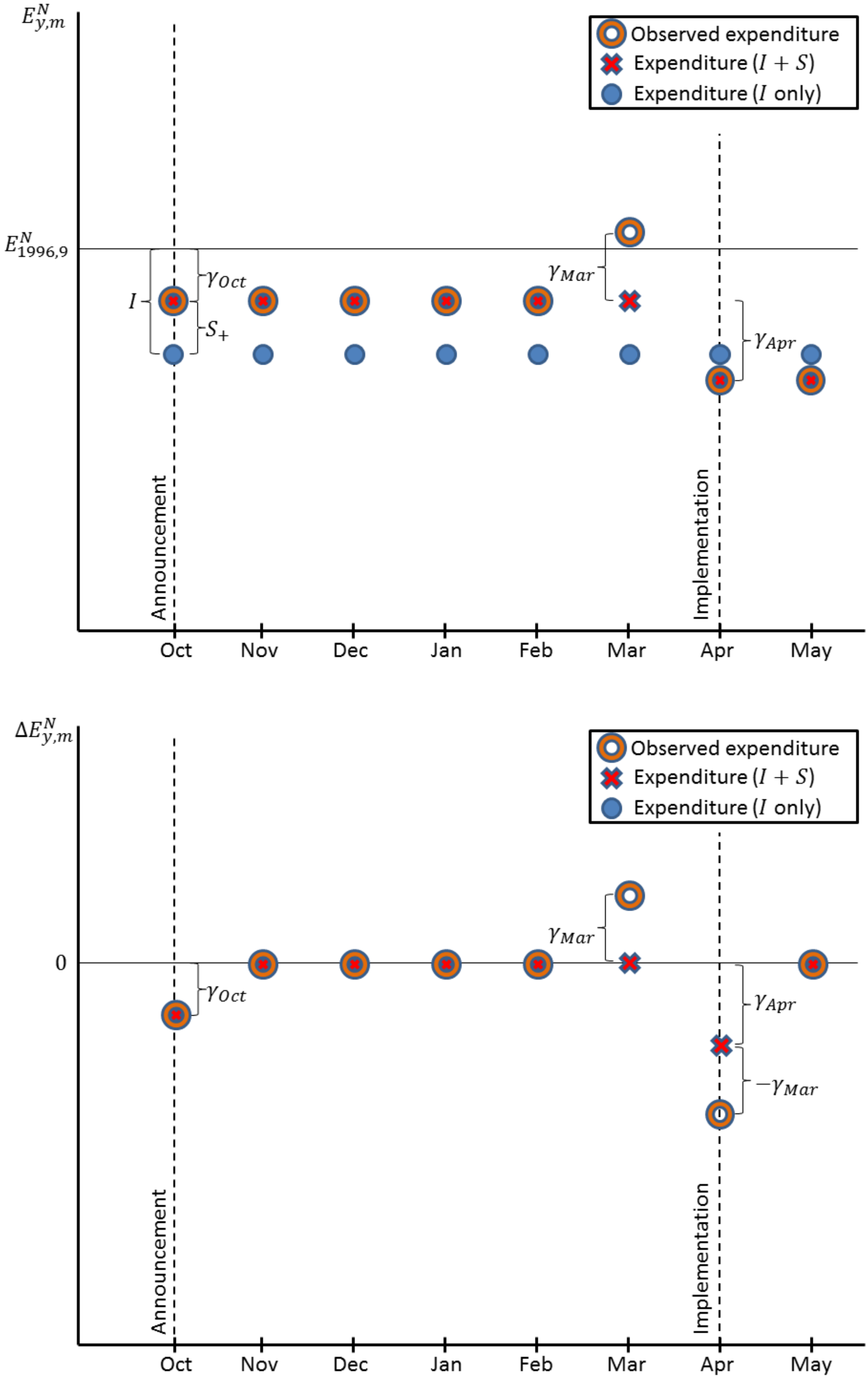


Figure I.4 presents the ratio of seasonally-adjusted durable and storable non-durable prices to non-storable non-durable prices. To remove seasonality, we regress the consumer price indices for durables, storable non-durable, and non-storable non-durable goods and services on month dummies. The residuals are added to the constant in the regression to obtain seasonally-adjusted price indices. To calculate the ratios, we divide the seasonally-adjusted durable and storable non-durable price by the seasonally-adjusted non-storable non-durable price in each month. The dashed vertical line in the figure is April 1997, the month of implementation.

FIGURE I.5. IDENTIFICATION OF THE INTERTEMPORAL SUBSTITUTION EFFECT



Appendix I

TABLE I.A.1. CATEGORIZATION OF GOODS AND SERVICES SUBJECT TO THE VAT

Durables	**Storable Non-Durables**	**Non-Storable Non-Durables**
Tools	Grains (e.g. noodles)	Bread
Cooking appliance	Fish (dried, fish paste)	Fish (fresh)
Refrigerator	Meat (processed)	Meat (raw)
Vacuum	Dairy (e.g. butter)	Dairy (e.g. milk)
Washing machine/dryer	Vegetable (e.g. beans)	Vegetable (fresh)
Other household durables (e.g. microwave)	Fruit (canned)	Fruit (fresh)
Air conditioner	Oils, spices, and seasonings	Cake
Fan heaters	Sugar	Cooked food (e.g. sushi)
Stove	Sweets (e.g. chocolate)	Electricity
Other heating and cooling appliances	Cooked food	Natural gas
General furniture	Beverages (e.g. tea)	Water
Clock	Alcoholic beverages	Gasoline
Lighting	Light bulbs	Flowers
Floor coverings and curtains	Domestic goods (e.g. laundry detergent)	Newspaper
Other interior furnishings	Cloth	Eating out
Bedding	Medicine	Domestic services
Utensils	Medical supplies (e.g. bandages)	Bus fare
Japanese clothing	Stationery	Taxi fare
Western clothing	Film	Airfare
Women’s coats	Recording media (e.g. CD)	Other public transit
Shirts	Pet food	Automotive fees
Underwear	Personal care items (e.g. toothbrush)	Automotive insurance
Other clothing	Tobacco	Telephone service
Footwear	Rail service	Recreational good repair
Automobile		Recreational durable good repair
Other vehicle		Lodging
Bicycle		Package tour
Auto parts		Lesson fees
Telephone		Television service
Textbook		Movie or play admission
Television		Other admissions
Stereo		Other recreational services
Portable audio equipment		Other insurance
Video recorder		Social expenses (e.g. money gifts)
Camera	**(Durables Cont.)**	
Computer	Personal effects (e.g. umbrella)	
Musical instrument	Handbag	
Desk	Accessories (e.g. watch)	
Other recreational durable goods	Other personal effects (e.g. cane)	
Golf equipment	Home repair (e.g. plumbing)	
Other sporting goods	Clothing services (e.g. tailoring)	
Sport outfits	Auto repair	
Toys	Personal care services (e.g. haircut)	
Other recreational goods	Personal effect services (e.g watch repair)	
Books	Personal care item (e.g. hair dryer)	

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CHAPTER II

Characterizing Intertemporal Substitution via Pre-Announced Consumption Tax Increase

Abstract

This study measures intertemporal substitution via pre-announced increase in Japan's VAT rate from three to five percent. Matching the time path of expenditures generated by a dynamic structural model of household consumption to empirical estimates of the intertemporal substitution response to the VAT increase, I find that expenditure is sensitive to a change in the future price level due to accelerated purchases of durables and stockpiling of storables. However, consumption is relatively insensitive. The intertemporal elasticity of substitution in consumption (IES) is 0.13, and is precisely estimated. The results suggest policies that alter the future price level will have a large, but short-lived impact on the timing of household expenditure.

1. Introduction

The sensitivity of household *expenditure* to a change in the future price level is of central importance to macroeconomics and public finance. The more sensitive is expenditure, the greater will be the impact of countercyclical policies that alter intertemporal price levels, such as nominal interest rate adjustments by the monetary authority or adjustments to the tax rate on expenditure (herein referred to as a 'consumption tax') by the fiscal authority. Alternatively, in an economy operating at full employment, the deadweight loss of tax policies that alter intertemporal prices is increasing in the sensitivity of household expenditure.

Cashin and Unayama (2012) take a novel approach to measuring the sensitivity of household *consumption* to a change in the future price level, using a pre-announced increase in Japan's Value Added Tax (VAT) rate from three to five percent as a natural experiment to estimate the intertemporal elasticity of substitution in consumption (IES). With a more appropriate categorization of non-durable goods and services than in previous studies, and an econometric specification that is robust to non-separable preferences over durables and non-durables, their point estimate of the IES is 0.21. This estimate is lower than previous estimates of the IES derived from survey data (e.g. Attanasio and Weber, 1993 and 1995; Vissing-Jorgensen, 2002), but the standard errors are sufficiently large such that the previous estimates cannot be ruled out either.

This study builds on the work of Cashin and Unayama (2012) in two ways. First, it characterizes the sensitivity of both household *consumption* and *expenditure* to the increase in Japan's VAT. For storable (e.g. laundry detergent) and durable (e.g. household appliances) goods, the timing of consumption and expenditure does not necessarily coincide. Storables can be stockpiled during low price periods for consumption in high price periods, while durables can be purchased during low price periods, with most of the flow of services generated by the durable consumed during a high price period. As a result, expenditure on these goods and services should be more sensitive to a change in the future price level than expenditure on (consumption of) non-storable non-durable goods and services. Given that storables and durables comprise a significant share of household expenditure, it is important to account for this behavior in order to fully characterize intertemporal substitution behavior.[1] Second, this study utilizes information on the durable and storable expenditure responses to the VAT rate increase to estimate the IES. Cashin and Unayama (2012) examine only the response of non-storable non-durable expenditure (e.g. dining out) to the tax rate increase. The additional information provided by the durable and storable responses should yield a more precise estimate of the IES.

To characterize the sensitivity of household consumption and expenditure to the VAT rate increase, I match the time path of expenditures generated by a dynamic structural model of household consumption to empirical estimates of the expenditure response. Specifically, using household survey data, I estimate the percentage deviation in durable, storable, and non-storable non-durable expenditures in the months surrounding implementation of the VAT rate increase relative to a base month that followed announcement of the tax rate increase, but preceded implementation. As a result, the estimates should be devoid of any income effect resulting from

[1] Expenditure on durables and storables accounted for 21 and 23 percent of expenditures subject to Japan's VAT during the sample period used in this study.

the tax rate increase, instead capturing only intertemporal substitution effects in the form of stockpiling, accelerated purchases of durables, and intertemporal substitution in consumption. I then employ a dynamic structural model of household consumption that predicts the durable, storable, and non-storable non-durable intertemporal substitution response to the VAT rate increase. The model is governed by parameters such as the intertemporal elasticity of substitution in consumption (IES), the elasticity of substitution between durables and non-durables, and adjustment cost parameters for storables and durables that characterize the sensitivity of household consumption and expenditure to a change in the future price level. The parameter estimates chosen are the set generating a time-path of expenditures that most closely match the empirical estimates of the intertemporal substitution response to the VAT rate increase.

I find that expenditure was sensitive to the VAT rate increase only in the months immediately prior to and following implementation. Durable expenditures were 8 and 22 percent higher in the two months prior to the tax rate increase than they would have been in its absence, dropped sharply following implementation, and returned to trend within a few months of implementation. This suggests that households accelerated purchases that would have otherwise been made after the tax rate increase, and is further supported by the fact that expenditures on goods with higher levels of durability were more sensitive to the VAT increase.

Expenditure on storable goods was nine percent higher in the month prior to implementation than it otherwise would have been, dropped precipitously in the month of implementation, and gradually returned to trend in the ensuing months, indicating that households engaged in a significant amount of stockpiling just prior to the price increase. This point is further bolstered by the fact that expenditures on goods with higher levels of storability were more sensitive to the tax rate increase.

Finally, non-storable non-durable expenditure was 1.51 percent higher in the month prior to the tax rate increase than it would have been in its absence, but showed little variation in other months prior to and following implementation. The lack of variation in expenditure prior to and following implementation suggests that the IES is small. The slight jump in expenditure in the month prior to implementation suggests that durables and non-durables are complements, because the reduction in the user cost of durables in that month coincided with an increase in non-storable non-durable expenditure.

The structural parameter estimates confirm these conjectures. The point estimate for the IES is 0.13, with a 95 percent confidence interval given by [0.05, 0.20]. As expected, the additional information provided by the durable and storable intertemporal substitution responses to the VAT rate increase yields a more precise estimate of the IES. The intratemporal elasticity of substitution between the durable stock and non-durables is estimated to be -0.03, with a 95 percent confidence interval given by [-0.05, -0.01]. While the estimate is slightly negative, it suggests that durables and non-durables are strong complements, which is consistent with recent research by Pakos (2011). Adjustment costs significantly reduce the accelerated purchase of durables and the stockpiling of storables in the month prior to implementation (relative to the frictionless case). For example, the marginal cost of adjustment to the durable stock is 0.28 percent of the average household's monthly income in the month prior to the tax rate increase.

To evaluate the external validity and generalizability of the elasticity and adjustment cost parameter estimates, I then compare the time path of expenditures generated by the model to the response of durable and non-durable (storable and non-storable) retail sales to the July 1989 increase in New Zealand's Goods and Services Tax (GST) rate, which is examined in Cashin (2011). This particular tax rate increase was also announced prior to its implementation, and it featured an increase in the tax rate from 10 to 12.5 percent. The time path of durable and non-durable expenditures generated by the model is similar to the observed response, which suggests the estimates presented in this paper are applicable in other contexts.

Finally, using the structural parameter estimates derived in this study, I predict the potential impact of the recently proposed VAT increase in Japan, which would gradually increase the VAT rate from five to eight percent in April 2014, and then from eight to ten percent in October 2015. I find that the deadweight loss associated with the tax rate increase is just 0.0009 percent of the present value of lifetime steady state expenditure, and is insensitive to the date of announcement.

The results presented in this study suggest that policies that alter the future price level will have a large, but short-lived impact on the timing of household expenditure. Because the IES is small, the deadweight loss associated with pre-announced increases in consumption tax rates will be small.

The remainder of the paper is organized as follows. Section 2 provides background on Japan's April 1997 VAT rate increase, explaining why the pre-announced tax rate increase presents an ideal natural experiment to measure intertemporal substitution behavior. Section 3 provides an overview of the data, empirical specification, and empirical results. Section 4 introduces the model, estimation strategy, and structural parameter estimates. It also presents the validation exercise and marginal excess burden calculation. Section 5 concludes.

2. The VAT Rate Increase: An Ideal Natural Experiment to Estimate the IES

2.1. Japan's VAT and the April 1997 Rate Increase

Japan's 'Consumption Tax' is a VAT. Unlike VAT in many other countries, it has a single flat rate with relatively few exemptions. [2] The VAT was introduced in 1989 at a rate of three percent, and the rate was increased from three to five percent in April 1997. The 1997 VAT rate increase, which is the focus of this study, was originally proposed as a part of the Murayama Tax Reform, which passed through the Japanese Diet in late 1994.[3] Because the primary purpose of the reform was to continue the shift from direct to indirect taxation, the future VAT rate increase was coupled with immediate cuts in income tax rates.

Although the Murayama reform package set a target date of April 1997 for the VAT rate increase, it was unclear whether the increase would actually be implemented then. This is because the reform legislation also stated that the rate increase would be imposed only if the economy had sufficiently recovered from a prolonged recession from 1991 to 1993, and feeble growth thereafter. Having judged the economy to have sufficiently recovered, the ruling Liberal Democratic Party (LDP) decided to raise the tax rate as scheduled. The bill to raise the VAT rate passed through the Upper House on June 25, 1996, and the tax rate increase was scheduled to become effective on April 1, 1997.

Even after this passage, the LDP stated that they would revisit the issue of the tax rate increase when they submitted the fiscal year 1997 budget. The VAT rate increase was the central issue in October 1996 elections to the Lower House of the Diet, with the LDP's opposition

[2] Exemptions included transfer of lease or land, transfer of securities and transfer of means of payment, interest on loans and insurance premiums, transfer of postal and revenue stamps, fees for government services, international postal money orders, foreign exchange, medical care under the Medical Insurance Law, social welfare services specified by the Social Welfare Services Law, midwifery service, burial and crematory service, transfer or lease of goods for physically handicapped persons, tuition, entrance fees, facilities fees, and examinations fees of schools designated by the Articles of the School Education Law, transfer of school textbooks, and the lease of housing units. For additional information on Japan's Consumption tax base and its administration, see Beyer (2000).

[3] For further discussion of the political process, see Ishi (2001) and Takahashi (1999).

promising to shelve the tax rate increase if elected. The LDP narrowly won the election, and on December 26, 1996, the government submitted the fiscal year 1997 budget, which officially increased the VAT rate to five percent on April 1, 1997.

2.2. The VAT Rate Increase as a Natural Experiment

Estimation of intertemporal substitution behavior requires variation in the real interest rate, which is the price of current consumption relative to future consumption. Because the real interest rate is defined as the nominal interest rate minus the expected inflation rate, a change in expected inflation will induce the necessary variation. As a result, the April 1997 VAT rate increase, which represented a plausibly exogenous and expected increase in the future price level during a period in which nominal interest rates and pre-tax prices were stable, presents an ideal natural experiment to estimate intertemporal substitution behavior.

First of all, the tax rate increase can be regarded as a plausibly exogenous change in the future price level. Not only is it the case that the tax system is exogenous from the perspective of individual households, but it is also true that the impact of the tax rate increase is largely independent of consumer behavior. This is because the VAT by and large applies to expenditures regardless of the characteristics of the consumer, the point of purchase, or the type of goods purchased.

While exogenous variation in the real interest rate is a necessary condition for estimating the IES, it must also be the case that households were aware of the change, and expected to bear the burden of the tax rate increase in the form of higher prices upon implementation. While I do not provide direct evidence on household awareness of the VAT rate increase, indirect evidence is available in the form of news coverage regarding the VAT rate increase prior to its implementation. Figure II.1 reports the number of articles per month that mention the phrase ‘Consumption Tax’ in the Nihon Keizai Shimbun, Japan’s leading business newspaper with a circulation of over three million (in 2010), and the Yomiuri Shimbun, a leading non-business newspaper with a circulation of over 10 million (in 2010).[4] There was a steady upward trend that began just prior to enactment of the June 1996 legislation. Coverage peaked in the Yomiuri Shimbun in October 1996, which coincided with elections to the Lower House of the Diet. Overall coverage in both papers was consistently high in the months following the election but

[4] Circulation numbers come from Japan’s Audit Bureau of Circulations.

prior to the tax change, with nearly 300 articles in the Nihon Keizai Shimbun mentioning the 'Consumption Tax' in March 1997. This suggests that households were aware of the tax rate increase and might therefore engage in intertemporal substitution behavior.

The news coverage also suggests that households were aware of the effects of the Murayama reform package as a whole. Figure II.1 shows that coverage initially peaked in September 1994, which coincided with the passage of the Murayama reform package. Accordingly, households may have known about the VAT rate increase well in advance of its implementation, and furthermore, that it was intended to be compensated in the form of the front-loaded income tax cuts. As a result, one might expect any income effect associated with the VAT rate increase to have been small, and to have taken effect well in advance of its implementation. This conjecture is important because it suggests that deviations in expenditure around the time of the VAT rate increase were due solely to intertemporal substitution. Nevertheless, the empirical estimates presented in Section 3.4 will be robust to any income effect that became evident upon 'announcement' of the VAT rate increase, which at the latest would be December 1996, when the tax rate increase became a certainty.

In addition to public awareness of the VAT rate increase, it seems likely that households expected to bear the full burden of the tax rate increase in the form of higher prices at the time of implementation. For one, when the VAT was imposed in April 1989 at a rate of three percent, the price of goods and services that had not previously been subject to tax increased by just under three percent upon implementation. Furthermore, the Japanese government made it clear that they expected consumers to bear the full burden of the VAT increase upon implementation. [5] It is also worth noting that Carroll et al. (2011) find that full forward shifting at the time of a consumption tax rate increase is the norm across most countries, likely as a result of factor price rigidities.

This appears to be true in Japan's case as well. The bottom right graph in Figure II.2 shows the seasonally-adjusted month-to-month percentage change in the consumer price index for all goods and services subject to the VAT. While inflation was negligible in most months

5 When the VAT was introduced in 1989, the government took several steps to ensure this outcome. First, a Special Council on the Transition was formed to promote enforcement of the VAT across agencies. Second, the government carried out an extensive advertising campaign to allay the public's fear of price hikes and to restrain overcharging by traders. A telephone service was also set up so consumers could report complaints about prices. Finally, the Economic Planning Agency increased the budget for the price monitoring system. The situation was nearly identical in 1997.

prior to and following implementation of the tax rate increase, the price level increased by just under two percent between March and April 1997, which is consistent with full forward shifting of the two percentage point tax rate increase onto consumers at the time of implementation. As a result, focus can be placed on a one-time price change, and I can ignore the influence of an additional factor (i.e. variation in pre-tax prices) that affects the real interest rate.

Also note that the VAT rate increase was nearly pushed onto consumers in full at the time of implementation for all three of the composite goods and services with which this study is concerned. Prices increased by 2.11, 1.67, and 1.82 percent in April 1997 for non-storable non-durables, storables, and durables, respectively. Consequently, I do not need to concern myself with intratemporal substitution resulting from relative price changes between the composite goods and services at the time of the VAT rate increase.[6]

In addition to pre-tax price variation, the influence of the nominal interest rate on the real interest rate around the time of the VAT increase can also be ruled out. Figure II.3 presents the average contracted interest rates on short-term loans and discounts, which are the average interest rates applied to a contract of less than one year between a commercial bank and lender. The average interest rate fell precipitously throughout 1995, but remained relatively constant thereafter. This suggests that households would not have changed their nominal interest rate expectations in the months surrounding implementation of the VAT rate increase. In other words, households should not have expected any changes in nominal interest rates by the central bank that would offset or augment the intertemporal substitution incentives resulting from the tax rate increase. Alternatively, the figure suggests that households did not demand higher nominal interest rates in response to the one-off increase in the price level.

These facts imply that the tax rate increase can be regarded as an exogenous change in the real interest rate, which allows for consistent estimation of the intertemporal substitution response using ordinary least squares (OLS). Previous studies of intertemporal substitution (e.g. Hall, 1988; Attanasio and Weber, 1993 and 1995; Ogaki and Reinhart, 1998) have relied on an instrumental variables approach to address the well-documented endogeneity between the real

[6] Even so, intratemporal substitution between durables and non-durables must still be taken into account. The user cost of durables is an increasing function of the real interest rate. Since the real interest rate falls prior to implementation of the VAT rate increase, so too does the user cost of durables, which could potentially induce substitution between durables and non-durables, biasing the estimate of the IES. See Ogaki and Reinhart (1998) for more information.

interest rate and consumption growth.[7] However, there are several potential issues with the instruments that have been employed. First, as Yogo (2004) notes, it is notoriously difficult to predict the real interest rate, and therefore, some of the previous studies in this literature (especially those using aggregate data) suffer from the weak instrument problem. Weak instruments lead to estimates of the IES biased in the direction of OLS, which itself is likely to suffer from a downward bias.[8,9] Furthermore, Attanasio and Weber (1993, 1995) show that studies using lagged instruments and aggregate non-durable expenditure data suffer from a downward bias in estimates of the IES known as aggregation bias. [10] This study avoids these issues by using an exogenous institutional price change.

To summarize, the April 1997 VAT rate increase presents an ideal natural experiment to estimate the IES for the following reasons: the tax rate increase can be regarded as a plausibly exogenous change in the real interest rate; the tax rate increase was predictable and consumer awareness was high; households could reasonably expect to bear the full burden of the tax rate increase in the form of higher prices, and did; other factors affecting the real interest rate were relatively stable prior to and following implementation; and there was little to no change in the relative price between durables, storables, and non-storable goods and services around the time of the tax rate increase.

3. The Intertemporal Substitution Response to the VAT Rate Increase

3.1. Data

[7] For example, an increase in the real interest rate will induce an income effect in addition to the intertemporal substitution effect. If households are net savers, then failure to account for the innovation in income will lead to an OLS estimate of the IES that is biased downwards (see Appendix Figure A.1 for a simple demonstration in a two-period setting).

[8] Two stage least squares (2SLS) estimators using weak instruments are biased in the direction of OLS for the following reason. Suppose the structural equation is given by $y_i = \beta x_i + \eta_i$, and the first stage equation by $x_i = \pi z_i + \xi_i$. If π is truly zero due to weak instruments, then any variation in the predicted value of x_i, $\hat{x}_i$, will come from ξ_i. It follows that the variation in $\hat{x}_i$ is no different from the variation in x_i, and the OLS and IV estimates are estimating the same quantity on average. For more information, see Pischke (2010).

[9] Using OLS, Gruber (2006) obtains an estimate of the IES of -0.55, which is significantly less than his estimates when instrumenting for the after-tax real interest rate. Vissing-Jorgensen (2002) finds that estimates of the IES converge towards zero as the number of instruments is increased. This is because the weak instrument problem is increasing in the degree of overidentification.

[10] Attanasio and Weber (2010) sum up aggregation bias as follows: "The aggregate consumption growth rate is computed by taking logs of the mean of individual consumption, whereas [the log-linearized Euler equation] implies that means of the logs should be taken instead…the difference between these two terms is highly serially correlated, thus invalidating lagged consumption growth as an instrument."

The Japanese Family Income and Expenditure Survey (JFIES) is used to estimate the intertemporal substitution response to the VAT rate increase.[11] The JFIES is a rotating panel survey in which households are interviewed for six consecutive months, and approximately 8,000 households are interviewed each month.[12]

The estimates make use of JFIES data from the period between April 1992 and March 2002, a symmetric five-year window around the April 1997 tax rate increase. Data from the "bubble" period (before April 1992) are excluded because household expenditures grew at a much faster pace than they did after the bursting of the economic bubble in 1991, while remaining more or less flat after that. The sample period ends in March 2002, which coincided with the beginning of another boom.

The sample is limited to households who complete all six interviews, but nearly all households can be used, as the response rate of the JFIES is quite high. Although data for agricultural households is available in the JFIES after 1999, they are excluded from the analysis to maintain consistency over the sample period. Also, the analysis restricts the sample to male-headed households and those whose head does not change his job. The latter restriction is imposed because March is the end of the fiscal year in Japan. As a result, several job changes are observed, which may cause systematic changes in consumption around the time of the VAT rate increase. After imposing the sample restrictions, the dataset includes 646,900 observations from 129,380 households. Table II.1 presents summary statistics for the sample.

The JFIES expenditure data is highly disaggregated by item type, which allows for an accurate categorization of goods and services. For the purposes of this study, it is critical to distinguish not only between taxable and tax-exempt goods and services, but also between durables, storables, and non-storable non-durables.

To construct the expenditure data, expenditure on goods and services that are not subject to the VAT are excluded. As shown in Table II.1, expenditure on taxed items comprised 70% of

[11] See Stephens and Unayama (2011, 2012) for more information regarding the JFIES design and content.
[12] Until 2002, single-person and agricultural households were excluded from the JFIES. As of the 2009 JFIES, single-person households comprised 11.8 percent of the population and were responsible for 18.1 percent of expenditures, while agricultural households accounted for 2.0 percent of the population, and 2.1 percent of expenditures.

total expenditure, while most tax-exempt expenditure consists of rent for housing and education (e.g. tuitions for school).[13]

The second step is to divide goods and services that are subject to the VAT into three sub-categories: durables (D), storables (S), and non-storable non-durables (N). N are defined as goods and services which are neither storable nor durable. That is, they depreciate relatively quickly over time when not in use, and when in use, are fully consumed. For example, fresh fruit, if not eaten, will spoil, and is fully consumed with use. This category also includes services such as taxi fare and dining out, which are consumed at the point of purchase. It follows that monthly expenditure on N should approximately coincide with monthly consumption of N.

S are defined as goods and services that depreciate slowly over time if not used and fully if used. For example, laundry detergent can be stored for long periods of time with little to no effect on its ability to clean clothing, but once it is put into use, whatever amount was used has been fully consumed. This category also includes public transit (rail and bus) passes, due to the fact that many Japanese households purchase passes which are good for train travel for several months after first use. Thus, one might expect that a household would purchase a pass good for several months during a low price period, and begin using the pass during a relatively high price period. More generally, the characteristics that define S allow for stockpiling during low price periods in order to consume in relatively high price periods. As a result, monthly expenditure on S does not necessarily coincide with consumption, and expenditure on S should be more sensitive to changes in intertemporal prices than N.

Finally, D are defined as goods and services which depreciate relatively slowly over time if not used and do not depreciate fully with use. This category includes traditional durables such as refrigerators and automobiles, as well as goods such as clothing and footwear that are classified as semi-durables in the JFIES. In addition, this category includes a select group of services such as home repair and tailoring, which consumers derive benefits from long after the service is provided. Like S, expenditure on D should be more sensitive to changes in intertemporal prices than N. This is because D can be purchased during a low price period, with

[13] I do not use tax-exempt goods and services as a control group because they are largely necessities, and as such, are unlikely to respond to changes in economic circumstances in the same manner that taxable items would.

most of its service flow consumed during a relatively high price period.[14] See Appendix Table II.A.1 for a complete categorization of N, S, and D.

Monthly expenditures on N, S, and D are then deflated using tax-inclusive consumer price indices specific to each category.[15] The analysis thus makes use of real monthly expenditures for Japanese households from April 1992 through March 2002. Table II.1 shows that more than half of taxable expenditure is on N, while expenditure on S and D is similar.

3.2. Empirical Model

Suppose that the logarithm of real monthly expenditure by household h on good-type $j \in \{D, S, N\}$ in year y and month m can be expressed as

$$\ln E^j_{h,y,m} = \mu^j_h + \boldsymbol{\delta^j_m Z_m} + \boldsymbol{\phi^j X_{h,y,m}} + \boldsymbol{\gamma^j_{y,m} D_{y,m}} + B^j_{y,m} + \epsilon^j_{h,y,m} \qquad (1)$$

where μ^j_h is a household fixed effect; $\boldsymbol{Z_m}$ is a vector of month dummies intended to capture seasonality effects; $\boldsymbol{X_{h,y,m}}$ is a vector of (potentially) time-varying household characteristics, including the number of household members, the number of workers, the number of household members under the age of 18, the number of household members over age 65, and interview dummies, which control for "survey fatigue", the tendency of households to report lower expenditure in later interviews; $\boldsymbol{D_{y,m}}$ is a vector of dummies for months surrounding the VAT rate increase, where $\boldsymbol{\gamma^j_{y,m}}$, a vector of the coefficients of interest, are intended to capture the (approximate) percentage deviation in expenditure on good j relative to some base month, which in practice is the month preceding the first $D_{y,m}$ dummy;[16] $B_{y,m}$ accounts for aggregate factors other than the tax rate increase that impact household expenditure, such as the business cycle and other policies that impact household expenditure; and $\epsilon^j_{h,y,m}$ accounts for unobservables that impact monthly household expenditures on good-type j.

[14] Barrell and Weale (2009) refer to this as an 'arbitrage' effect.
[15] In particular, Laspeyres price indices are constructed for each of the four categories using item-specific price indices and expenditure shares in 1990 for each of these items as the weights.
[16] Halvorsen and Palmquist (1980) demonstrate that in regressions with a logarithmic dependent variable, it is incorrect to interpret the coefficient on a dummy variable multiplied by 100 as the percentage effect of that variable on the variable being explained. Nonetheless, when the coefficients on the dummy variables are close to zero, as is the case in this study, multiplying the coefficient by 100 provides a good approximation to the actual percentage effect of the variable on the variable being explained.

Taking the first difference of (1) removes the household fixed effect, which yields

$$\Delta \ln E^{j}_{h,y,m} = \boldsymbol{\Delta}(\boldsymbol{\delta^{j}_{m} Z_{m}}) + \boldsymbol{\phi^{j} \Delta X_{h,y,m}} + \boldsymbol{\Delta}(\boldsymbol{\gamma^{j}_{y,m} D_{y,m}}) + \Delta B^{j}_{y,m} + \Delta \epsilon^{j}_{h,y,m} \qquad (2)$$

In order to separately identify the impact of the VAT rate increase on household expenditures from the impact of changes in $B^{j}_{y,m}$, additional restrictions must be placed on $B^{j}_{y,m}$. Suppose that $B^{j}_{y,m}$ follows either of the two conditions listed below:

1) There is no change in $B^{j}_{y,m}$ from one month to the next.
2) $B^{j}_{y,m}$ follows a linear trend.

Under condition (1), the term $\Delta B^{j}_{y,m}$ drops out, while under condition (2), the term $\Delta B^{j}_{y,m}$ becomes a constant, c^{j}. More generally, if there is little change in $B^{j}_{y,m}$ other than the linear trend, (2) can be rewritten as

$$\begin{aligned} \Delta \ln E^{j}_{h,y,m} &= c^{j} + \boldsymbol{\Delta}(\boldsymbol{\delta^{j}_{m} Z_{m}}) + \boldsymbol{\phi^{j} \Delta X_{h,y,m}} + \boldsymbol{\Delta}(\boldsymbol{\gamma^{j}_{y,m} D_{y,m}}) + (\Delta B^{j}_{y,m} - c^{j} + \Delta \epsilon^{j}_{h,y,m}) \\ &= c^{j} + \boldsymbol{\Delta}(\boldsymbol{\delta^{j}_{m} Z_{m}}) + \boldsymbol{\phi^{j} \Delta X_{h,y,m}} + \boldsymbol{\Delta}(\boldsymbol{\gamma^{j}_{y,m} D_{y,m}}) + \Delta \nu^{j}_{h,y,m} \qquad (3) \end{aligned}$$

where $\Delta \nu^{j}_{h,y,m}$ is composed of $\Delta \epsilon^{j}_{h,y,m}$ and perturbations in $\Delta B^{j}_{y,m}$ from c^{j}.

3.2. Empirical Specification

Recall that Japan's VAT rate increase took effect in April 1997. I am therefore interested in (percentage) deviations in expenditure in the months prior to and following April 1997. These deviations will inform us of the nature of intertemporal substitution, such as whether it is driven by changes in the timing of consumption (i.e. intertemporal substitution in consumption), changes in the timing of expenditure (e.g the stockpiling of storables), or both, and will be used in conjunction with the dynamic structural model of household consumption introduced in the next section to generate the structural parameter estimates.

The baseline specification used to generate the empirical estimates of the expenditure response to the VAT rate increase is

$$\Delta \ln E^{j}_{h,y,m} = c^{j} + \boldsymbol{\Delta(\delta^{j}_{m} Z_{m})} + \boldsymbol{\phi^{j} \Delta X_{h,y,m}} + \sum_{y=1997,m=1}^{y=1997,m=12} \Delta(\gamma^{j}_{y,m} D_{y,m}) + \Delta \nu^{j}_{h,y,m} \qquad (4)$$

where $\gamma^{j}_{y,m}$ is the average percentage deviation in household expenditures on good-type j in year y and month m relative to December 1996, after controlling for household fixed effects, a linear trend in expenditure growth, seasonality, and time-varying household characteristics. [17, 18] I choose December 1996 as the base month against which expenditure in the months surrounding the VAT rate increase are compared because it coincided with passage of the fiscal year 1997 budget, which made the tax rate increase a certainty, and because news coverage of the proposed tax rate increase had been high for the previous few months. Therefore, households knew that the tax rate increase would be implemented in April 1997 as planned, and should have responded accordingly no later than December 1996. This further implies that the $\gamma^{j}_{y,m}$ will capture only the stockpiling, accelerated durable purchase, and (negative) intertemporal substitution in consumption effects associated with the VAT rate increase, as intended. Nonetheless, it is worth noting that the empirical estimates and the structural parameter estimates presented in Section 5 are robust to the choice of earlier base months as well. [19]

Assuming that I have properly controlled for any income effect associated with the VAT rate increase, in order to make the assertion that $\hat{\gamma}^{j}_{y,m}$ is capturing only the intertemporal substitution effects resulting from the VAT rate increase, it must also be the case that $\Delta B^{j}_{y,m} \approx c$. Otherwise, $\hat{\gamma}^{j}_{y,m}$ will be biased upwards when there is a significantly positive change in $\Delta B^{j}_{y,m}$, and vice versa. As a result, I do not utilize the estimates of $\gamma^{j}_{y,m}$ beyond July 1997 in the structural estimation procedure described below. There are two reasons for this. First, household expenditures on N increased significantly in the third quarter of 1997. I suspect that

[17] To avoid taking the logarithm of zero, monthly durable expenditure is set to ¥100, or approximately U.S. $1, in months that a household reported zero expenditure on durables. The results are robust to different choices of minimum durable expenditure values (e.g. ¥1 or ¥1000). Overall, 94 percent of the monthly observations report positive durable expenditures.

[18] As a robustness check, year dummies were also added to the empirical specification given in Equation (4). These dummies capture average monthly growth rates in household spending within a year relative to the omitted year (captured by c), and are important if growth rates varied considerably over the sample period. I find that inclusion of year dummies does not significantly impact the results of the baseline specification. Furthermore, it is worth noting that the standard errors are panel-robust.

[19] In particular, I chose October 1996, the election month that made the tax rate increase a relative certainty, as an alternative base month.

this is due to unseasonably warm weather that summer that lead to high cooling costs, but I do not yet have the data to test this hypothesis. Second, and more important, is the impact of the Japanese banking crisis, which began in November 1997 and likely had a negative impact on household expenditure at the end of 1997 and beyond. The structural estimation will thus make use of the estimates of $\gamma_{y,m}^{j}$ from January 1997 through July 1997.

3.3. Identification of $\gamma_{y,m}^{j}$

It may not be readily apparent how first differenced year-month dummies for the months surrounding the VAT rate increase identify $\gamma_{y,m}^{j}$. Figure II.4 demonstrates how they do so. In the top portion of this hypothetical example, a household engages in stockpiling in March 1997, the month prior to implementation, which leads to an increase in storable expenditure relative to previous months, and is captured by γ_{Mar}. In April 1997, there is an equal and offsetting stockpiling effect, as well as the (negative) intertemporal substitution in consumption effect. The combined impact of these two effects is captured by γ_{Apr}.

When taking the first difference of expenditure, as depicted in the bottom portion of Figure II.4, it is clear that inclusion of a dummy variable for April 1997 will yield a coefficient equal to $\gamma_{Apr} - \gamma_{Mar}$ rather than γ_{Apr}. The solution to this problem is to difference out the effect from the previous month. In practice, this means including the first difference of the March 1997 dummy in the empirical specification, rather than just a March 1997 dummy. That is, a dummy that takes on a value of 1 in March 1997 and a dummy that takes on a value of -1 in March 1997, with the dummies sharing a common coefficient. Doing so, the April 1997 dummy will capture γ_{Apr} as intended.[20]

3.4. Empirical Estimates of the Intertemporal Substitution Response to the VAT Rate Increase

Figure II.5 presents estimates of $\gamma_{y,m}^{j}$ for durables, storables, and non-storable non-durables for January to July 1997, along with the corresponding 95 percent confidence intervals. On average, there was little change in non-storable non-durable expenditures prior to and following implementation of the VAT rate increase. Note, however, that non-storable non-durable expenditures were 1.51 percent higher in March 1997 than they otherwise would have been, which is significant at the ten percent level. Given that the user cost of durables fell in the

[20] The empirical specification is robust to non-symmetric stockpiling effects as well.

same month, this result suggests that durables and non-durables are complements, while the lack of variation in expenditures prior to and following implementation suggests the IES is small. The intuition for both conjectures is discussed further in Section 4.4 with the aid of the model.

The top right graph in Figure II.5 shows the intertemporal substitution response for storables. Expenditure in March 1997 was nine percent higher than it otherwise would have been. In April 1997, storable non-durable expenditure was 7 percent lower than it would have been in the absence of the VAT rate increase, and gradually increased over the next few months. This pattern suggests that households stockpiled goods just prior to implementation, and then consumed from their storable inventory over the next few months.

This explanation is further reinforced by comparing the intertemporal substitution response for storable non-durables that possess different levels of storability. Figure II.6 examines the response of domestic household goods (e.g. laundry detergent, toilet paper), personal care items (e.g. medicine, shaving cream), beverages (alcoholic and non-alcoholic), and storable foods (e.g. butter, noodles, yogurt) to the VAT rate increase. Domestic household goods and personal care items are storable for long periods of time, while beverages and foods are storable for a relatively shorter period. As Hendel and Nevo (2006) note, this is at least in part because storability for the latter groups decreases once the container or packaging is opened. I find that expenditure is more sensitive for goods with higher levels of storability, which is consistent with the consumer inventory model of stockpiling behavior (see Hendel and Nevo, 2004 and 2006). It is also worth noting that there was a highly significant intertemporal substitution response for public transit passes in March 1997, as hypothesized in Section 3.1.

The bottom left graph in Figure II.5 presents estimates of the durable intertemporal substitution response. Expenditures in the final two months prior to implementation were 8 and 23 percent higher than they otherwise would have been. Expenditure in April 1997 was 13 percent lower than it would have been in the absence of the VAT rate increase, and gradually returned to trend over the next few months. This pattern is consistent with accelerated purchases of durables that would have otherwise been bought after the tax rate increase.

Figure II.7 lends further support to this conjecture. Note that the intertemporal substitution response in March 1997 was largest for furniture and household appliances, followed by consumer electronics, with almost no response for automobiles. Perhaps not coincidentally, there is some evidence of an inverse relationship between the expenditure response observed in March 1997 and the depreciation rate estimates associated with each good type in Fraumeni (1997).[21] All else equal, a dynamic model of durable consumption would predict that expenditure in the month prior to implementation would be more sensitive for goods with lower depreciation rates, and the estimates in Figure II.7 are generally consistent with this prediction. Finally, it is interesting to note that the dip in durable expenditures in July 1997 is due primarily to a reduction in expenditures on household appliances, and specifically, air conditioners. This suggests that households were forward looking enough to purchase air conditioners in March 1997 that would not be used until later in the year.

In summary, the empirical results suggest that the timing of expenditure was sensitive to the VAT rate increase, but the timing of consumption was not. And while expenditure did respond to the price change, the response was confined to the months immediately preceding and following implementation.

4. Characterizing the Intertemporal Substitution Response to the VAT Rate Increase

4.1. The Household's Problem

This section develops a dynamic model of household consumption of durables, storables, and non-storable non-durables that mimics the environment that characterized the Japanese economy around the time of the VAT rate increase. Its purpose is to allow for the estimation of structural parameters that fully characterize the intertemporal and intratemporal substitution response to the VAT rate increase. Furthermore, unlike the standard approach to estimation of the IES, the model will allow me to incorporate the storable and durable expenditure responses into the estimate of this important policy parameter, allowing for more precision.

The model is constructed as follows. In each period t, taken here to be one month, a representative household chooses non-storable non-durable consumption, C_t^N; storable consumption, C_t^S; storable expenditure, X_t^S; the stock of storables, S_t, that will be carried over into period $t+1$; the durable stock, D_t, which provides a flow of consumption services; durable expenditure, X_t^D; and financial assets, A_t, to maximize the present value of expected lifetime utility subject to the budget constraint, laws of motion for S_t and D_t, and stochastic processes for the tax rate on expenditure, τ_t, and income, Y_t. Formally, the household solves

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[21] Specifically, the annual rates of depreciation given in Fraumeni (1997) are the following: furniture (0.12), household appliances (0.15), home electronic equipment (0.18), and motor vehicles (0.17).

$$\max \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\frac{1}{\sigma}}\right) \left(\left[(1-\psi^D)^{\frac{1}{\epsilon^D}} \left\{ \left[(1-\psi^S)^{\frac{1}{\epsilon^S}} C_t^{N^{1-\frac{1}{\epsilon^S}}} + \psi^{S\frac{1}{\epsilon^S}} C_t^{S^{1-\frac{1}{\epsilon^S}}} \right]^{\frac{\epsilon^S}{\epsilon^S-1}} \right\}^{1-\frac{1}{\epsilon^D}} + \psi^{D\frac{1}{\epsilon^D}} D_t^{1-\frac{1}{\epsilon^D}} \right]^{\frac{\epsilon^D}{\epsilon^D-1}} \right)^{1-\frac{1}{\sigma}}$$

subject to

1) $A_t = (1+i)A_{t-1} + Y_t - (1+\tau_t)(C_t^N + X_t^S + X_t^D) - \frac{\zeta^D}{2}(D_t - D_{t-1})^2 - \frac{\zeta^S}{2}(S_t - S^*)^2$

2) $S_t = S_{t-1} + X_t^S - C_t^S$

3) $D_t = (1-\delta)D_{t-1} + X_t^D$

4) $\tau_t = \tau_{t-1} + \epsilon_{t-l}^{\tau}$

5) $Y_t = Y_{t-1} + \epsilon_{t-l}^{Y}$

Intertemporal preferences are assumed to be iso-elastic and governed by the IES, σ, which is one of the parameters to be estimated. Note that the value of σ will be determined by changes in C_t^N, C_t^S, and D_t in response to the VAT rate increase. As noted earlier, a potential advantage of the approach employed in this study is that information from consumption of all three goods will be used to determine σ. While C_t^S and D_t are not directly observable, their values can be inferred using observable expenditures, X_t^S and X_t^D, in conjunction with the laws of motion for S_t and D_t.

The intratemporal preference specification is assumed to take a nested constant elasticity of substitution (CES) form. Preferences over the durable stock and a non-durable composite good are governed by ψ^D, a parameter measuring the overall importance of the durable stock in generating utility, and ϵ^D, the elasticity of substitution between durables and non-durables.[22] The value of ϵ^D will also be estimated using the expenditure response to the VAT rate increase. In particular, it is identified off of the change in the durable to non-durable consumption ratio resulting from the reduction in the user cost of durables prior to the VAT rate increase. It is

[22] As in many previous studies of durable goods, such as Bernanke (1985), I assume that the service flow derived from durables is proportional to the durable stock.

worth noting that because I allow for non-separable preferences over durables and non-durables (i.e. ϵ^D is not restricted to be equal to σ), the estimate of σ should be free from intratemporal substitution bias (see Ogaki and Reinhart, 1998).[23] Preferences over the non-durable composite good are also assumed to be of the CES form, where ψ^S is the share of storables in non-durable consumption, and ϵ^S is the elasticity of substitution between storable and non-storable non-durables.[24, 25]

Note that preferences over the durable stock and the non-durable composite good are assumed to be homothetic. In contrast, Pakos (2011) provides evidence that durables are luxuries and non-durables are necessities, and that the assumption of homotheticity when preferences are actually non-homothetic biases estimates of ϵ^Dupward. However, given the relatively short period of time this study concerns itself with, the modest increase in the VAT rate, the fact that the VAT rate increase was intended to be compensated, and that any income effect associated with the tax reform should have occurred prior to the period I am concerned with, the assumption of homotheticity seems innocuous.

The following assumptions are made with respect to prices. The nominal interest rate, i, is constant, since Japan's benchmark nominal interest rate was constant in the years prior to and following the VAT rate increase. The model abstracts from time-varying pre-tax prices on the three composite goods, as the price ratios for these goods were stable during the period of interest. Finally, the burden of the VAT is assumed to fall entirely on the representative consumer in the form of higher prices, which is consistent with Japan's experience and the experience of other countries with a VAT.

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[23] Intratemporal substitution bias is a problem when preferences between durables and non-durables, assumed to be separable, are in fact non-separable, and households substitute between durables and non-durables at the same time they engage in intertemporal substitution. To illustrate, suppose the real interest rate rises. Because the user cost of durables is an increasing function of the real interest rate, the user cost of durables also rises. If durables and non-durables are substitutes, then households will substitute away from durables towards non-durables. Under the assumption of separable preferences, the IES can be identified by examining only the non-durable consumption response. Because households substituted away from durables and towards non-durables when the interest rate is high, the resulting estimate of the IES will be biased downwards.

[24] ψ^S represents a share only if preferences are Cobb-Douglas, or if prices are assumed to be one, as in this study.

[25] The nested CES form restricts the intratemporal elasticity of substitution between storables and durables and non-storables and durables to be the same. To test the validity of this assumption, I used a quadratic specification that allowed for an interaction term between storables and durables, as well as non-storables and durables. After doing so, the implied intratemporal elasticities of substitution between storables and durables and non-storables and durables were similar.

The budget constraint also includes durable and storable adjustment cost functions, both of which take quadratic functional forms.[26] The durable adjustment cost function is intended to capture the time cost of shopping for durable goods and services. This is because a durable purchase is an infrequent event requiring more effort than a non-durable purchase. The adjustment cost is increasing and convex in net expenditure, reflecting the fact that the time devoted to shopping for a durable is likely increasing in expenditure, and the opportunity cost of one's time is an increasing and convex function. The parameter associated with the adjustment cost function, ζ^D, is another parameter which I will estimate based on the expenditure response to the VAT rate increase. It is identified by the difference between the durable expenditure response that would be observed in the months preceding and following implementation (holding the other parameters fixed) in the absence of frictions and the observed response, and is increasing in that difference.

The adjustment cost function for storables depends on two parameters, S^* and ζ^S. S^*, which is assumed to be greater than zero, is a storable inventory bliss point. $S_t > S^*$ generates a cost to the household due to space constraints and the time cost associated with stockpiling. $S_t < S^*$ also generates a cost due to the inconvenience of holding too few storables. For example, there is a time cost associated with having to make a shopping trip to pick up a new tube of toothpaste after the previous tube runs empty. ζ^S is a parameter to be estimated based on the expenditure response to the VAT rate increase. In particular, it will be identified primarily by the difference between the storable non-durable expenditure response in March 1997 that would be observed in the absence of frictions (again holding the other parameters fixed) and the observed response, and is increasing in that difference.

The law of motion for the stock of storables is the same as that used by Hendel and Nevo (2006). Note that the stock of storables carried over from one period to the next does not depreciate. This seems plausible for highly storable items like laundry detergent, but perhaps less so for storable foods that have been opened. In effect, I assume that these foods are fully consumed before they perish. The law of motion for durables is standard and depends on the durable depreciation rate, δ.

[26] Including the adjustment cost functions in the budget constraint rather than the preference specification does not significantly impact the time path of expenditures generated by the model, though it will impact the point estimate for the parameters ζ^D and ζ^S.

The tax rate on expenditure in period t, τ_t, is set equal to last period's tax rate, plus any shock to the tax rate that was announced l periods prior. Recall that Japan's VAT rate increase was part of a compensated tax reform package introduced in September 1994, 31 months prior to its implementation in period t^*. Thus, I set $\epsilon^{\tau}_{t^*-31} = 2$, while $\epsilon_{t-31} = 0$ in all other periods.

The model abstracts away from the income tax cuts that took effect immediately upon passage of the reform package, instead compensating households for the two percentage point increase in the tax rate on expenditure with a 1.94 percent increase in income in period $t^* - 31$. The tax rate increase and the offsetting compensation are known to the representative household well before t^*, and thus any change in expenditure around the time of the tax rate increase that is generated by the model will be attributable to intertemporal substitution.[27]

The model does not account for the labor/leisure decision. This is a simplifying assumption, as I do not have access to monthly labor supply data. In addition, the time period examined is short, and I find it unlikely that households immediately adjusted their labor supply in response to such a modest, and compensated, change in the VAT rate. Finally, recall that households whose job status changed around the time of the VAT rate increase are excluded from the empirical estimates, which further mitigates any impact the VAT rate increase may have had on the labor/leisure decision.

4.2. Econometric Methodology

To estimate the model, the parameters are separated into three groups. The first group includes i, β, ψ^S, δ, ϵ^S, and S^*, which are fixed prior to estimation based on available data. The value of i is set to 0.0015, which corresponds to an annual interest rate of 0.018. This was the average annual interest rate on short-term loans and discounts prior to and following the VAT rate increase (see Figure II.3). β is set such that $\beta(1+i) = 1$, because the model begins in steady state. ψ^S is set to 0.29, which was storable non-durable expenditure as a share of non-durable expenditure in the JFIES in 1996. The value of δ is set to 0.022, which corresponds to an annual depreciation rate of 0.23. This value was computed by combining good-specific annual depreciation rates from Fraumeni (1997) with good-specific expenditure shares on durables from the JFIES. The value of ϵ^S has no impact on the time path of expenditures generated by the

[27] Introducing the VAT rate increase with a shorter lag between announcement and implementation does not significantly impact the time path of expenditures generated by the model in the months immediately surrounding the tax rate increase.

model, because there is no change in the price of storables relative to non-storable non-durables. The output generated by the model is also completely insensitive to the choice of S^*.[28]

The second group of parameters are given by the P x 1 vector $\theta = [\sigma \;\; \epsilon^D \;\; \zeta^D \;\; \zeta^S \;\;]^T$, where $P = 4$ is the number of parameters to be estimated. These parameters will be estimated by minimizing a measure of the distance between the time path of expenditures generated by the model and the empirical estimates presented in Section 3.4., a procedure which I discuss further below.

The third group consists of just one parameter, ψ^D, which can be written as a function of parameters from the first two groups and the ratio of steady state durable expenditure to non-storable non-durable expenditure, $\frac{X^D}{C^N}$. I set this ratio to 0.42, which was the ratio in the JFIES in 1996.[29] Finally, initial income, $Y_0 + iA_0$, is normalized to 1, and the initial tax rate on expenditure is set to $\tau_0 = 0.03$.

To generate a time path of expenditures from the model, the following method is used. Given a full set of model parameters, I first solve for the model's steady state. I then log-linearize the model around its steady state. The shocks to the tax rate on expenditure and income are then introduced. They propagate through the system of equations, generating a time path of percentage deviations in durable, storable, and non-storable non-durable expenditures from their steady state values.

Recall that $\hat{\gamma}$, the vector of $\hat{\gamma}^j_{y,m}$'s to which the time path of expenditures generated by the model will be matched, are percentage deviations in expenditure relative to December 1996, four months prior to implementation of the VAT increase. It follows that in order to make the output generated by the model consistent with the empirical estimates, I must convert the output from percentage deviations in expenditure relative to the steady state to percentage deviations in expenditure relative to expenditure four periods prior to the tax rate increase.[30]

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[28] The difference between S_t and S^*, which is what generates the storage cost, is independent of the magnitude of S^*. Rather, this difference is a function of τ_t, i, and ζ^S. For example, in steady state, $S - S^* = -(1+\tau)\left(\frac{r}{1+r}\right)\left(\frac{1}{\zeta^S}\right)$.

[29] Specifically, $\psi^D = \frac{(1-\psi^S)\left(\frac{1}{\delta}\right)\left(\frac{r+\delta}{1+r}\right)^{\epsilon^D}\left(\frac{X^D}{C^N}\right)}{1+(1-\psi^S)\left(\frac{1}{\delta}\right)\left(\frac{r+\delta}{1+r}\right)^{\epsilon^D}\left(\frac{X^D}{C^N}\right)}$. This expression is obtained by solving for steady state durable expenditure in terms of non-storable non-durable expenditure, and then rearranging and solving for ψ^D.

[30] In practice, this conversion has little impact on the results, because the compensation to the household for the tax rate increase removes the income effect, and the intertemporal elasticity of substitution in consumption is found to

To estimate θ, I use an econometric procedure similar to that employed by Christiano et al. (2005). I conduct a grid search over combinations of θ. $\hat{\theta}$ is the vector of parameter values that minimizes a weighted sum of the squared deviations between the M x 1 vector of time-series output generated by the model, $\gamma(\theta)$, and the M x 1 vector of empirical estimates, $\hat{\gamma}$, depicted in Figure II.5. The estimates are chosen to match the durable, storable, and non-storable non-durable empirical estimates from January through July 1997. Thus, M = 7 months x 3 goods = 21. Formally,

$$\hat{\theta} = \arg\min_{\theta}[\hat{\gamma} - \gamma(\theta)]^T W^{-1}[\hat{\gamma} - \gamma(\theta)] \qquad (5),$$

where W is an M x M matrix that contains the sample variances and covariances of the $\hat{\gamma}_{y,m}^{j}{}'s$, and T is the transpose operator.[31] The sample variances are the basis of the confidence intervals reported in Figure II.5. Standard errors for the structural parameters are estimated using the delta method, which is documented in Appendix B.

4.3. Structural Parameter Estimates

Table II.2 presents point estimates and 95 percent confidence intervals for the model parameters that comprise θ. The estimate of σ is 0.13, with a 95 percent confidence interval given by [0.05, 0.20]. The point estimate is similar to, though slightly lower than, the estimate in Cashin and Unayama (2012). However, the confidence interval is much tighter, as expected. The null hypothesis that the IES is zero can be rejected at conventional levels of significance. The result implies that consumption growth was insensitive to the VAT rate increase.[32]

The point estimate of ϵ^D is small and negative. The value is -0.03, with a 95 percent confidence interval given by [-0.05, -0.01]. The null hypothesis that durables and non-durables are perfect complements (i.e. $\epsilon^D = 0$) is rejected at conventional significance levels. However, the small point estimate suggests that the asssumption of Leontief preferences, where durables

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be small. Thus, there is little difference between steady state expenditure and expenditure four periods prior to the tax rate increase.

[31] The covariances for different goods are assumed to be zero. That is, $cov(\hat{\gamma}_{y,m}^{j}, \hat{\gamma}_{z,n}^{k}) = 0, j \neq k$.

[32] There exists a literature (e.g. Watanabe et al., 2001; Poterba, 1988) which finds that the income effect associated with a tax change does not become evident until implementation. If this is true, then the estimate of σ will be biased upwards, as the fall in expenditure upon implementation will be attributed solely to the intertemporal substitution effect rather than the income effect.

and non-durables are consumed in fixed proportions, is a good starting point when jointly modeling durable and non-durable consumption. In addition, the small point estimate of ϵ^D is consistent with the recent findings of Pakos (2011), who finds a smaller value of ϵ^D than previous studies using aggregate expenditure data (e.g. Ogaki and Reinhart, 1998) after allowing for non-homothetic preferences over durables and non-durables.

The null hypothesis that preferences over durables and non-durables are separable is rejected at all conventional significance levels.[33] This finding suggests that the assumption of separability in previous studies induced bias in the estimates of σ. In particular, given that I find a high level of complementarity between durable and non-durable consumption, previous estimates of σ that assumed separable preferences and were derived from non-durable consumption expenditure data may suffer from an upward bias.

The point estimate for ζ^D, the durable adjustment cost parameter, is 0.09, and is significant at the one percent level. To get a better sense of what this value implies, note that a household will increase its durable stock prior to the VAT rate increase so long as the marginal benefit of adjustment exceeds the marginal cost. As demonstrated in Figure II.8, the marginal benefit of adjustment is decreasing in D_t, which is due to the fact that the marginal utility of the contemporaneous service flow derived from durables is decreasing in D_t, and also because accelerated purchases of durables today implies additional costly adjustments in the future.[34] The marginal adjustment cost is given by $\zeta^D(D_t - D_{t-1})$, and increases linearly in D_t. Substituting the relevant values into the marginal adjustment cost function for March 1997, the month in which durable expenditure was most sensitive to the VAT rate increase, yields a value of 0.0028. That is, the marginal adjustment cost is 0.28 percent of monthly income.

The point estimate for the storage cost parameter, ζ^S, is 1.30, and is significant at the one percent level. A household will continue stockpiling so long as the marginal benefit of doing so exceeds the marginal cost. As shown in Figure II.9, the marginal benefit of stockpiling in March

[33] The Wald test statistic, W, for the null hypothesis $H_0: \sigma = \epsilon^D$ is $W = 9.64$, which exceeds the critical value of 6.63 when the degrees of freedom equals one, and the significance level is one percent.

[34] Specifically, the marginal benefit of adjustment is given by $(1+\tau_t)\frac{U_{D_t}}{U^N_{C_t}} + \left(\frac{1-\delta}{1+r}\right)(1+\tau_{t+1}) - (1+\tau_t) + \frac{1}{1+r}\zeta^D(D_{t+1} - D_t)$. It is decreasing in D_t for two reasons. First, the marginal utility of the service flow provided by durables is decreasing in the durable stock, which can be seen in the first term. Second, increasing D_t implies additional costly adjustment in the future, as shown in the final term.

1997 is constant at $\left(\frac{1+\tau_{t+1}}{1+i}\right) - (1 + \tau_t) \approx 0.02$, since i is small.[35] That is, for every purchase of a storable made in March 1997 rather than April 1997, a household saves approximately two percent on the storable's purchase price. The marginal cost of stockpiling is given by $\zeta^S(S_t - S^*)$. The lower is ζ^S, the greater the amount of stockpiling that will be observed in March 1997.

Recall that several of the model parameters were fixed prior to estimation. While their values were fixed based on the available data, it seems reasonable to test the sensitivity of the structural parameter estimates to different values of the fixed parameters. Table II.3 presents the results of the sensitivity analysis. In general, the structural parameter estimates, including estimates of σ, are robust to alternative fixed parameter values. Given a change in a Group 1 parameter, each new parameter estimate lies within its confidence interval shown in Table II.2.

Figure II.10 plots the time path of expenditures generated by the model against the empirical estimates previously shown in Figure II.5. Overall, the model matches the empirical estimates reasonably well, though the validity of the model is rejected by the test of overidentifying restrictions.[36] Non-storable non-durable expenditures lie entirely within the confidence interval. The model closely matches non-storable non-durable expenditure in the months prior to implementation, but over predicts expenditure in the month following implementation, which could be due to limited arbitrage opportunities for non-storable non-durables (e.g. buying bananas on March 31, 1997, and consuming them in early April) that the model does not allow.

The model closely matches storable expenditure in the months prior to and including implementation, but the match is rather poor in the months following implementation. This is because the model considers only one storable composite good that is costly to store. It follows that the representative household will fully consume the stockpiled storable good in the month of implementation before making any additional purchases. Storable expenditure will then return to a new steady state in the months following implementation. In reality, some households stockpile, while others don't. Among those that do, some stockpile a lot, and others stockpile a little. As a result, there is a gradual return to trend in storable expenditure following implementation that the model is not flexible enough to match.

[35] This expression holds under the model assumptions that $\beta(1 + i) = 1$ and relative pre-tax prices are constant.
[36] The J-statistic equals 71.84, which exceeds the critical value of 33.41 (df = 17, $\alpha = 0.01$).

The time path of durable expenditures generated by the model stays within the 95 percent confidence interval in most months used in the estimation of the structural parameters. Furthermore, the pattern of durable expenditure predicted by the model is generally consistent with the empirical estimates. However, the model under predicts the sensitivity of durable expenditure to the VAT rate increase in February and March 1997, and over predicts the decline in expenditure in April 1997. This is a result of the choice of a quadratic adjustment cost specification, which requires symmetric expenditure responses on either side of the tax rate increase. The model could roughly match the expenditure response in February and March 1997, but if it did, there would have to be a much larger reduction in expenditure in April 1997 than was observed. The estimate of ζ^D is thus a compromise between matching the expenditure response in March without overshooting the decline in expenditure in April 1997. The model also over predicts expenditure in July 1997, though this can be explained primarily by the fact that many households purchased air conditioning units prior to the VAT rate increase that would have otherwise been purchased in July 1997, a month which marks the end of the rainy, relatively cool portion of the summer in Japan.

4.4. Identifying the Structural Parameters

This section provides intuition for the identification and magnitudes of the structural parameter estimates presented in the previous section. Identification of σ and ϵ^D are closely linked. Recall that the user cost of durables fell relative to non-durables prior to implementation of the VAT rate increase. As illustrated in Figure II.11, if $\sigma < \epsilon^D$, one would observe non-storable non-durable expenditures trending downwards in the months prior to implementation, as households substitute away from non-durables to durables, followed by an upward trend thereafter. In addition, Figure II.12 demonstrates that durable expenditures would fall far more drastically upon implementation, and return to trend much more gradually, than was observed. This is because a larger value of ϵ^D will require a greater fall in durable expenditure after implementation in order to restore the original durable to non-durable consumption ratio. If instead preferences are separable over durables and non-durables (i.e. $\sigma = \epsilon^D$), one would observe no change in non-storable non-durable expenditure in the months prior to implementation, and a fall in expenditure upon implementation that remains constant thereafter. Durable expenditures would exhibit a similar, albeit less pronounced, pattern as was the case when $\sigma < \epsilon^D$. Finally, if $\sigma > \epsilon^D$, one would observe an upward trend in non-storable non-durable expenditure in the months prior to implementation (as households increase non-durable consumption to complement durable consumption), a fall in expenditure upon implementation, and a slight decline thereafter. This pattern is largely consistent with the empirical estimates. Durable expenditures would exhibit a far less pronounced decline upon implementation, and a quicker return to trend, which is also consistent with the empirical estimates. Consequently, I find that $\sigma > \epsilon^D$.

Given that $\sigma > \epsilon^D$, what can be said about the magnitude of σ? Figure II.13 illustrates the non-storable non-durable expenditure response for $\sigma = 0.8, 0.4,$ and 0.13 when the other structural parameters are set to their baseline values. Note that the larger is σ, the larger is the fall in non-storable non-durable expenditure following implementation. In addition, Figure II.14 demonstrates that larger values of σ imply that the fall in durable expenditure upon implementation greatly exceeds the spike in expenditure in the month prior to implementation. The empirical estimates in Figure II.13 show that non-storable non-durable expenditure was not noticeably lower following implementation than it was before. The estimates in Figure II.14 show that durable expenditures fell upon implementation, but not by an amount greater than the spike in expenditure in the month prior to implementation. Together, these facts imply that σ is small.

Taking as given that $\sigma > \epsilon^D$ and that σ and ϵ^D are small, Figure II.15 demonstrates that ζ^D is identified primarily by the spike and trough in durable expenditure in the months prior to and including the VAT rate increase. Simply, the larger is ζ^D, the smaller will be the spike and trough in durable expenditure in March and April 1997, respectively. Similarly, the larger is ζ^S, the lower will be the amount of stockpiling in the month prior to implementation, and consequently, the lower will be the jump in storable expenditures.

Finally, previous studies of intertemporal substitution that rely on household-level expenditure data (e.g. Attanasio and Weber, 1993 and 1995; Vissing-Jorgensen, 2002; Gruber, 2006) have found significantly larger estimates of the IES than this study, generally ranging from 0.8-1, and as high as 2. These studies make the simplifying assumption that preferences are separable over durables and non-durables, which allows for estimation of the IES by examining only the non-durable expenditure (consumption) response to changes in the real interest rate over time. Figure II.16 compares the time path of non-storable non-durable and durable expenditures when σ and ϵ^D are set equal to 0.8 to the observed response.[37] Under this choice of parameters, the model is unable to match the jump in non-storable non-durable expenditure that was observed in March 1997. Furthermore, it over predicts the decline in expenditure upon implementation of the VAT rate increase. The model performs even more poorly in its prediction of the durable expenditure response, missing the spike in expenditures in March 1997 almost entirely, and over predicting the decline in expenditure upon implementation.

This begs the question of what is driving the difference between the estimates of σ in this study and Cashin and Unayama (2012), and those in other studies using household expenditure data. One possibility is that the estimates in this study and Cashin and Unayama (2012) do not account for borrowing constraints, and thus yield an estimate of σ that is biased downwards. Vissing-Jorgensen (2002), for example, finds that the IES is significantly higher for asset holders than non-asset holders. However, when Cashin and Unayama (2012) split their sample between groups that are more and less likely to be borrowing constrained, there is little difference in their estimates of σ. For example, the difference in σ for retired households, who are unlikely to experience future income growth and are in the asset decumulation stage, and working households, is not significant. The same holds true for high and low income households.

Another possibility is that the estimate of σ in this study captures a smaller short-run elasticity, while the previous studies capture a larger long-run elasticity. Vissing-Jorgensen (2002) notes that households may not reoptimize their consumption allocations every quarter, and as a result, she chooses to use semiannual consumption expenditure data for her analysis. She finds that results based on quarterly data were weaker than those using semiannual data. In contrast, this study relies on only seven months of data surrounding the VAT rate increase. However, I have shown that the tax rate increase was highly salient, making reoptimization more likely. Furthermore, durable and storable expenditures responded strongly to the tax rate increase, which implies that consumers did reoptimize in response to the tax change.

While the previous studies utilizing survey data do not suffer from aggregation bias, they may face other methodological issues that would bias the estimate of σ upwards. For one, the analyses include storable and some durable expenditures (e.g. apparel). If households stockpile in response to an increase in the future price level (decrease in the real interest rate), these studies would incorrectly attribute the response to increased consumption during the low-price period,

[37] ζ^D and ζ^S are chosen to minimize Equation (5).

and thus a larger estimate of σ. Working against this explanation, however, is the fact that the previous studies use quarterly or semiannual data, where stockpiling behavior is more difficult to observe. In addition, the changes in the real interest rate that are the subject of those studies are not necessarily anticipated like the change in this study, further mitigating the amount of stockpiling that is likely to occur.

Finally, the difference in estimates of σ may be a result of the previous studies' assumption of separable preferences over durables and non-durables. Suppose that durables and non-durables are instead strong complements, as found in this study. As stated above, the reduction in the real interest rate prior to implementation of the VAT rate increase will lead to a fall in the user cost of durables. This will in turn lead to even greater non-durable consumption growth, because as strong complements, the two goods will be consumed in nearly fixed proportions regardless of their relative prices. It follows that an estimate of σ based only on non-durable consumption growth will be biased upwards, because some of the non-durable consumption growth, which should be attributed to complementarities between durables and non-durables, is instead attributed to the change in the relative price of current and future consumption. Indeed, Cashin and Unayama (2012) obtain an estimate of σ of 0.91 under the assumption of separable preferences. This estimate is significantly larger than their baseline estimate of 0.21, which is robust to the possibility of non-separable preferences.

4.5. External validity check

One might question the external validity of the parameter estimates, given that the estimates are derived from one event in one country. To address this concern, I use the model and the baseline structural parameter estimates to predict the expenditure response to New Zealand's Goods and Services Tax (GST) rate increase from 10 to 12.5 percent, which was announced in March 1989 and implemented in July 1989.

Figure II.17 compares the time path of expenditures generated by the model to empirical estimates of the durable and non-durable retail sales response to the GST rate increase, which is documented in Cashin (2011). The empirical estimates provide seasonally-adjusted percentage deviations in retail sales for May through October 1989 relative to April 1989. The expenditure patterns generated by the model match up quite well with the point estimates for non-durable expenditures (storables and non-storables are summed to match the available retail sales data from New Zealand) before and after implementation, and durable retail sales prior to implementation. The model over predicts the fall in durable retail sales upon implementation, and the recovery of durable expenditure following implementation is quicker than what was observed in New Zealand. This is likely the result of the choice of a quadratic adjustment cost function for durables, which does not allow for asymmetries in the response before and after implementation.

Overall, however, this exercise lends additional support to the main finding in this paper, which is that expenditure is sensitive to a change in the future price level, albeit over a short period preceding and following the price change, while consumption growth is not.

4.6. Application: The Marginal Excess Burden of Japan's Proposed VAT Rate Increase

In August 2012, Japan's Prime Minister, Yoshihiko Noda, successfully pushed a bill through Japan's Diet (legislature) to gradually increase the VAT rate from five to ten percent. Specifically, the bill would increase the VAT rate from five to eight percent in April 2014, and from eight to ten percent in October 2015. The measure is intended to rein in public debt, which now exceeds 200 percent of GDP. However, there is some uncertainty as to whether the government will proceed with the tax rate hike. This is because the law contains a provision stating that the government should consider the overall economic situation before proceeding with the VAT rate increase.[38]

To evaluate the marginal excess burden of the proposed tax rate increase and whether the uncertainty associated with its implementation will significantly reduce the burden (by reducing intertemporal substitution), I generate the (Hicks) compensated expenditure response to the VAT rate increase under two scenarios, using the baseline parameter estimates in Table II.2. The first assumes that passage of the August 2012 bill constitutes announcement of the tax rate increase. The second assumes that haggling over the aforementioned provision prevents the tax rate increase from becoming a certainty until December 2013, when the fiscal year 2014 budget is submitted. Using a compensating variation measure, I then calculate the marginal excess burden of the tax rate increase under each scenario. See Appendix C for details on the estimation.

Figure II.18 presents the time paths of expenditure generated under the two scenarios. What is immediately obvious is that the announcement date has very little impact on the amount

[38] "…the provision says that before implementing the higher levy, the government will 'give holistic consideration to the economy and will take appropriate measures, which could include halting [the tax's] enactment' if economic conditions are languishing." Warnock, Eleanor. "Loophole Threatens Implementation of Controversial Japan Sales Tax." Wall Street Journal Online August 14, 2012. http://online.wsj.com/article/BT-CO-20120814-702666.html

of intertemporal substitution in consumption, stockpiling, and arbitrage that households engage in, though it does change the timing of the initial durable response. The negligible difference in the magnitude of the expenditure response follows from the low value of σ, and suggests that the deadweight loss of the VAT rate increase is largely independent of the delay between announcement and implementation of the rate increase. The low value of σ also suggests that the deadweight loss will be quite small.

Indeed, I find that the deadweight loss is only 0.0009 and 0.0006 percent of the present value of steady state lifetime expenditure for the August 2012 and December 2013 announcement scenarios, respectively. In contrast, suppose that $\sigma = 0.8$, a value consistent with previous intertemporal substitution studies using survey data. In that case, the deadweight loss associated with the phased-in rate increase is 0.005 and 0.002 percent for the August 2012 and December 2013 scenarios, respectively. It is clear that as σ increases, the delay between announcement and implementation has a larger impact on the deadweight loss associated with the tax rate increase. However, the small estimate of σ in this study implies that the delay between announcement and implementation is of little consequence, as the distortions resulting from the tax change are largely confined to the months immediately preceding the change, and some delay between announcement and implementation is inevitable.

6. Conclusion

This study uses a pre-announced increase in Japan's VAT rate from three to five percent to measure intertemporal substitution behavior. The main finding is that households accelerated purchases of durable goods and stockpiled storable goods just prior to the tax rate increase, but did not change their consumption patterns.

To the extent that the results in this study can be applied to other contexts, they suggest that policies that alter the future price level will have a large, but short-lived impact on household expenditure, with changes in the timing of expenditure confined to the months just prior to and following the price change. Consequently, one might question the efficacy of countercyclical policies that alter the relative price of current and future consumption with the intention of yielding a more persistent change in the timing of household expenditure.

Even if the intertemporal substitution effects are small, however, it should not be forgotten that these policies also have income effects, which were not addressed in this study, and could be significant for, say, a borrowing constrained household in a country where the consumption tax rate has been temporarily reduced to combat a recession.[39] Without empirical evidence on the income effects, it seems premature to rule out the effectiveness of countercyclical policies that alter the real interest rate, though it does lead one to wonder whether countercyclical policies should directly target income rather than intertemporal substitution effects.

[39] Crossley and Low (2009) address this issue in the context of the 2009 temporary VAT cut in the U.K.

TABLE II.1. SUMMARY STATISTICS				
Variable	**Mean**	**Std.**	**Min**	**Max**
Age of head	51.5	13.7	17	99
Number of household members	3.38	1.24	2	11
Number of household members under age 15	0.68	0.98	0	7
Number of household members aged 65+	0.47	0.75	0	4
Number of working members	1.52	0.95	0	7
Yearly income (1,000 yen)	7,113	4,652	0	97,043
Total expenditure (1,000 yen)	317	266	20	14,346
Excluding Tax Exempted items (1,000 yen)	221	195	15	9,255
Non-storable non-durables (N) (1,000 yen)	120	78	7	5,523
Storable non-durables (S) (1,000 yen)	52	32	.58	3,790
Durables (D) (1,000 yen)	47	138	0	7,678
Number of Observations	646,900			
Number of Households	129,380			

Note: Yearly household income and monthly household expenditures are listed in thousands of yen, with 2005 serving as the base year.

Table II.2. Baseline Structural Parameter Estimates

Parameter	Estimate
σ	0.13***
	[0.05, 0.20]
ϵ^D	-0.03***
	[-0.05, -0.01]
ζ^D	0.09***
	[0.01, 0.18]
ζ^S	1.30***
	[1.12, 1.47]

95 percent confidence intervals for the structural parameter estimates above are listed in brackets, and are computed using the delta method (see Appendix B for a full explanation). *** implies significance at the one percent level.

Table II.3. Sensitivity of Structural Parameter Estimates to the Fixed Parameter Values

Calibrated parameter	Value	$\boldsymbol{\sigma}$	$\boldsymbol{\epsilon^D}$	$\boldsymbol{\zeta^D}$	$\boldsymbol{\zeta^S}$
Baseline	See Section 4.2	0.13	-0.03	0.09	1.30
i	0.0008 (0.01)	0.13	-0.03	0.09	1.30
	0.0025 (0.03)	0.13	-0.03	0.10	1.28
δ	0.01 (0.15)	0.08	-0.02	0.11	1.27
	0.03 (0.30)	0.19	-0.04	0.09	1.31
ψ^S	0.25	0.12	-0.03	0.08	1.54
	0.35	0.14	-0.03	0.10	1.05
X^D	0.35	0.14	-0.03	0.12	1.22
$\overline{C^N}$	0.50	0.11	-0.03	0.07	1.37

Numbers listed in parentheses represent annual values for the fixed parameters.

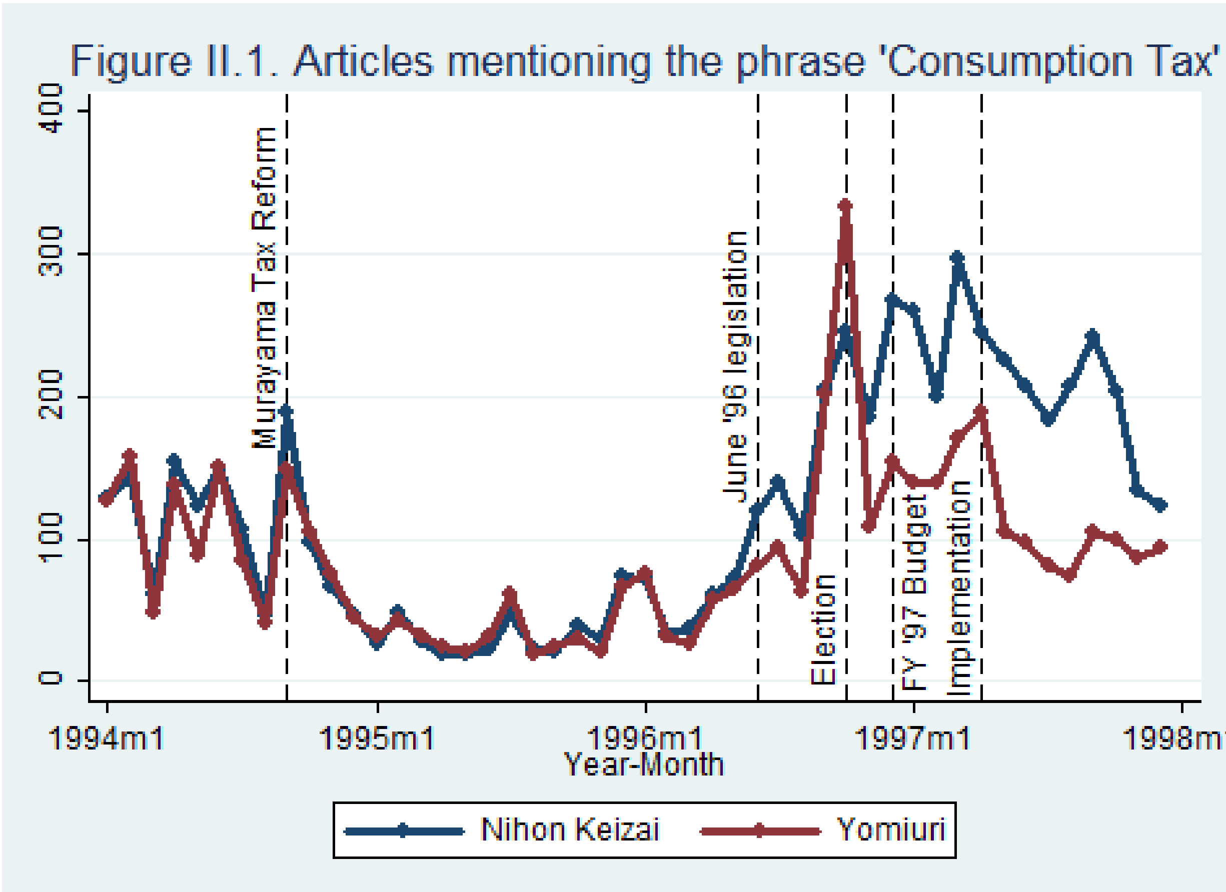


Figure II.1 presents the number of articles per month that mention the phrase 'Consumption Tax' in the Nihon Keizai Shimbun and the Yomiuri Shimbun..

Source: Author's calculations. Circulation numbers come from Japan's Audit Bureau of Circulations.

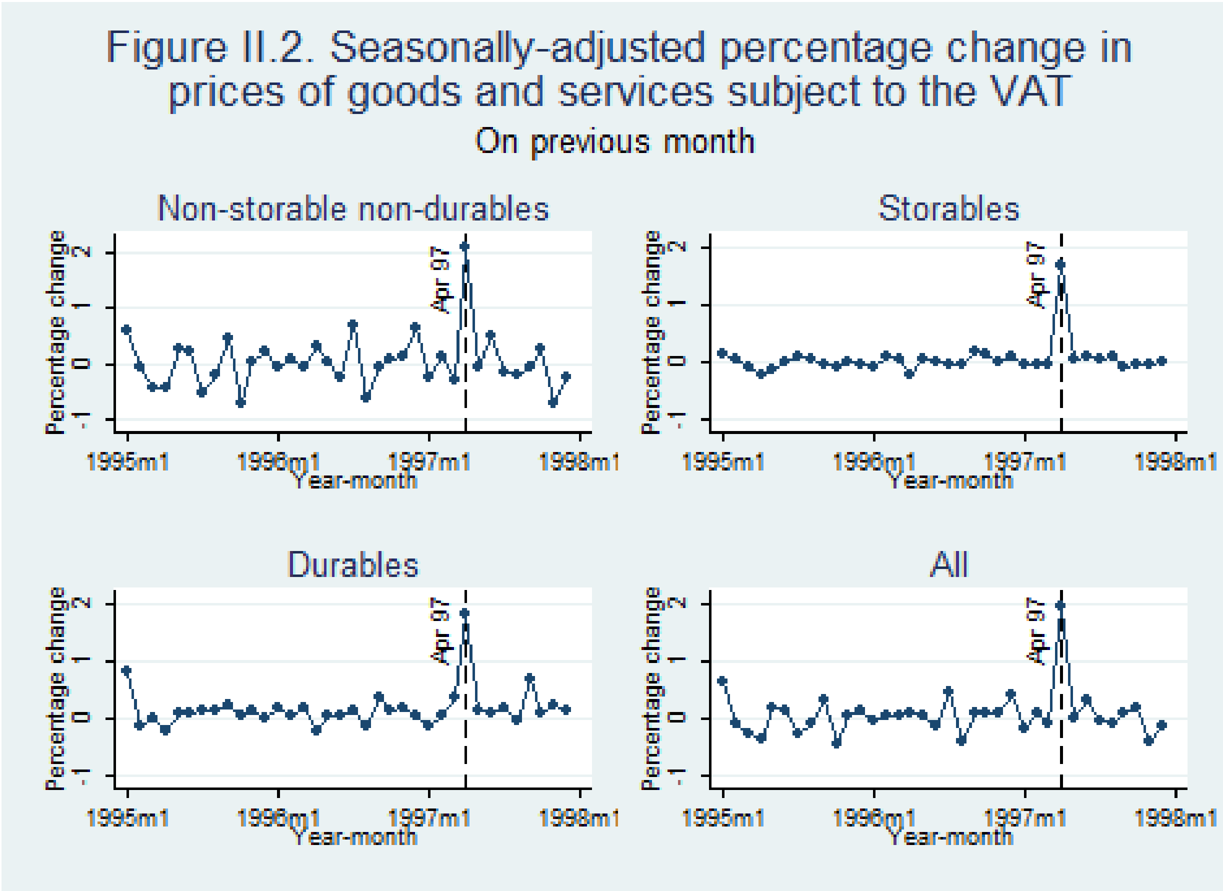


Figure II.2 presents seasonally-adjusted month-to-month percentage changes in the price of goods and services that were subject to the VAT. The vertical dashed line represents April 1997, the month of the VAT rate increase from three to five percent. To generate these estimates, the month-to-month percentage change in price is regressed on month dummies. The residuals from this regression yield the seasonally-adjusted month-to-month percentage change in the price indices.

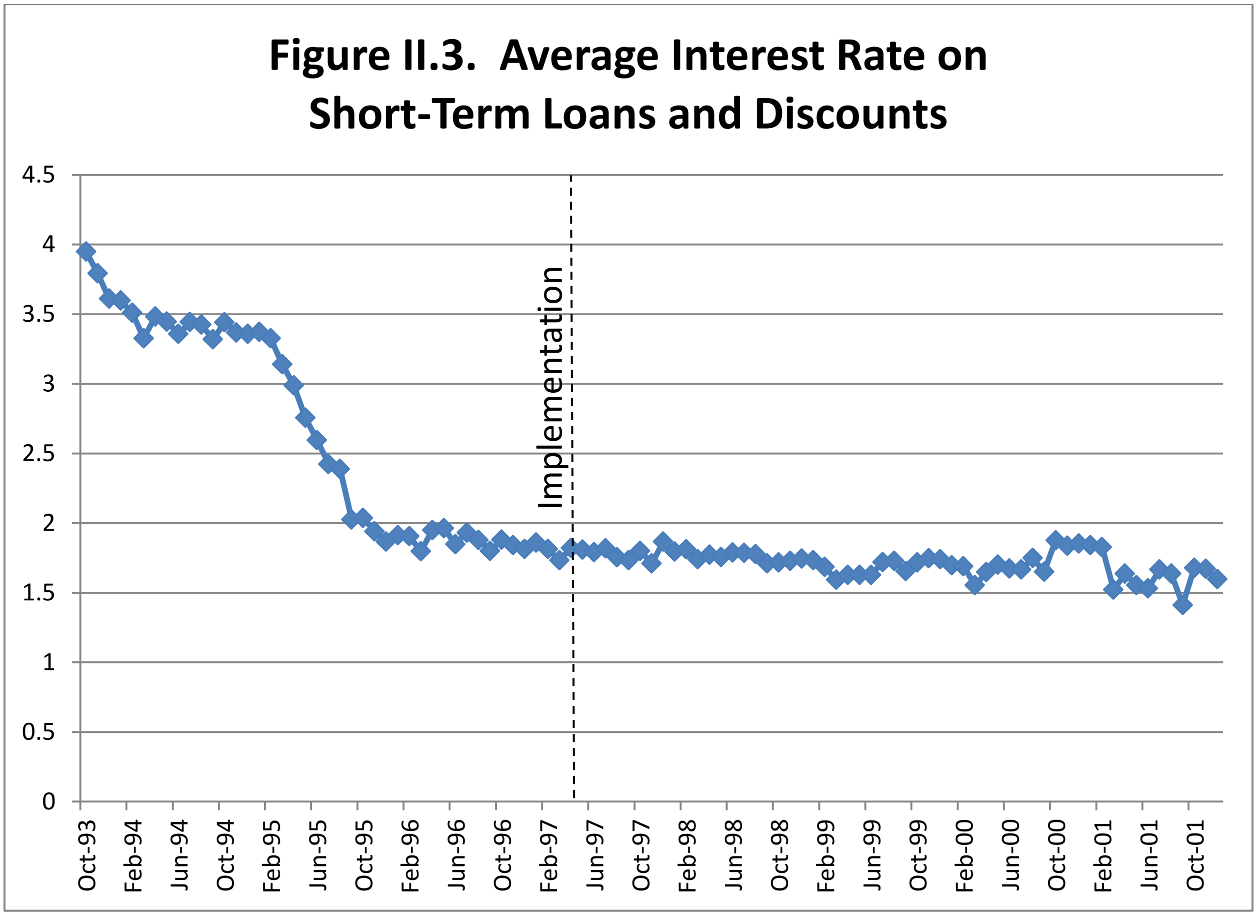


Figure II.3 presents the average contracted interest rate on short-term loans and discounts. These are the average interest rates applied to a contract of less than one year between commercial banks and lenders. The data comes from the Bank of Japan.

Figure II.4. Identifying the Intertemporal Substitution Response to the VAT Rate Increase

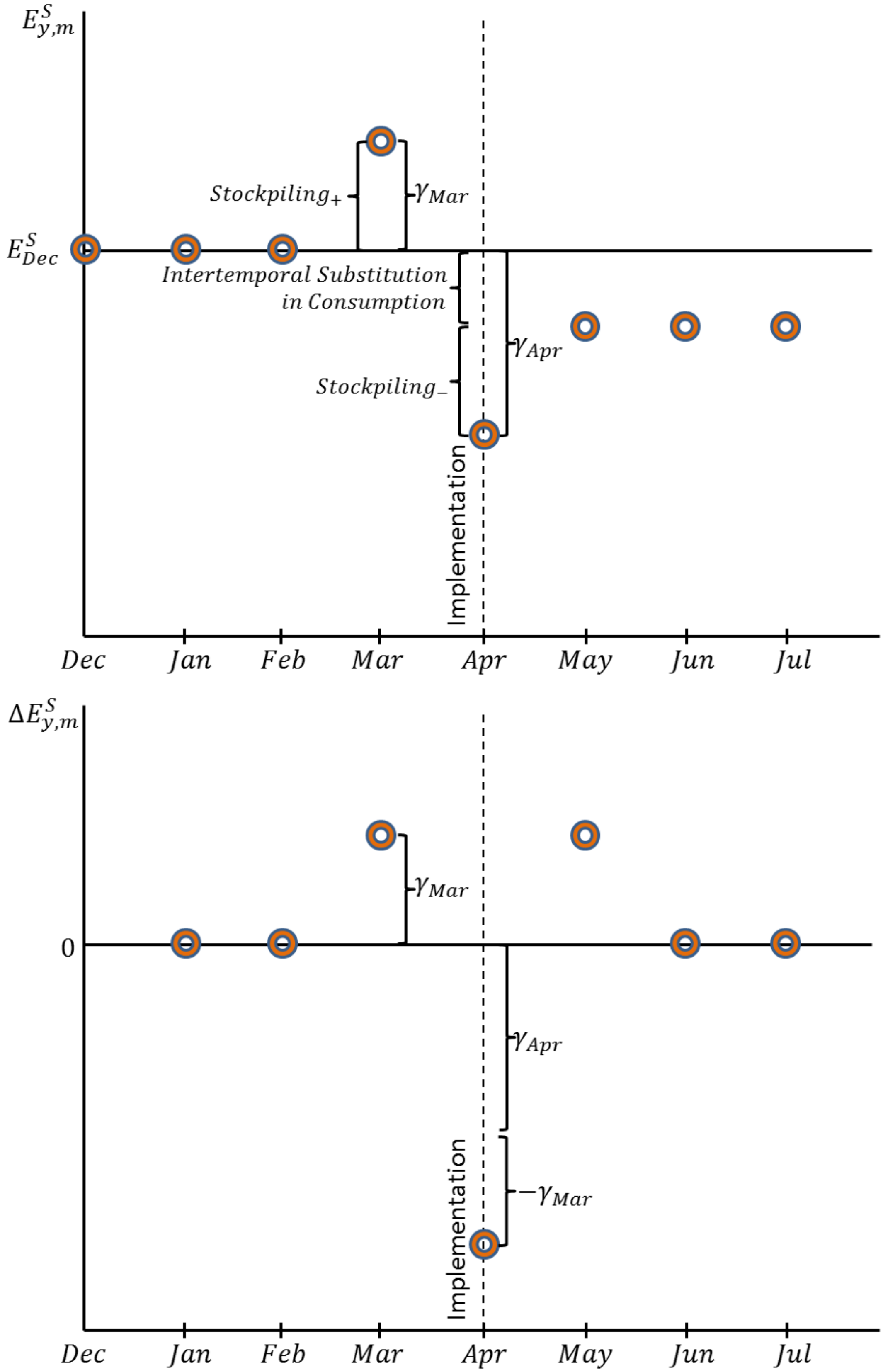
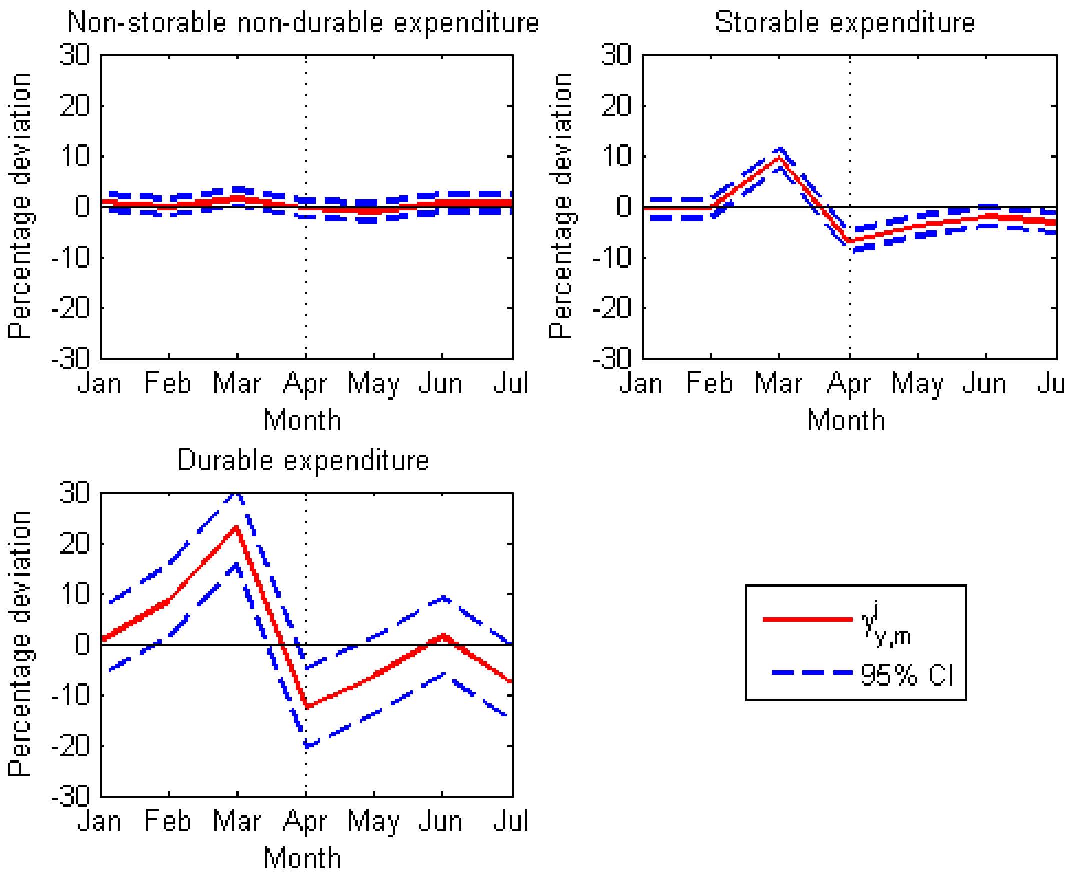
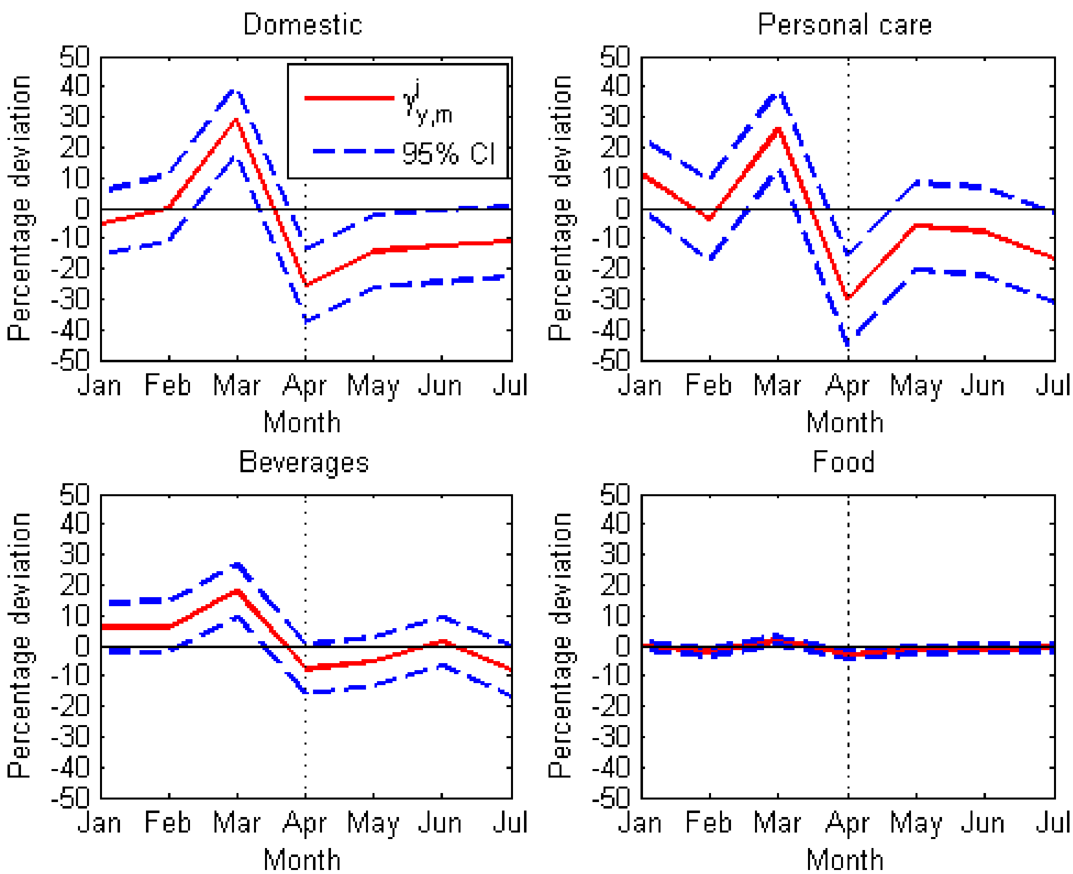


Figure II.5. The Intertemporal Substitution Response to the VAT Rate Increase



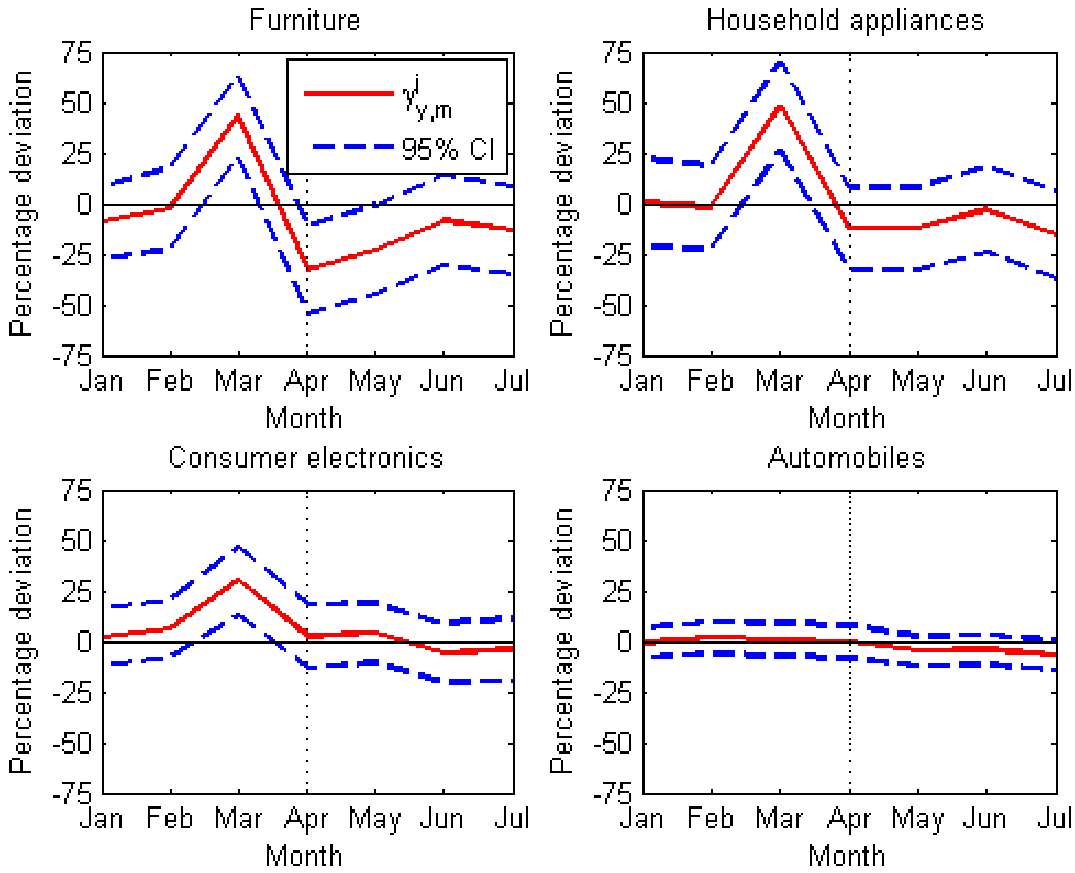
The figure above shows the percentage deviation in durable, storable, and non-storable non-durable expenditures relative to expenditure in these categories in December 1996, controlling for household fixed effects, a linear trend in consumption growth, seasonality, and time-varying household characteristics. I interpret the results as yielding the intertemporal substitution effects associated with the VAT rate increase. The solid red line gives the point estimates in each month. The dashed blue lines give the 95 percent confidence intervals. The dashed vertical line represents April 1997, the month of implementation. The results are based on the specification given in Equation (4). Standard errors are panel-robust. If monthly durable expenditure for a household is reported as zero, it is set to ¥100 to avoid taking the logarithm of zero.

Figure II.6. The Storable Intertemporal Substitution Response to the VAT Rate Increase



See Figure II.5 for an explanation of how these plots were generated.

Figure II.7. The Durable Intertemporal Substitution Response to the VAT Rate Increase



See Figure II.5 for an explanation of how these plots were generated.

Figure II.8. The Costs and Benefits of Adjusting the Durable Stock at the Margin

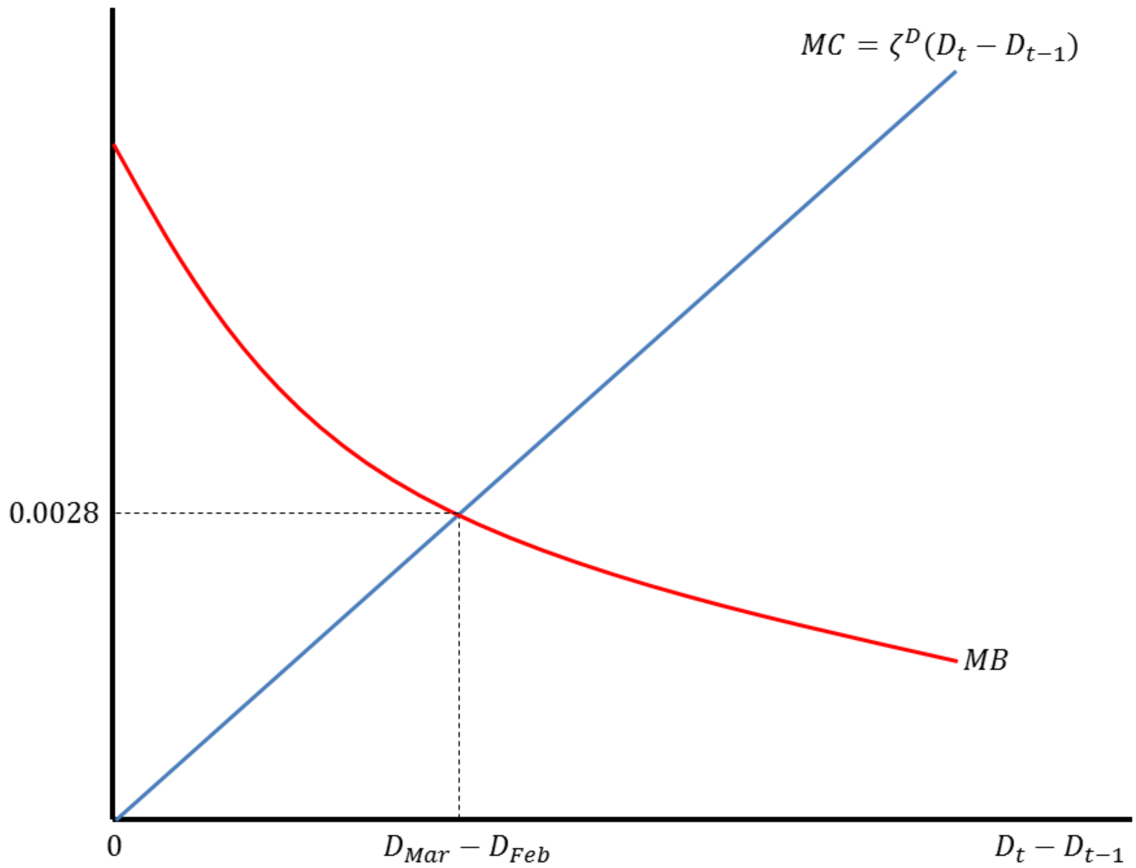


Figure II.9. The Costs and Benefits of Stockpiling at the Margin

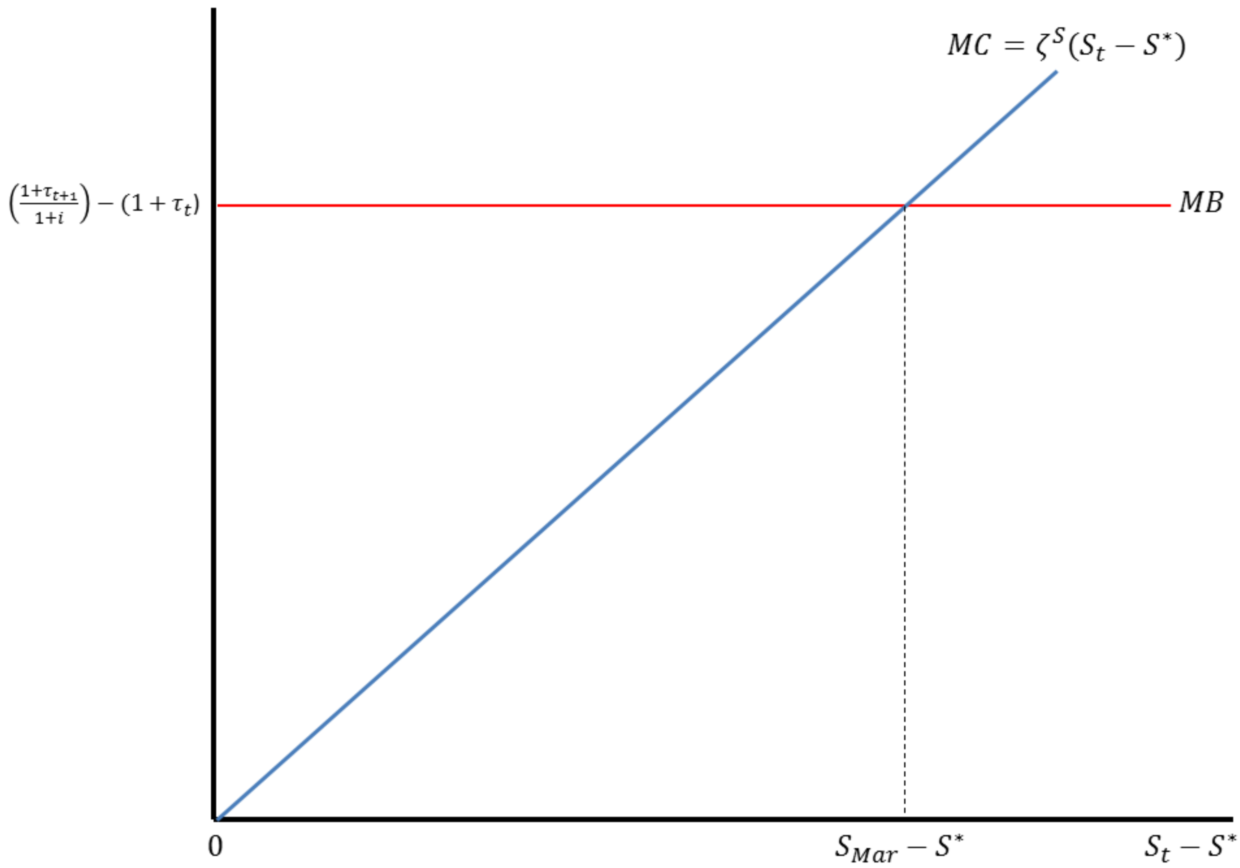


Figure II.10. Comparison of the Time Path of Expenditures Generated by the Model to the Empirical Estimates

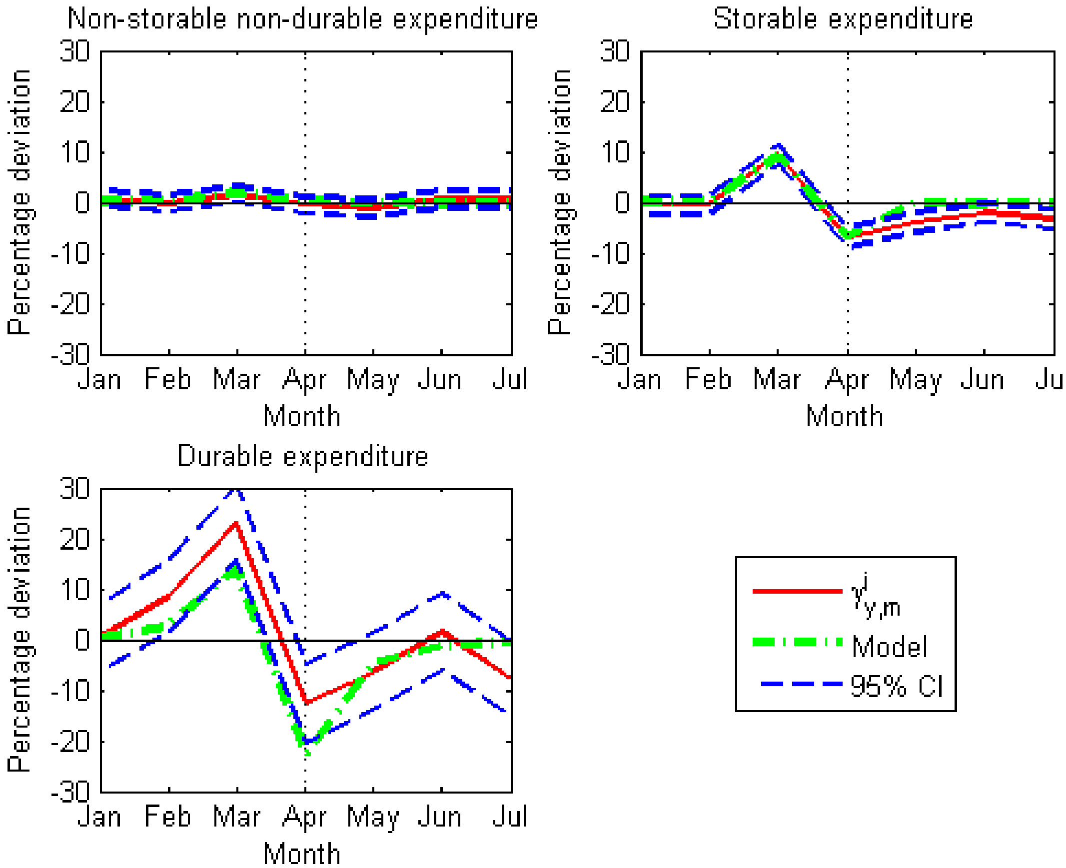


Figure II.10 compares the time path of expenditures generated by the model to the empirical estimates shown in Figure II.5. The dashed green line shows the time path generated by the model, while the solid red line shows the empirical estimates of the expenditure response to the VAT rate increase based on the JFIES survey data and the specification in Equation (4). The dashed blue lines are 95 percent confidence intervals for the empirical estimates. The dashed vertical line represents April 1997, the month the VAT rate increase was implemented.

Figure II.11. Non-storable Non-durable Expenditure Patterns for Different Values of ϵ^D when $\sigma = 0.13$

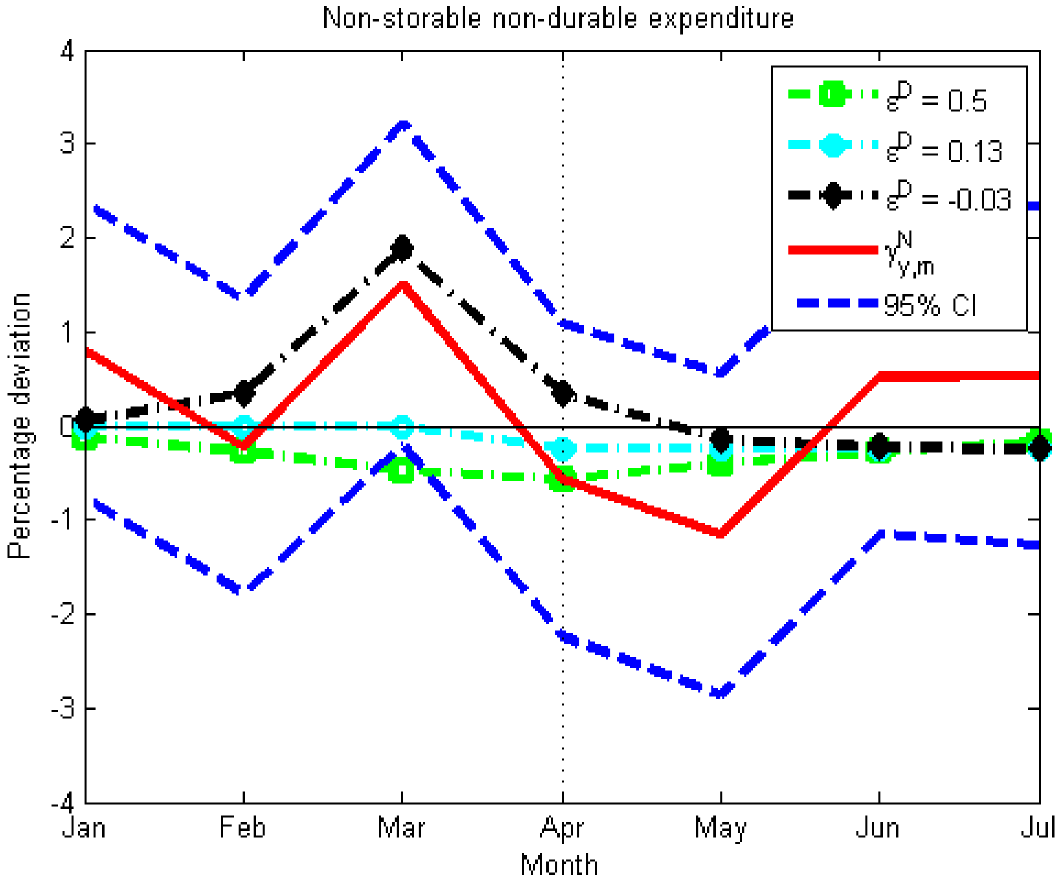


Figure II.11 presents non-storable non-durable expenditure patterns in the months prior to and following implementation of the VAT increase for different values of ϵ^D when $\sigma = 0.13$, which is the baseline estimate for σ. The squared green, circled cyan, and black diamond lines show expenditure when $\epsilon^D = 0.5, 0.13$, and -0.03, respectively. The figure also displays the empirical estimates from the top left plot in Figure II.5, where the solid red line represents the point estimates, and the dashed blue lines the 95 percent confidence intervals for the point estimates.

Figure II.12. Durable Expenditure Patterns for Different Values of ϵ^D when $\sigma = 0.13$

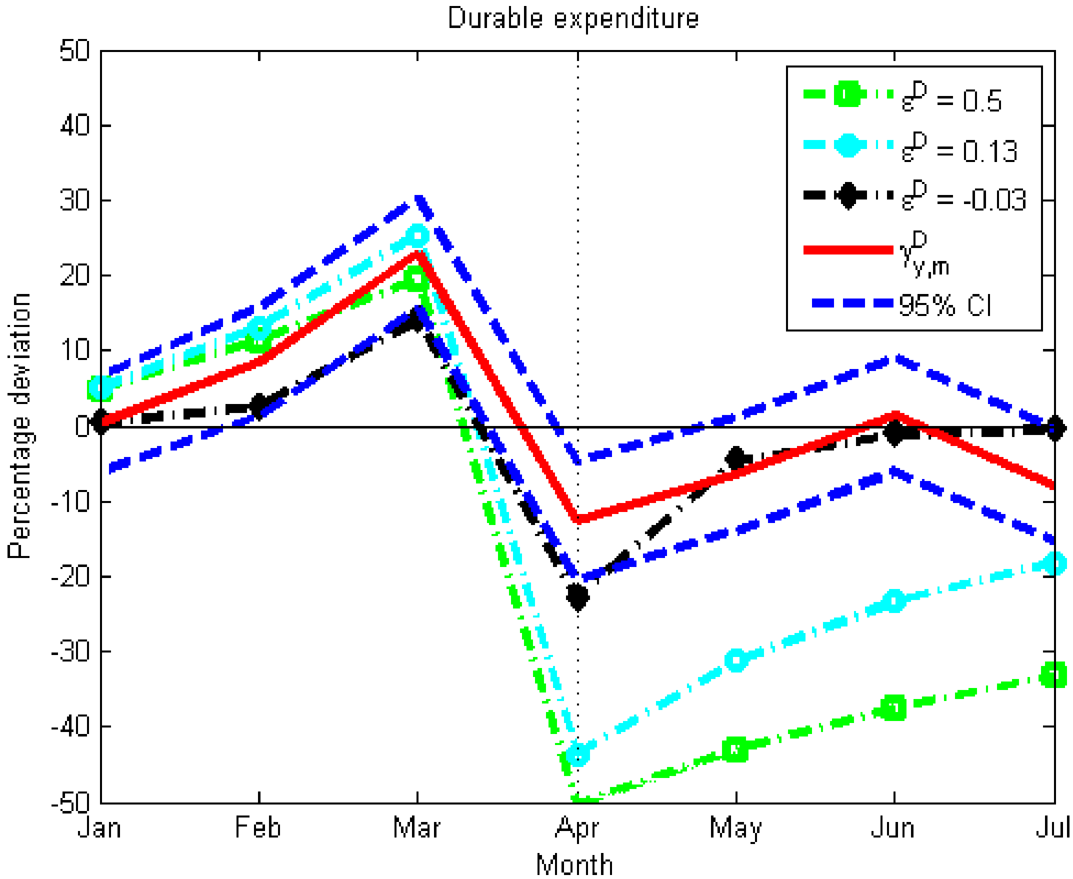


Figure II.12 presents durable expenditure patterns in the months prior to and following implementation of the VAT increase for different values of ϵ^D when $\sigma = 0.13$, which is the baseline estimate for σ. The squared green, circled cyan, and black diamond lines show expenditure when $\epsilon^D = 0.5, 0.13$, and -0.03, respectively. The figure also displays the empirical estimates from the bottom left plot in Figure II.5, where the solid red line represents the point estimates, and the dashed blue lines the 95 percent confidence intervals for the point estimates.

Figure II.13. Non-storable Non-durable Expenditure Patterns for Different Values of σ

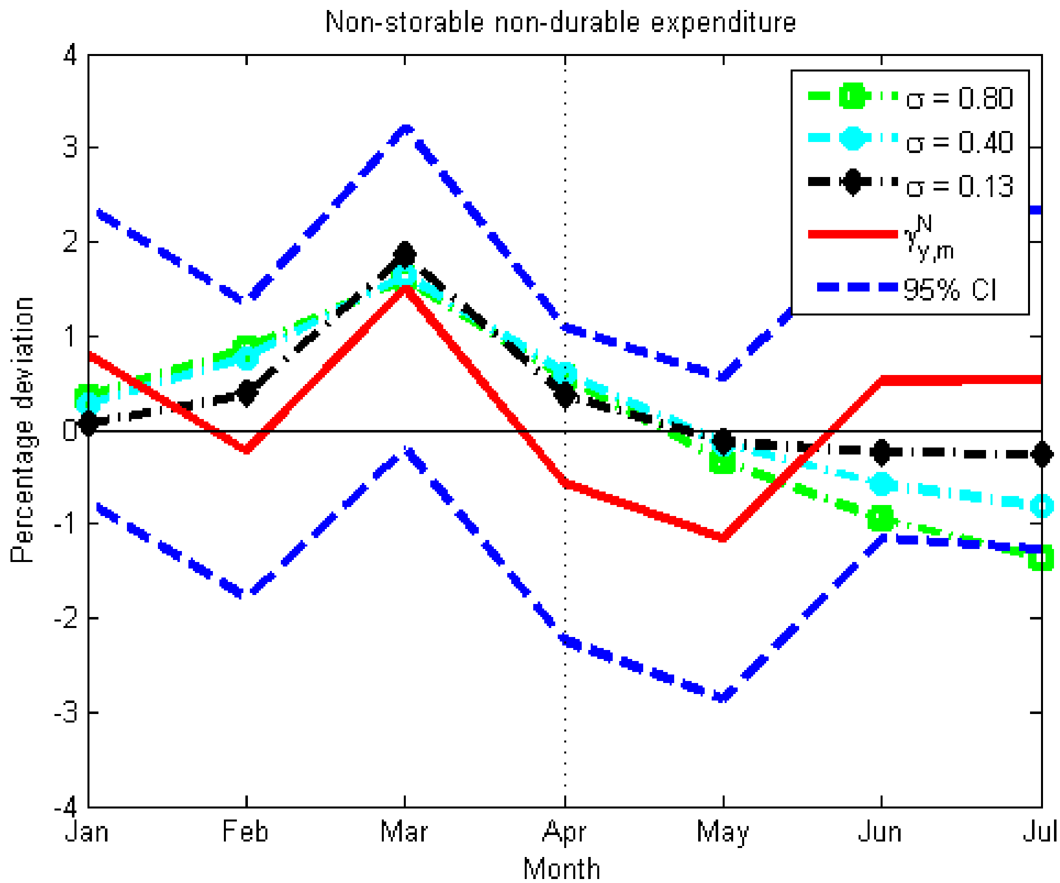


Figure II.13 presents non-storable non-durable expenditure patterns in the months prior to and following implementation of the VAT increase for different values of σ when the other structural parameters are set to their baseline values. The squared green, circled cyan, and black diamond lines show expenditure when $\sigma = 0.80, 0.40,$ and 0.13, respectively. The figure also displays the empirical estimates from the top left plot in Figure II.5, where the solid red line represents the point estimates, and the dashed blue lines the 95 percent confidence intervals for the point estimates.

Figure II.14. Durable Expenditure Patterns
for Different Values of σ

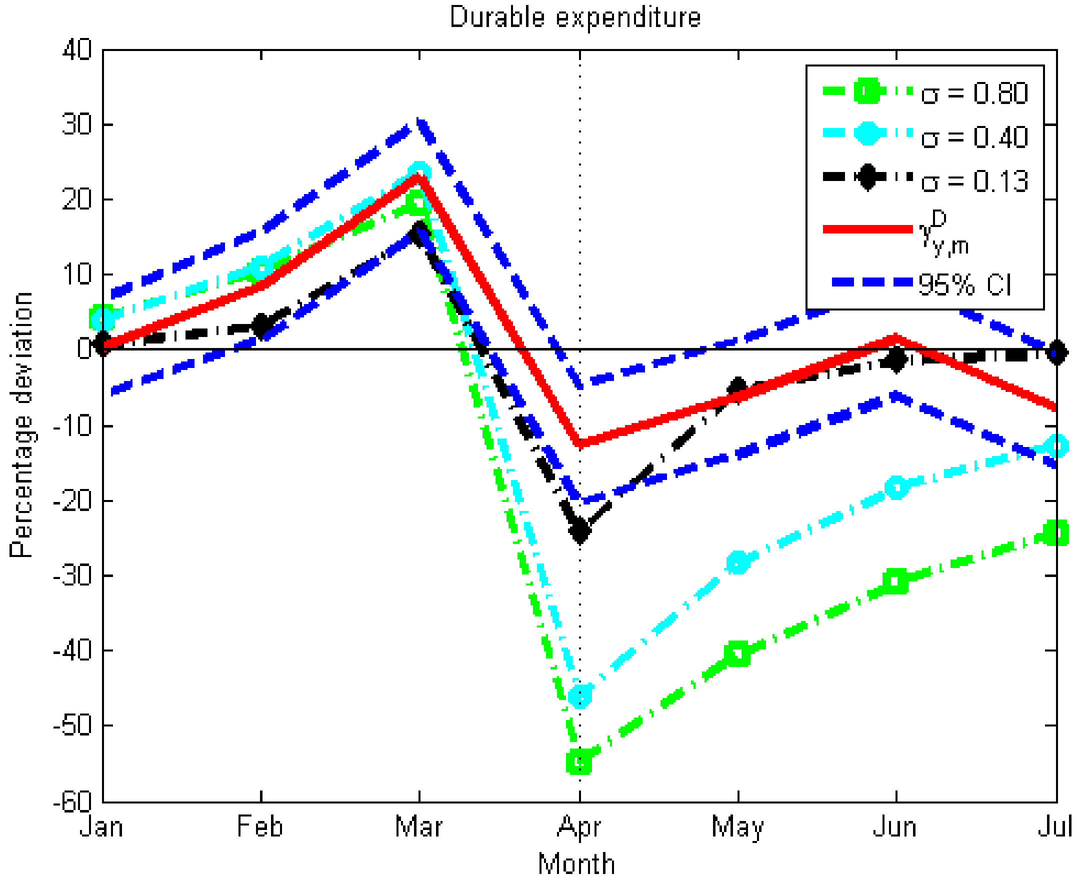


Figure II.14 presents durable expenditure patterns in the months prior to and following implementation of the VAT increase for different values of σ when the other structural parameters are set to their baseline values. The squared green, circled cyan, and black diamond lines show expenditure when $\sigma = 0.80, 0.40,$ and 0.13, respectively. The figure also displays the empirical estimates from the bottom left plot in Figure II.5, where the solid red line represents the point estimates, and the dashed blue lines the 95 percent confidence intervals for the point estimates.

Figure II.15. Durable Expenditure Patterns for Different Values of ζ^D

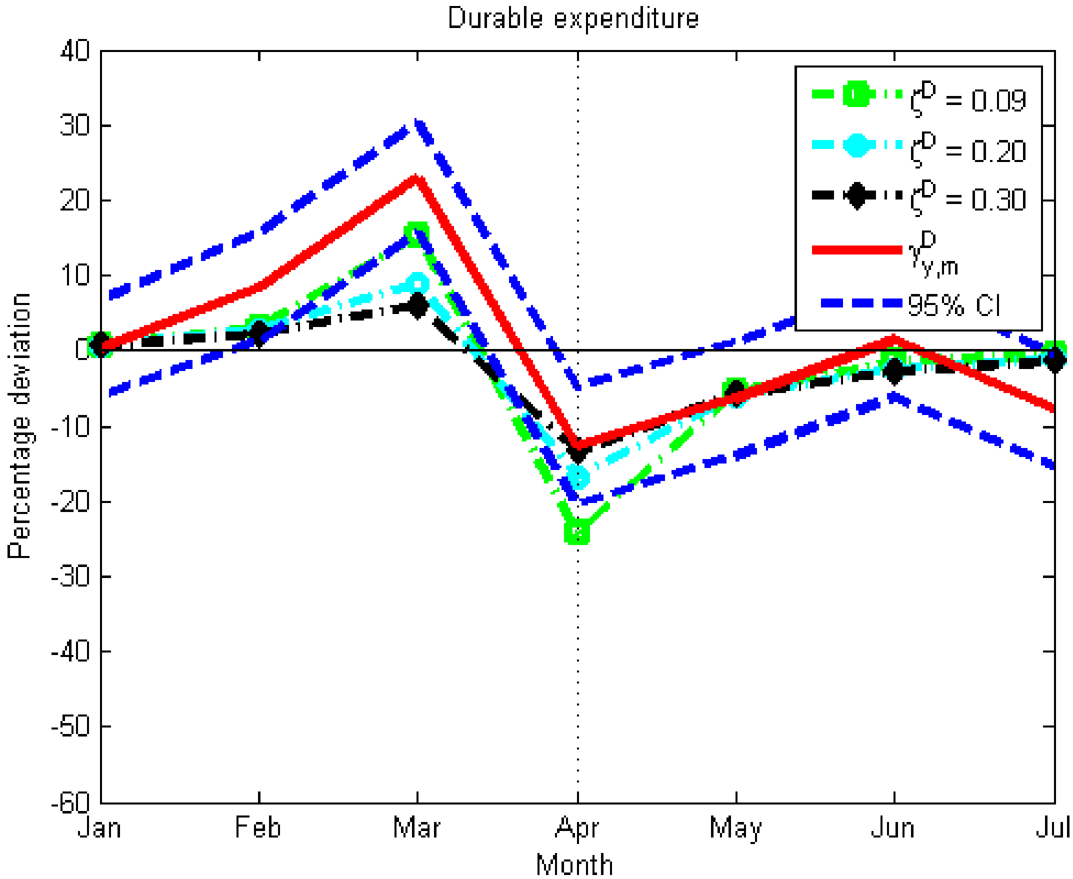
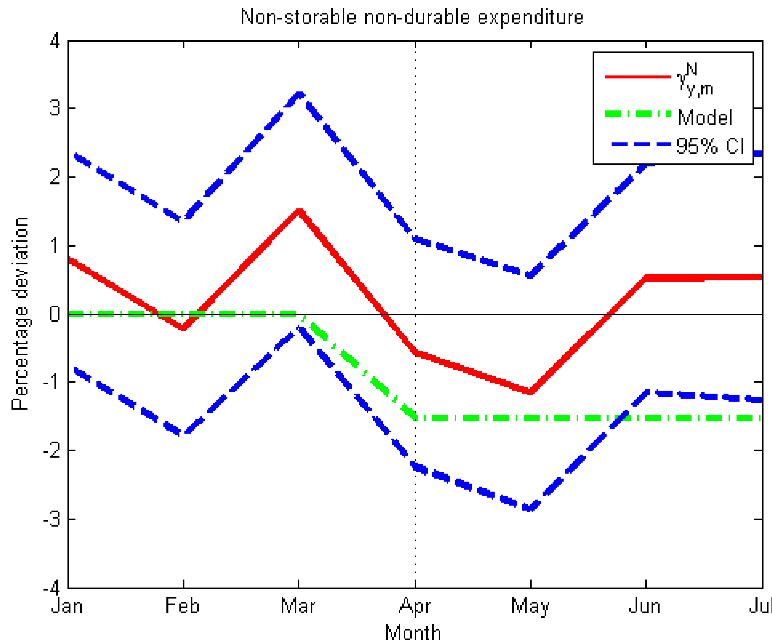


Figure II.15 presents durable expenditure patterns in the months prior to and following implementation of the VAT increase for different values of ζ^D when the other structural parameters are set to their baseline values. The squared green, circled cyan, and black diamond lines show expenditure when $\zeta^D = 0.09, 0.20,$ and 0.30, respectively. The figure also displays the empirical estimates from the bottom left plot in Figure II.5, where the solid red line represents the point estimates, and the dashed blue lines the 95 percent confidence intervals for the point estimates.

Figure II.16. Expenditure Patterns for $\sigma = \epsilon^D = 0.8$



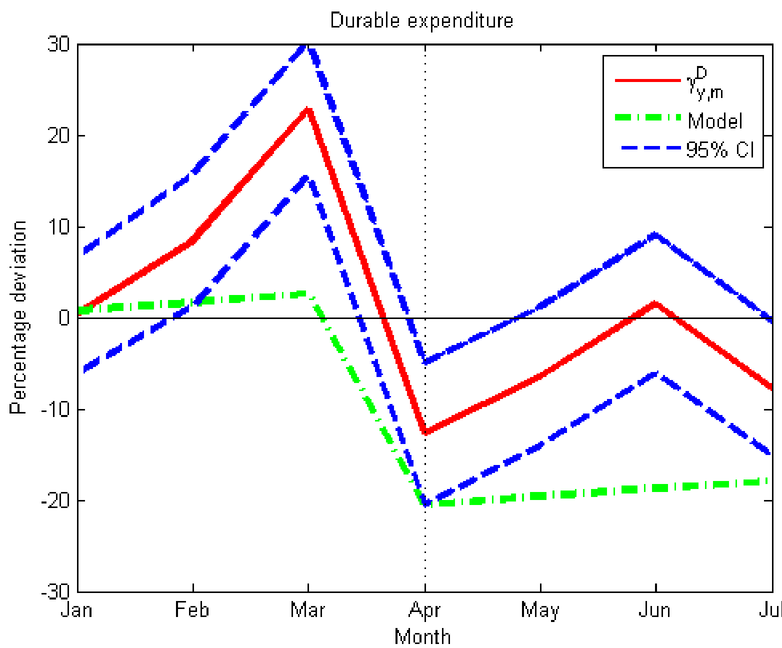


Figure II.16 compares non-storable non-durable and durable expenditure patterns in the months surrounding the VAT rate increase when $\sigma = \epsilon^D = 0.8$, and ζ^D and ζ^S are chosen to minimize Equation (5). The dashed green line shows the time path generated by the model, while the solid red line shows the empirical estimates of the expenditure response to the VAT rate increase based on the JFIES survey data and the specification in Equation (4). The dashed blue lines are 95 percent confidence intervals for the empirical estimates. The dashed vertical line represents April 1997, the month the VAT rate increase was implemented.

Figure II.17. Predicting the Response to New Zealand's July 1989 GST Rate Increase

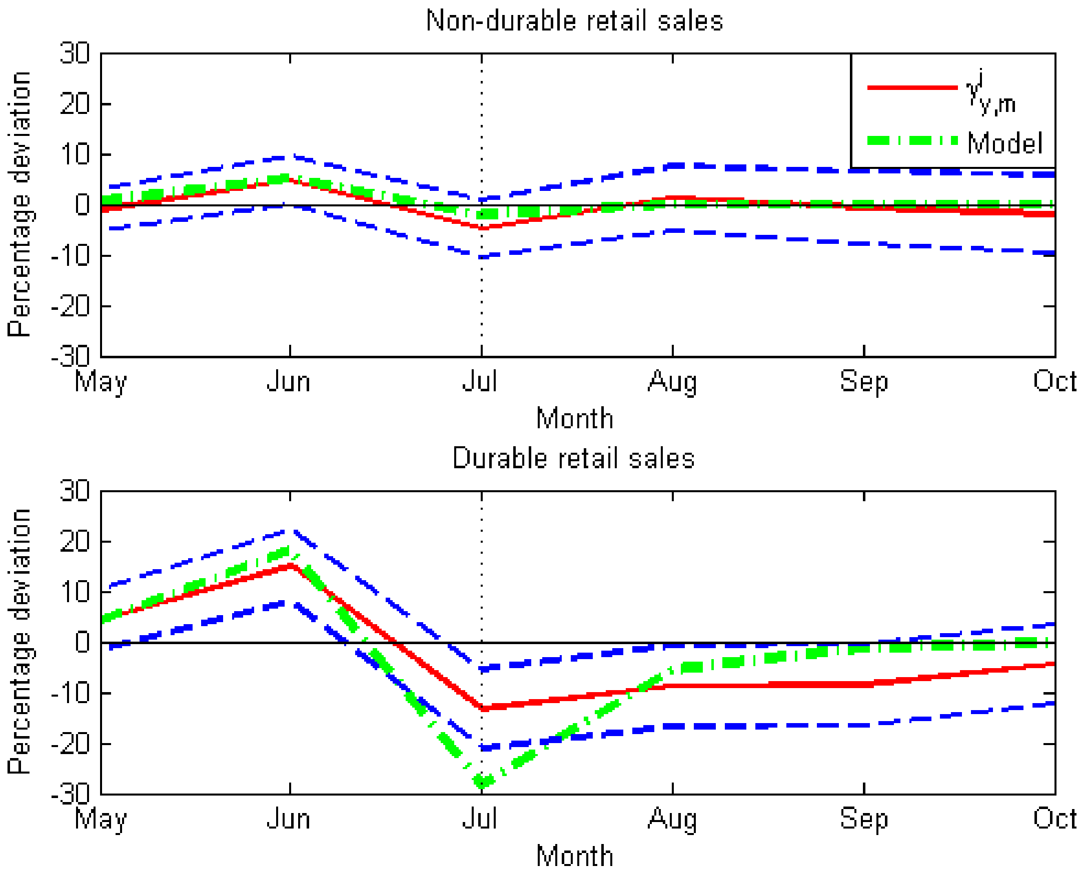


Figure II.17 compares the time path of expenditures generated by the model to empirical estimates of the seasonally-adjusted percentage deviation (relative to April 1989) in retail sales in the months surrounding New Zealand's July 1989 Goods and Services Tax (GST) rate increase from ten to 12.5 percent, which is documented in Cashin (2011). The rate increase was announced in March 1989, four months prior to implementation, and was uncompensated.

Figure II.18. The (Hicks) Compensated Expenditure Response to Japan's Proposed VAT Rate Increase

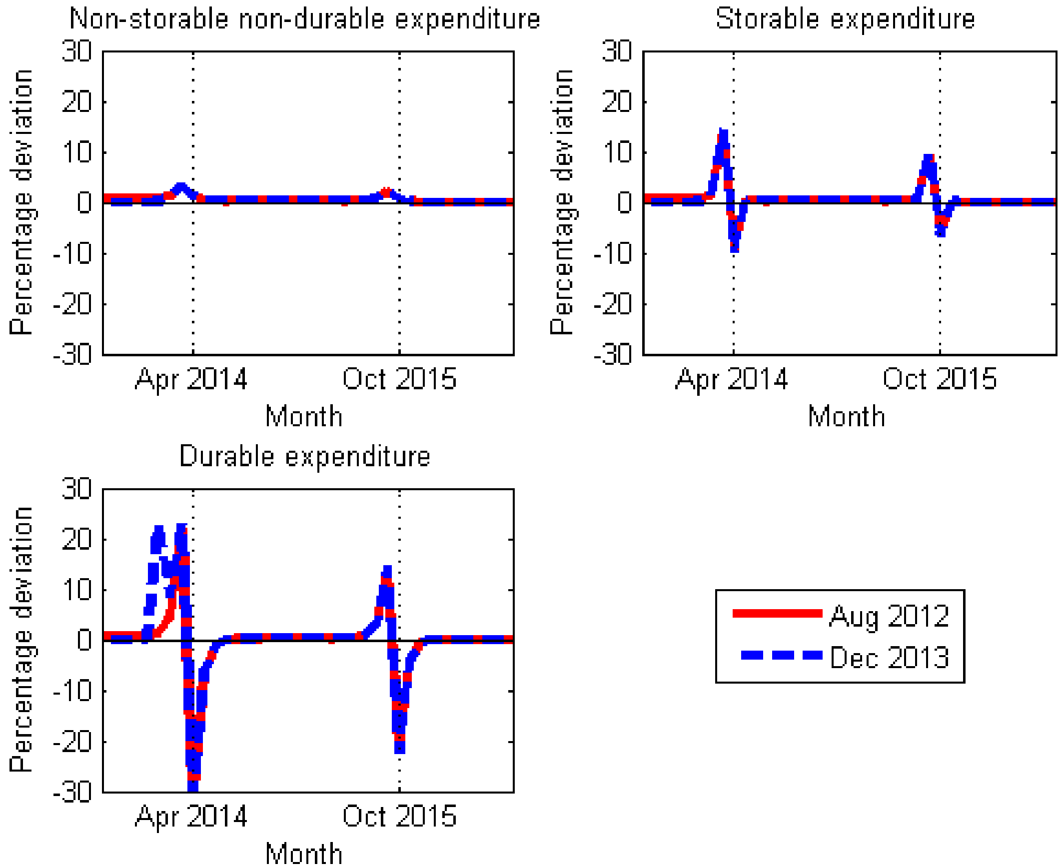
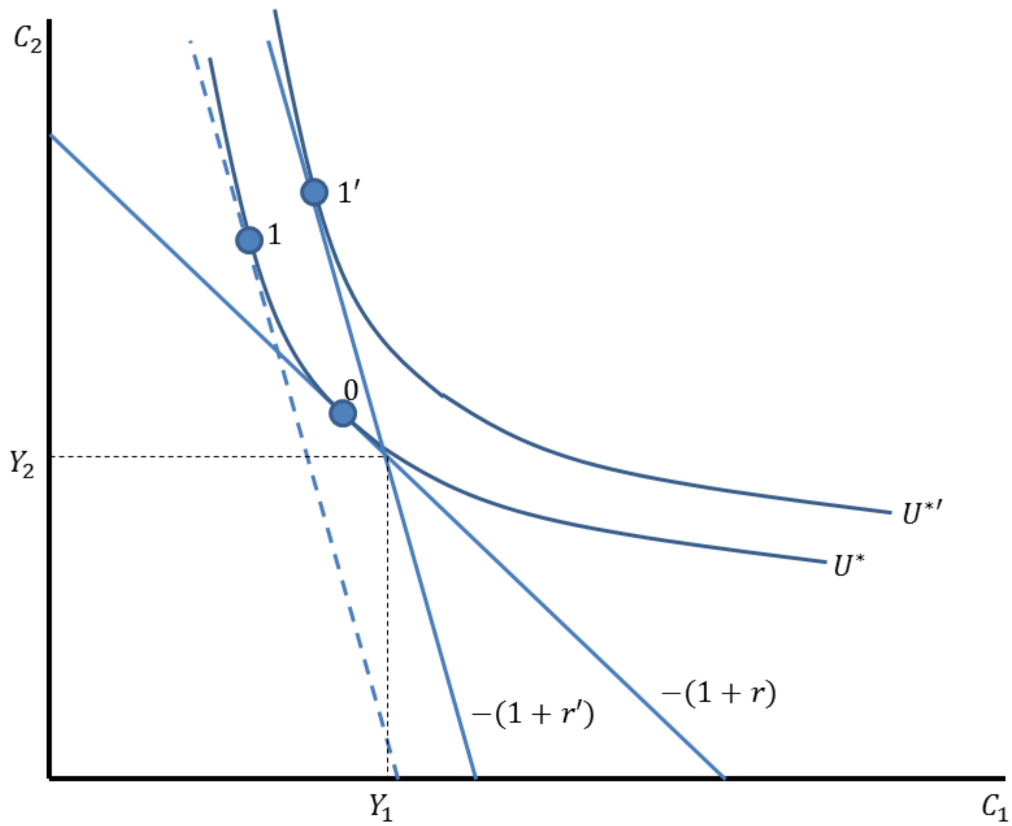


Figure II.18 displays the (Hicks) compensated expenditure response to the proposed VAT rate increase in Japan under two scenarios, using the baseline parameter estimates presented in Table II.2. The first, labeled 'Aug 2012' and represented by a solid red line, assumes that the August 2012 passage of a bill to increase the VAT rate constitutes announcement, with the rate increased from five to eight percent in April 2014, and from eight to ten percent in October 2015. The second scenario, labeled 'Dec 2013' and represented by a dashed blue line, assumes that passage of the fiscal year 2014 budget constitutes announcement.

Appendix II.A

Figure II.A.1. The Impact of an Increase in the Real Interest Rate When Households are Net Savers



In the figure above, the real interest rate increases from r to r'. Prior to the change, the optimizing bundle for the representative consumer is given by bundle 0. Note that the consumer is a net saver since $C_1 < Y_1$, where C_1 is first period consumption and Y_1 is first period income. Given the increase in the real interest rate, the true intertemporal substitution effect is identified by holding utility constant at U^* while allowing for the increase in the interest rate. The new optimizing bundle would be given by bundle 1. However, the increase in the interest rate also induces an income effect, so the optimizing consumption bundle is given by bundle $1'$. The ratio of C_2 to C_1 is smaller at bundle $1'$ than it is at bundle 1, and thus a simple regression of the first difference of the log of the consumption ratio on the real interest rate will lead to a downward biased estimate of the IES.

TABLE II.A.1. CATEGORIZATION OF GOODS AND SERVICES SUBJECT TO THE VAT

Durables	**Storables**	**Non-Storable Non-Durables**
Tools	Grains (e.g. noodles)	Bread
Cooking appliance	Fish (dried, fish paste)	Fish (fresh)
Refrigerator	Meat (processed)	Meat (raw)
Vacuum	Dairy (e.g. butter)	Dairy (e.g. milk)
Washing machine/dryer	Vegetable (e.g. beans)	Vegetable (fresh)
Other household durables (e.g. microwave)	Fruit (canned)	Fruit (fresh)
Air conditioner	Oils, spices, and seasonings	Cake
Fan heaters	Sugar	Cooked food (e.g. sushi)
Stove	Sweets (e.g. chocolate)	Electricity
Other heating and cooling appliances	Cooked food	Natural gas
General furniture	Beverages (e.g. tea)	Water
Clock	Alcoholic beverages	Flowers
Lighting	Light bulbs	Newspaper
Floor coverings and curtains	Domestic goods (e.g. laundry detergent)	Eating out
Other interior furnishings	Cloth	Domestic services
Bedding	Medicine	Bus fare
Utensils	Medical supplies (e.g. bandages)	Taxi fare
Japanese clothing	Stationery	Airfare
Western clothing	Film	Other public transit
Women's coats	Recording media (e.g. CD)	Automotive fees
Shirts	Pet food	Automotive insurance
Underwear	Personal care items (e.g. shaving cream)	Telephone service
Other clothing	Tobacco	Recreational good repair
Footwear	Rail service	Recreational durable good repair
Automobile	Gasoline	Lodging
Other vehicle		Package tour
Bicycle		Lesson fees
Auto parts		Television service
Telephone		Movie or play admission
Textbook		Other admissions
Television		Other recreational services
Stereo		Other insurance
Portable audio equipment		Social expenses (e.g. money gifts)
Video recorder		
Camera		
Computer	**(Durables Cont.)**	
Musical instrument	Personal effects (e.g. umbrella)	
Desk	Handbag	
Other recreational durable goods	Accessories (e.g. watch)	
Golf equipment	Other personal effects (e.g. cane)	
Other sporting goods	Home repair (e.g. plumbing)	
Sport outfits	Clothing services (e.g. tailoring)	
Toys	Auto repair	
Other recreational goods	Personal care services (e.g. haircut)	
Books	Personal effect services (e.g watch repair)	

Appendix II.B: Computing the Standard Errors

Denote the mapping in Equation (5) as

$$\hat{\theta} = f(\hat{\gamma}).$$

Provided that

$$\sqrt{n}(\hat{\gamma} - \gamma_0) \xrightarrow{d} N(0, W),$$

by the delta method, it can be shown that

$$\sqrt{n}\left(\hat{\theta} - \theta_0\right) \xrightarrow{d} N(0, f'(\gamma_0)W\, f'(\gamma_0)^T),$$

where n is the number of observations used in the regressions that yield the $\hat{\gamma}'s$, $f'(\gamma_0)$ is a P x M matrix of derivatives, and W is the asymptotic variance-covariance matrix of $\sqrt{n}(\hat{\gamma} - \gamma_0)$. In practice, W is replaced by its sample estimate, $\widehat{W}$.

To compute $f'(\gamma_0)$, let

$$L\left(\hat{\gamma}, \gamma(\theta)\right) = \left(\hat{\gamma} - \gamma(\theta)\right)^T W^{-1}\left(\hat{\gamma} - \gamma(\theta)\right).$$

Then

$$\frac{\partial L(\hat{\gamma}, \theta)}{\partial \theta} = L_\theta(\hat{\gamma}, \theta)$$

is a 1 x P vector, where $L_\theta\left(\hat{\gamma}, \hat{\theta}\right) = \mathbf{0}$. By the implicit function theorem,

$$L_{\theta,\hat{\gamma}}(\hat{\gamma}, \theta) + L_{\theta,\theta}(\hat{\gamma}, \theta)\, f'(\gamma) = 0,$$

and it follows that $f'(\gamma)$ can be approximated as

$$f'(\gamma) = -L_{\theta,\theta}(\hat{\gamma},\hat{\theta})^{-1} L_{\theta,\hat{\gamma}}(\hat{\gamma},\hat{\theta}),$$

where $f'(\gamma)$ is a P x M matrix, $L_{\theta,\theta}(\hat{\gamma},\theta)$ is a P x P matrix, and $L_{\theta,\hat{\gamma}}(\hat{\gamma},\theta)$ is a P x M matrix. Each element of $L_{\theta,\theta}(\hat{\gamma},\theta)$ can be expressed as

$$L_{\theta_p,\theta_q} = \sum_{i=1}^{M}\sum_{j=1}^{M} \omega_{j,i} \left[\frac{\partial \gamma_i(\theta)}{\partial \theta_p}\frac{\partial \gamma_j(\theta)}{\partial \theta_q} + \frac{\partial \gamma_j(\theta)}{\partial \theta_p}\frac{\partial \gamma_i(\theta)}{\partial \theta_q}\right] \; \forall\, p = 1, \dots, P; q = 1, \dots, P$$

where $\omega_{j,i}$ is the element of W^{-1} found in row j and column i. Each element of $L_{\theta,\hat{\gamma}}(\hat{\gamma},\theta)$ can be expressed as

$$L_{\theta_p,\hat{\gamma}_m} = -2\sum_{i=1}^{M} \omega_{i,m} \frac{\partial \gamma_i(\theta)}{\partial \theta_p} \; \forall\, m = 1, \dots, M;\; p = 1, \dots, P.$$

$\frac{\partial \gamma_m(\theta)}{\partial \theta_p}$ is computed numerically as

$$\frac{\partial \gamma_m(\theta)}{\partial \theta_p} = \frac{\gamma_m(\hat{\theta} + he_p) - \gamma_m(\hat{\theta} - he_p)}{2h} \;\; \forall\, m = 1, \dots, M;\; p = 1, \dots, P,$$

where h is small and e_p is a P x 1 vector with a one in the p^{th} row and a zero in all others.[40]

[40] In practice, $h = 1 \text{ x } 10^{-6}$. The standard error estimates are robust to larger choices of h.

Appendix II.C: Computing the Marginal Excess Burden of Japan's Proposed VAT Rate Increase

This section describes the methodology used to compute the marginal excess burden measures presented in Section 4.6. The initial tax rate on expenditure is $\tau = 0.05$. In period $t = t_A^*$, it is announced that the tax rate on expenditure will increase from 0.05 to 0.08 in period $t = t_I^*$, and from 0.08 to 0.10 in period $t = t_I^{**}$. Producer prices are assumed to be fixed, so the entire burden of the tax rate increase is borne by consumers in the form of higher prices. Let p_0 represent the vector of prices in the absence of taxation (i.e. $p_0 = 1 \;\forall\; t$), and p_1 the vector of prices under the initial tax regime (i.e. $p_1 = 1 + \tau = 1.05 \;\; \forall\; t$). Let

$$p_2 = [1.05, t = t_A^*, \dots, t_{I-1}^*; 1.08, t = t_I^*, \dots, t_{I-1}^{**}; 1.05, t = t_I^{**}, \dots, \infty]$$

represent a vector of prices for which only the tax rate increase from periods $t = t_I^*, \dots, t_{I-1}^{**}$ is imposed. Finally, let

$$p_3 = [1.05, t = t_A^*, \dots, t_{I-1}^*; 1.08, t = t_I^*, \dots, t_{I-1}^{**}; 1.10, t = t_I^{**}, \dots, \infty]$$

represent the vector of prices under the new tax regime.

To calculate the marginal excess burden associated with the pre-announced and phased-in tax rate increase, begin with the compensating variation measure of marginal excess burden (in present value) in the presence of pre-existing taxes, given by

$$EB_C = \sum_{j=2}^{3} \sum_{t=t_A^*}^{\infty} \left(\frac{1}{1+i}\right)^{t-t_A^*} EB_C(p_{j,t}, p_{j-1,t}, p_{0,t}; U_1) \qquad (1)$$

$$= \sum_{j=2}^{3} \sum_{t=t_A^*}^{\infty} \left(\frac{1}{1+i}\right)^{t-t_A^*} \Big[[E(p_{j,t}; U_1) - E(p_{j-1,t}; U_1)] - [R(p_{j,t}, p_{0,t}; U_1) - R(p_{j-1,t}, p_{0,t}; U_1)] \Big]$$

where i is the nominal interest rate, $[E(p_{j,t}, U_1) - E(p_{j-1,t}, U_1)]$ is the amount required in period t to leave a household as well off (in terms of the present value of liftetime utility under the initial tax regime, U_1) after the tax change ($p_{j,t}$) as it was beforehand ($p_{j-1,t}$), and

$\left[R\left(p_{j,t}, p_{0,t}; U_1\right) - R\left(p_{j-1,t}, p_{0,t}; U_1\right)\right]$ is the change in compensated tax revenue in period t between the tax regimes j and $j-1$, where

$$R\left(p_{j,t}, p_{0,t}; U_1\right) = \left(p_{j,t} - p_{0,t}\right) x^C\left(p_{j,t}; U_1\right)$$

is compensated tax revenue under tax regime j, and $x^C\left(p_{j,t}; U_1\right)$ is compensated demand in period t under tax regime j.

Excluding the subscript t for simplicity, one can then rewrite the period-specific marginal excess burden, $EB_C\left(p_j, p_{j-1}, p_0; U_1\right)$, as

$$\begin{aligned} EB_C&\left(p_j, p_{j-1}, p_0; U_1\right) \\ &= E\left(p_j; U_1\right) - E\left(p_{j-1}; U_1\right) - \left(p_j - p_{j-1}\right) x^C\left(p_j; U_1\right) \\ &+ \left(p_{j-1} - p_0\right)\left[x^C\left(p_{j-1}; U_1\right) - x^C\left(p_j; U_1\right)\right] \qquad (2) \end{aligned}$$

Taking a second-order Taylor series approximation of (2) around p_{j-1} and ignoring the curvature terms of the compensated demand function, $\frac{d^2 x^C(p;U_1)}{dp^2}$, yields

$$\begin{aligned} EB_C\left(p_j, p_{j-1}, p_0; U_1\right) &\approx \left.\frac{dEB_C}{dp}\right|_{p_{j-1}} \left(p_j - p_{j-1}\right) + \frac{1}{2}\left.\frac{d^2 EB_C}{dp^2}\right|_{p_{j-1}} \left(p_j - p_{j-1}\right)^2 \\ &\approx -\left(p_{j-1} - p_0\right)\left.\frac{dx^C(p; U_1)}{dp}\right|_{p_{j-1}} \left(p_j - p_{j-1}\right) - \frac{1}{2}\left.\frac{dx^C(p; U_1)}{dp}\right|_{p_{j-1}} \left(p_j - p_{j-1}\right)^2 \\ &= -\left[\left(p_{j-1} - p_0\right) \Delta x^C\left(p_{j-1}; U_1\right) + \frac{1}{2}\left(p_j - p_{j-1}\right) \Delta x^C\left(p_{j-1}; U_1\right)\right], \qquad (3) \end{aligned}$$

where the last equality follows from the fact that the Slutsky term, S, is equal to $\frac{dx^C}{dp}$, and $\Delta x^C = S\left(p_j - p_{j-1}\right)$. For more information, see Auerbach (1985).

Plugging (3) into (1) yields the following equation, which is used to compute the marginal excess burden of Japan's proposed tax rate increase:

$$EB_C = -\sum_{j=2}^{3} \sum_{t=t_A^*}^{\infty} \left(\frac{1}{1+i}\right)^{t-t_A^*} \left[\left(p_{j-1,t} - p_{0,t}\right) \Delta x^C \left(p_{j-1,t}; U_1\right) + \frac{1}{2} \Delta p_{j,t} \Delta x^C \left(p_{j-1,t}; U_1\right)\right],$$

where $\Delta p_{j,t} = p_{j,t} - p_{j-1,t}$.

Appendix Figures C.1 and C.2 demonstrate how this expression approximates the marginal excess burden of the phased-in tax rate increase in period t_I^*. First, one must account for the additional burden caused by the tax increase in period t_I^*. This is accomplished by comparing prices and compensated demand under price regimes p_1 and p_2, and is approximated by

$$(p_{1,t_I^*} - p_{0,t_I^*}) \Delta x^C \left(p_{1,t_I^*}; U_1\right) + \frac{1}{2} \Delta p_{2,t_I^*} \Delta x^C \left(p_{1,t_I^*}; U_1\right) \qquad (4)$$

The first term in (4) is represented by area B in Figure C.1, while the second term is an approximation of area A in the same figure.

However, (4) will be at least partially offset by the additional tax revenue that is generated under p_3 in period t_I^* relative to p_2, which is given by

$$(p_{2,t_I^*} - p_{0,t_I^*}) \Delta x^C \left(p_{2,t_I^*}; U_1\right),$$

and is represented by area C in Figure C.2. The additional tax revenue results from the fact that compensated demand in period t_I^* is greater under p_3 than p_2. This is because the price level in period t_I^* is relatively lower under price regime p_3 than it is under p_2. It follows that the area $A + B - C$ yields an approximate value for the marginal excess burden created by the tax rate increase in period t_I^*. The above approach is used for each period t, and the values for each period are appropriately discounted and summed over all periods to yield the present discounted value of the marginal excess burden of the tax rate increase.

Figure II.C.1. Marginal excess burden ($j = 2, t = t_I^*$)

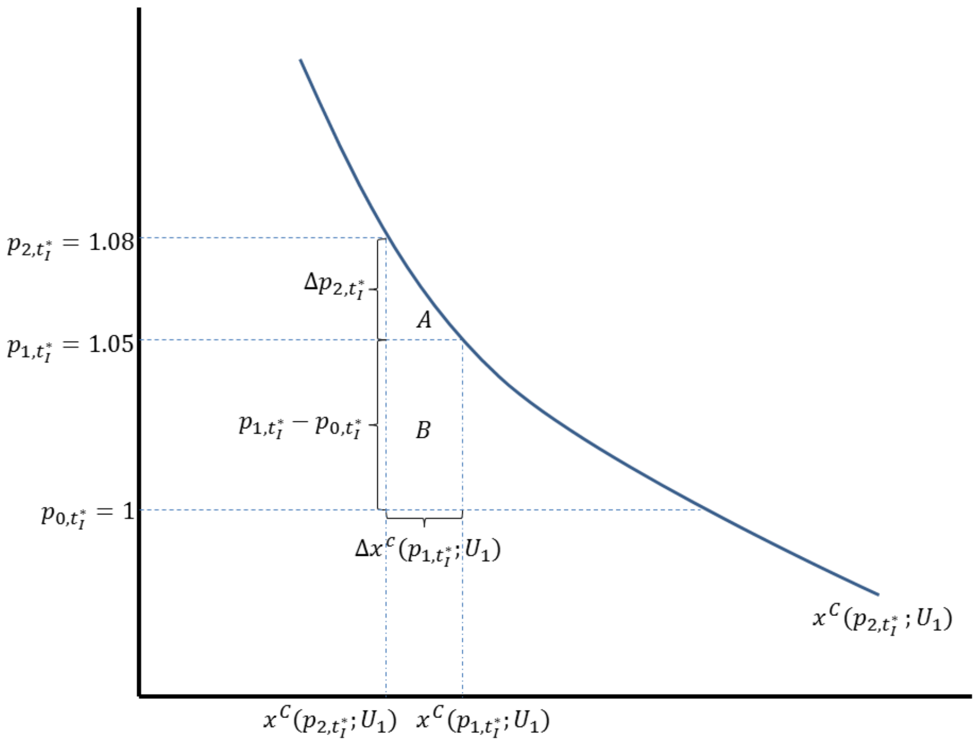
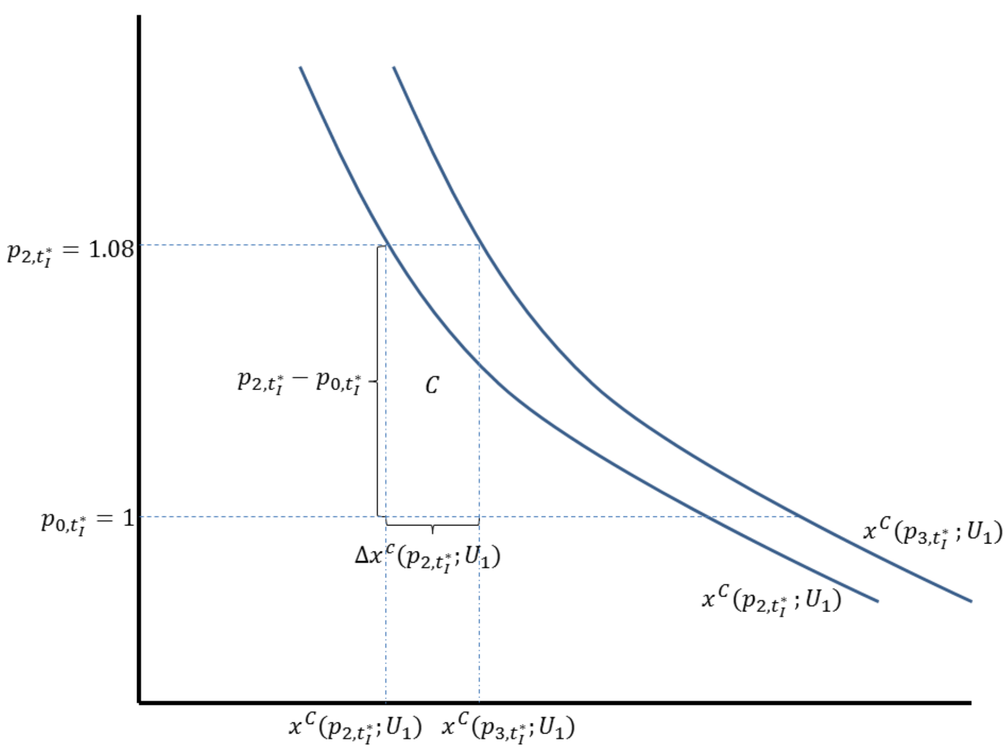


Figure II.C.2. Marginal excess burden ($j = 3, t = t_I^*$)



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CHAPTER III

The Intertemporal Substitution and Income Effects of GST Rate Increases: Evidence from New Zealand

Abstract

Increases in consumption tax rates are an important political issue in New Zealand and around the world, as governments have become increasingly reliant upon them as a source of revenue. And while economic theory is generally favorable towards consumption taxation, increases in consumption tax rates have the potential to induce short-term macroeconomic volatility as a result of intertemporal substitution, as well as depress household consumption due to income effects. This study quantifies these effects using retail sales data from New Zealand and three separate increases in the country's Goods and Services Tax (GST) as event studies. I find that increases in the GST rate are associated with a statistically and economically significant amount of intertemporal substitution in the month just prior to and the quarter following implementation, though the response is likely to be greatly reduced when households are overleveraged or expect prices to decline in the future. The results also suggest that intertemporal substitution is driven largely by the durability or storability of a good, rather than a positive intertemporal elasticity of substitution. Over a longer period of time, I find that uncompensated increases in consumption tax rates depress retail sales in proportion to the increase in the overall price level, while compensated rate increases have no discernible impact on total retail sales.

1. Introduction

Increases in consumption tax rates are a major political issue in New Zealand and around much of the developed world. Governments have become increasingly reliant on indirect taxes as a source of revenue, often as part of an effort to sustain unfunded, or pay-as-you-go, pension systems, rather than resorting to the more politically sensitive decision to cut benefits or raise payroll taxes. And while economic theory is generally favorable towards consumption taxation (e.g. Auerbach et al., 1983), increases in consumption tax rates have the potential to induce short-term macroeconomic disruptions around the time of the tax change as a result of intertemporal substitution, as well as depress household consumption in the long-run as a result of income effects.

Specifically, an increase in the consumption tax rate should result in an increase in price levels. As these rate increases are inevitably announced prior to being implemented, households have an incentive to accelerate purchases to avoid higher prices in the future. As documented by Cashin and Unayama (2011), this incentive is especially strong for durable and storable non-durable goods and services, for which the timing of purchase and consumption do not necessarily coincide, but less so for non-storable non-durable goods and services, for which intertemporal substitution should be governed solely by the intertemporal elasticity of substitution (IES) in consumption. As a result of these incentives, one would expect to observe an increase in sales in the period between announcement of the rate increase and its implementation, and a decline thereafter. This is the intertemporal substitution effect. In addition, if a consumption tax rate increase is uncompensated – that is, if the rate increase is not offset by a reduction in income tax rates or an increase in benefits which allows the household to consume the same bundle it consumed prior to the tax change – it has the potential to reduce household consumption in the long-run.[1] If this occurs, one would expect to observe a decline in sales independent of the intertemporal substitution effects.

Cashin and Unayama (2011) examine these effects using Japan's April 1997 Value Added Tax (VAT) rate increase from three to five percent as a case study, finding that the rate increase was responsible for a significant amount of intertemporal substitution, largely among durable and storable non-durable goods and services, but did not lead to significant reductions in

[1] An uncompensated rate increase will not necessarily reduce household consumption. Households could, for example, increase their lifetime labor supply, or alternatively, draw down on a buffer stock of savings.

household spending over a longer time period as has been previously speculated, perhaps because the rate increase was part of a staggered reform package that was intended to be revenue-neutral (i.e. compensated).

In this paper, I use monthly and quarterly Retail Trade Survey data from New Zealand to quantify the intertemporal substitution and income effects of rate increases in the country's Goods and Services Tax (GST). While estimating these effects for a second country is interesting in and of itself, New Zealand's experience with GST is of additional value because there are three separate rate increases – the October 1986 implementation of GST at a flat rate of 10 percent, the July 1989 rate increase from 10 to 12.5 percent, and the October 2010 rate increase from 12.5 to 15 percent – to examine. Furthermore, the GST implementation and October 2010 rate increase were intended to be compensated, while the July 1989 rate increase was widely viewed as being uncompensated, and thus one might expect to observe heterogeneity in the income effects associated with the rate increases. In addition, the length of time between the passage of legislation and implementation varied for the rate increases, which could potentially affect the magnitude and timing of intertemporal substitution. Finally, the July 1989 and October 2010 rate increases were of similar magnitudes, but economic circumstances around the time the tax rates were changed differed markedly, which provides an opportunity to determine what factors other than the size of the rate increase drive the intertemporal substitution response.

Using seasonally-adjusted monthly Retail Trade Survey data, I find that households engaged in a significant amount of intertemporal substitution prior to both the October 1986 GST implementation and the July 1989 rate increase. Despite the fact that the period between announcement and implementation was much greater for the October 1986 GST implementation than it was for the July 1989 rate increase, nearly all intertemporal substitution for both events occurred in the month prior to the rate change, with sales in September 1986 21 percent higher than they would have been in the absence of a rate increase, and sales in June 1989 11 percent higher. Furthermore, the vast majority of intertemporal substitution was driven by increased outlays on durable goods and services, and industry-specific intertemporal substitution responses suggest that most of the non-durable intertemporal substitution was due to purchases of storable non-durable goods such as liquor. These findings indicate that intertemporal substitution is driven largely by the durability or storability of a good, as opposed to a positive IES. Related to this point, the results suggest that the timing of announcement is of little consequence in minimizing revenue losses sustained by governments as a result of pre-announcement. Because nearly all intertemporal substitution occurs in the month prior to the rate increase, and some delay between announcement and implementation is inevitable, there is little benefit to minimizing the amount of time between the two events. Following both the GST implementation and the July 1989 rate increase, two rate hikes which differed in magnitude, the intertemporal substitution effects died out within three months, suggesting that households do not plan purchases more than a few months in advance.

Surprisingly, the October 2010 GST rate increase elicited a muted intertemporal substitution response compared to the July 1989 episode, despite the fact that the rate changes were similar in magnitude and the October 2010 rate increase was compensated. Several possible explanations for the heterogeneity in the two responses are addressed, with liquidity/borrowing constraints and increases over time in the frequency and depth of retailer discounting as two plausible culprits.

Deflated and seasonally-adjusted quarterly Retail Trade Survey data is used to quantify the income effects associated with the GST rate increases. While the samples that generate these estimates are likely too small to make inferences, the results suggest that the July 1989 GST rate increase, which was uncompensated, reduced retail sales by over two percent in the quarters following its announcement. Given that full forward shifting of the rate increase implied a 2.3 percent increase in prices, the equal and opposite movements in sales and prices indicate first that the average household did not expect the rate increase to benefit it in the form of increased government transfers, and second, that households did not initially increase their labor supply or draw down on a buffer stock of savings to maintain consumption at its prior level. Quarterly retail sales increased slightly (0.34 percent) and fell slightly (0.60 percent) following announcement of the compensated 1986 GST implementation and 2010 rate increases, respectively.[2] Since (Slutsky) compensated rate increases should lead to an unambiguous increase in household consumption, the results suggest either that the rate increases were not truly compensated in the present value sense, or that the estimation strategy used covers an

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[2] I also find that while total retail sales remain largely unchanged, durable retail sales declined, while non-durable retail sales increased, a result also observed in Cashin and Unayama (2011). I plan to investigate this issue further.

insufficient number of periods to capture consumption increases.[3] The decline in retail sales following announcement of the 2010 rate increase is consistent with the claims of some experts that the compensation provided to the lower and middle income classes was less generous than the government suggested it would be. Unfortunately, given that the data is aggregate retail sales data, I am unable to conduct a distributional analysis to elucidate further on this issue.

The remainder of the paper is organized as follows. Section 2 presents some basic theoretical predictions regarding the intertemporal substitution and income effects resulting from increases in GST rates. Section 3 provides background on GST in New Zealand and details on the October 1986 GST implementation, July 1989 rate increase, and the October 2010 rate increase. Section 4 provides an overview of the design and content of the Retail Trade Survey. Section 5 introduces the empirical methodology used to identify the intertemporal substitution and income effects. Section 6 presents the results. Section 7 discusses the implications of the results, and Section 8 concludes.

2. Theoretical Framework

2.1. Heterogeneity in Intertemporal Substitution Across Goods and Services

The magnitude of intertemporal substitution observed between announcement and implementation of a consumption tax rate increase should depend not only on how sensitive a household's consumption is to anticipated price changes (summarized by the IES), but also on the types of goods being purchased and consumed. In particular, the more durable is a good or service, the greater is the incentive to engage in intertemporal substitution, as household's can purchase a good in a relatively low price period and continue to derive a service flow from that same good during a relatively high price period. To demonstrate, suppose that a household solves the following two-period optimization problem:

$$\max_{I_0, I_1} \frac{I_0^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \frac{[(1-\delta)I_0 + I_1]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} \qquad s.t.\ 1)\ I_0 + S_0 = Y_0$$

$$2)\ (1+\tau)I_1 = Y_1 + S_0$$

where

[3] This could be true given that reductions in income tax rates should minimize the disincentive to save.

I_t: Investment in good I in period t

σ: IES

δ: Depreciation rate of good I between period 0 and period 1

S_0: Savings in period 0

Y_t: Income in period t

τ: Tax rate on good I in period 1

The household chooses how much to invest in good I in periods 0 and 1 in order to maximize its lifetime utility subject to a budget constraint. In period 0, the household knows that a consumption tax will be imposed in period 1 at a rate τ, and can adjust its behavior accordingly. What separates this problem from a standard optimization problem with iso-elastic utility is that good I may possess durability. That is, it may not fully depreciate between periods 0 and 1. In other words, it may be the case that $0 < \delta < 1$. Solving the household's problem for period 0 investment in good I yields

$$I_0 = \frac{Y_0 + Y_1}{1 + (1+\tau)\left(\left(\left(\frac{1}{1+\tau}\right) - (1-\delta)\right)^{\sigma} - (1-\delta)\right)} \qquad (1),$$

where

$$I_0 = \frac{Y_0 + Y_1}{1 + (1+\tau)^{1-\sigma}} \qquad (2)$$

if $\delta = 1$. From (2), one observes that the magnitude of intertemporal substitution for non-durable goods depends only on the IES. The larger is the IES, the greater is period 0 investment in good I when a consumption tax is applied in period 1. On the other hand, when $\delta < 1$, (1) makes clear that the magnitude of intertemporal substitution depends not only on the IES (positively), but also on good $I's$ depreciation rate (negatively). In fact, even if the IES is zero, intertemporal substitution of durable goods should be evident in period 0. Furthermore, if the

IES is positive, there is a positive interaction between the durability of the good and the IES. For a given IES, the more durable is the good (i.e. the lower its depreciation rate), the greater will be the magnitude of intertemporal substitution.

In addition to differences in the intertemporal substitution response between durables and non-durables, one would also expect to observe a greater amount of intertemporal substitution among storable non-durable goods and services than non-storable non-durable goods and services. Storable goods, such as laundry detergent, depreciate very slowly over time or not at all if not used, but unlike durable goods, are consumed fully with use. As a result, these goods can be stockpiled during relatively low price periods for consumption during high price periods. Again, a two-period optimization problem can be used to demonstrate that the magnitude of intertemporal substitution should increase the more storable is the good (i.e. the lower is the cost of storage):

$$\max_{I_0,X_0,I_1} \frac{[I_0 - X_0]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \frac{[I_1 + X_0]^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} \qquad s.t.\ 1)\ I_0 + aX_0 + \frac{b}{2}X_0^2 + S_0 = Y_0$$

$$2)\ (1+\tau)I_1 = Y_1 + S_0$$

where

I_t: Investment in good I in period t

X_0: Amount of good I purchased in period 0 for consumption in period 1

σ: IES

a: Linear storage cost parameter

b: Quadratic storage cost parameter

S_0: Savings in period 0

Y_t: Income in period t

τ: Tax rate on good I in period 1

The household again chooses how much to invest in good I in periods 0 and 1 to maximize lifetime utility subject to a budget constraint. In addition, the household can choose to store some of the good purchased in period 0 for consumption in period 1 at a cost, which is assumed to be increasing and convex in the amount stored, X_0. For simplicity, it is assumed that the stored good does not depreciate from period 0 to period 1, though this would not fundamentally alter the results. Solving the household's problem for period 0 investment in good I yields

$$I_0 = \frac{Y_0 + Y_1}{1 + (1+\tau)^{1-\sigma}} + \frac{\tau - a}{b} + \frac{(\tau - a)^2}{2b[1 + (1+\tau)^{1-\sigma}]} \qquad (3)$$

where I_0 reduces to (2) if the good is not storable (i.e. $b \rightarrow \infty$). In the case of storable non-durable goods, intertemporal substitution depends not only on the IES, but also on the storage cost parameters, a and b. Specifically, the magnitude of intertemporal substitution is decreasing in these two parameters. As was the case with durable goods, even if the IES is zero, intertemporal substitution should be present in period 0. For a more thorough treatment of intertemporal substitution among storable non-durable goods, see Hendel and Nevo (2004, 2006).

2.2. Compensated and Uncompensated Consumption Tax Rate Increases and Their Implications for Household Consumption Levels

Consumption tax rate increases can be either compensated or uncompensated. A (Slutsky) compensated increase in the consumption tax rate compensates households such that they are just able to afford the consumption bundle that maximized utility prior to the tax change. Compensated consumption tax rate increases often take the form of reductions in income tax rates, increases in income tax exemption levels, increases in benefits to offset the price increases that accompany a consumption tax rate hike, new social spending, or a combination of these. Uncompensated increases in the consumption tax rate, on the other hand, are not offset by a reduction in income tax liability or increases in benefits, though even an uncompensated increase may in a sense compensate households, as discussed below.

Figure III.1A depicts optimal consumption bundles prior to and following announcement of an uncompensated tax rate increase in the final period of a two-period model, where the revenue from the rate increase is not rebated to households in a lump sum fashion. Prior to announcement of the rate increase, the price of consumption in period 0 is the foregone interest earned from deferring consumption, and thus the slope of the budget line is $-\frac{1}{1+r}$. Under this scenario, the optimal consumption bundle is (C_1, C_0). Following announcement of the rate increase, the slope of the budget line becomes steeper, as the relative price of period 0 consumption has declined. The new utility maximizing consumption bundle is given by (C_1', C_0'). Total consumption and welfare following announcement are lower than they otherwise would have been, as evidenced by the fact that the bundle (C_1', C_0') lies inside the original budget set.

By how much should one expect total consumption to fall following announcement? Since the period between announcement and implementation of the consumption tax rate increase is in general far shorter than the period following implementation, an upper bound for the percentage decline in total consumption would be the percentage increase in the price level resulting from the consumption tax rate increase. Such an increase would be consistent with an infinitesimally short period between announcement and implementation, an IES of zero, no labor supply response to the increase in the price level, and no drawdown on a buffer stock of savings.

In a traditional general equilibrium framework, however, the revenue from an uncompensated consumption tax rate increase will be rebated in a lump sum fashion to households. This scenario is depicted in Figure III.1B. As was the case for the uncompensated consumption tax rate increase with no lump sum rebate, the budget line becomes steeper, with a slope of $-\frac{1+\tau_{C1}}{1+r}$. The lump sum rebate, however, pushes the budget line outwards. The new utility maximizing bundle, (C_1^R, C_0^R), will lie at the intersection of the original budget line and the income expansion path under the new prices $(1 + \tau_{C1}, 1)$. Under this scenario, total consumption may not fall at all, though welfare will due to the distortion caused by the change in price levels. This places a lower bound on the decline in total consumption resulting from an uncompensated tax rate increase.

Figure III.2 depicts a third scenario, a (Slutsky) compensated consumption tax rate increase. In this example, an income tax regime is replaced by a consumption tax regime, with the assumption that the consumption tax rate in period 1 exceeds the real rate of return. Under this scenario, total consumption (and welfare) increases under the new tax regime, since the utility maximizing consumption bundle, (C_1', C_0'), was not attainable under the original budget set. As a result, provided that the rate increase is truly compensated in the Slutsky-sense, the total consumption response should be weakly positive.

3. GST in New Zealand[4]

3.1. The October 1986 GST Implementation

GST was imposed in New Zealand on October 1, 1986 at a flat rate of ten percent on most goods and services. It coincided with the repeal of the Wholesale Sales Tax (WST), which had been levied at the manufacturing stage on a select number of goods (mostly durables) at various rates ranging from 10 to 50 percent, with a standard rate of 20 percent.[5] Relative to the Value Added Taxes (VAT) that were in place in other countries at this time, New Zealand's GST was notable for its broad tax base, which covered 87 percent of consumption. Major exemptions were limited to financial services, existing housing sold by unregistered persons, residential rent, sales of secondhand goods by unregistered traders, sales of donated goods and services by nonprofit organizations, and fundraising activities.

The introduction of GST coincided with a period of major economic reforms undertaken by the ruling Labor Party, whose general goal was economic liberalization.[6] In regards to tax policy, the goal of reform was to increase revenue, reduce high average and marginal tax rates, broaden the tax base, and in so doing, remove or reduce the economic distortions that result from narrow tax bases with high rates. The broad conceptual design for GST was laid out in the November 1984 Budget speech, with a target date of April 1, 1986 set for implementation. However, in June 1985, it was announced that GST introduction would be delayed by at least six months. In August 1985, the government released the Statement on Taxation and Benefit Reform, which officially set October 1, 1986 as the date of implementation for GST, which would be levied at a rate of ten percent and replace the WST. In addition, the Statement laid out additional reforms of income tax, corporate tax, and benefits. For these reasons, I consider August 1985 to constitute "announcement", which will be important for the income effect

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[4] The factual content in Section 2 is largely derived from Douglas (2007), Dickson (2007), Stephens (2007), Stephens (1993), Harding (2010), and the "New Zealand Economic Chronology" statements published annually in the *Reserve Bank Bulletin*. Much of the information regarding the October 2010 rate increase stems from conversations with New Zealand Treasury and Inland Revenue Department officials.

[5] See Appendix Table A.1 for a list of the various WST rates and the goods to which they applied. See Appendix Table A.2 for a list of goods that were exempt from the WST.

[6] In addition to changes in tax policy, other major economic reforms included a shift from import licenses to tariffs, the floating of the exchange rate, privatization of state-owned enterprises, deregulation of the financial, agricultural, transport, and retail sectors, and the elimination of export incentives to manufacturers and supplementary minimum prices for farmers.

estimation, as the Life Cycle Permanent Income Hypothesis (LCPIH) predicts that any income effect associated with a tax change should become evident immediately following announcement. In April 1986, in an effort to mitigate price disruptions upon introduction of GST, all WST rates that exceeded 20 percent were reduced to the standard rate. In July 1986, the government reconfirmed that the GST would be implemented in October as planned.[7] Finally, on October 1, 1986, GST took effect, an event I refer to as "implementation".

The introduction of GST coincided with a host of other tax and benefit reforms designed to increase economic efficiency and offset the additional burden imposed by the GST. In particular, the number of income tax brackets was reduced from five to three, with a reduction in the top marginal tax rate from 66 to 48 percent, while several personal tax expenditures were eliminated. Furthermore, the government set out to ensure that the most vulnerable groups were not made any worse off by GST introduction. Specifically, upon introduction of GST, the government increased all benefits, including superannuation (pension), by five percent, which was the government's estimate of the simultaneous price impact of repeal of the WST and introduction of GST. Family Support was also introduced for those households not on benefit, which included a payment of $36 per week for the first child, $16 per week for additional children, and a guaranteed minimum income of $294 per week for families with at least one child.[8]

The government intended for the tax reforms to leave the average household no worse off than it was prior to the tax changes, and Stephens (2007) claims that the reforms were perceived to be fair. However, the changes may have favored high income households over the less well off. For one, the price impact of GST introduction appears to have exceeded the government's estimates, an issue we return to below. Furthermore, as Stephens (2007) concedes, only higher income households enjoyed large reductions in personal income tax rates. However, given that I rely on aggregate data, I cannot explore the distributional consequences further. Thus, one would expect that GST implementation, coupled with income tax and benefit reforms, would likely not have a significant impact on average retail sales in the long-run.

[7] As a robustness check, I will also allow for July 1986 to constitute "announcement" of GST implementation.
[8] The government also reformed the corporate tax system, closing loopholes, aligning the corporate income tax rate with the top personal income tax rate at 48 percent, introducing a Fringe Benefits Tax, and switching from a classical tax system to an imputation system in order to remove the distortion caused by the double taxation of dividends.

In order for households to accelerate purchases prior to implementation of the GST, it must be the case that they were aware of the impending rate increase, and furthermore, that they expected the rate increase to lead to an increase in price levels. Stephens (2007), Douglas (2007), and Dickson (2007) all note that the public was bombarded with a public relations campaign in the lead up to GST imposition, so it seems safe to assume that public awareness was high. Price expectations are a more complex issue, especially given that goods subject to the standard rate of WST technically experienced a rate reduction. The standard assumption, and working assumption throughout this paper, is that households expected to bear the entire burden of the rate increase in the form of higher prices. Carroll et al. (forthcoming) find that full forward shifting of consumption tax rate increases is the norm across most countries, which the authors suspect is due largely to factor price, and namely wage, rigidities. This appears to have been the New Zealand government's belief as well, as the Statement on Taxation and Benefit Reform predicted that the simultaneous replacement of WST with GST would lead to a one-time increase in the average price level of 5-5.5 percent.[9]

Table III.1 provides estimates of the impact of GST implementation on overall price levels and for specific goods in the quarter of implementation. To generate these estimates, the percentage change in the price level on the previous quarter was regressed on flexible time trend polynomials, quarter dummies (if seasonality was present), and a dummy specific to the quarter of implementation. The time trend polynomial allows for a moving average in quarter-to-quarter price changes, while the 1986 Q4 dummy should capture any deviation above and beyond the average change, which I attribute to GST implementation. Overall price levels increased by 6.53 percent as a result of GST implementation, which exceeds the government's prediction of 5-5.5 percent, but is in line with previous estimates (see Dickson, 2007). For goods such as food that were not previously subject to the WST, GST was fully shifted forward. On the other hand, goods that were previously subject to WST, such as floor coverings, experienced price increases, despite the fact that the WST rate that was being replaced exceeded the new GST rate. This is consistent with Dickson's (2007) claim that at the time of implementation, margins were widened as GST was generally applied to the pre-existing WST inclusive prices, and likely

[9] In addition to these explanations, New Zealand is a small open economy which imports most of its consumption goods (33 percent of GDP in 1986, as opposed to about 11 percent in the United States around the same time period). Provided there exists a world price for these goods, GST would need to be passed onto New Zealand consumers in order for importers to be willing to sell the goods in New Zealand.

accounts for the fact that the overall impact of GST implementation on price levels exceeded the government's prediction.

Identification of the income effect resulting from GST implementation and the tax reforms that coincided with it relies on the assumption that there was not a significant change in other factors that affect household expenditure during our estimation period. The October 1987 global stock market crash was responsible for a sharp decline in both the New Zealand share market and the New Zealand dollar. Furthermore, the crash was blamed for the prolonged economic malaise that followed. As a result, the income effect estimation does not include 1987 Q4 or any subsequent periods.[10]

3.2. The July 1989 GST Rate Increase

On July 1, 1989, the GST rate rose from 10 percent to 12.5 percent. The prospect of an increase in the GST rate was first broached in December 1987, but it was not until March 1989 that the rate increase was formally passed. I consider this event to constitute "announcement" of the rate increase. Thus, relative to GST implementation, households were aware of the rate increase for a shorter period than was the case in 1985-1986.

The 1989 rate increase was primarily intended as a revenue-raising measure. That is, it was widely perceived as being uncompensated. Unlike in 1986, benefits were not immediately adjusted to compensate households for the increase in the price level, nor was the additional revenue intended to fund new social programs. Instead, the additional revenue was intended to plug a $1 billion hole in government accounts. Because the rate increase was uncompensated, and perhaps also because of tight monetary controls that were in place at the time to rein in inflation, Bollard (1992) and Stephens (1993) claim that the rate increase delayed economic recovery from the October 1987 stock market crash, an event which was blamed for the protracted economic downturn in New Zealand.

Full forward shifting of the July 1989 rate increase would have implied a price increase of 2.3 percent on goods and services that were subject to GST. The best available data regarding price expectations is the Reserve Bank of New Zealand's (RBNZ) Survey of Expectations, a quarterly survey of New Zealand business managers, which asks the question "What quarterly

[10] I will likely add more information on macroeconomic trends over this time period, monetary policy, international terms of trade, as well as excise tax changes.

percentage change do you expect in the Consumer Price Index for the [next quarter]?”[11] The mean response in 1989 Q2 for 1989 Q3 was 2.3 percent, which is consistent with full pass through. However, taking first differences, and assuming that any deviation in inflation expectations between 1989 Q2 and 1989 Q3 is due to the GST rate increase, the survey respondents expected the GST rate increase to result in a price increase of only one percent. It is not possible to determine whether respondents factored inflation independent of that caused by the GST rate increase into their 1989 Q3 expectations, but it does seem safe to assume that the expectation was that consumers would bear a significant portion of the rate increase at the very least. As shown in Table III.1, the estimated price impact of the 1989 GST rate increase was 2.31 percent, again implying that consumers bore the full burden of the rate increase.

3.3. The October 2010 GST Rate Increase

On October 1, 2010, the GST rate increased from 12.5 to 15 percent. The prospect of a rate increase was first discussed by the Victoria University Tax Working Group (TWG). The TWG was set up by Victoria University with the support of the government to consider a broad range of medium-term policy options for the New Zealand tax system. The group’s final report, which was released in January 2010, called for an increase in the GST rate from 12.5 to 15 percent. Following the release of the report, Prime Minister John Key announced that the government was carefully considering an increase in the GST rate to 15 percent, and on May 21, 2010, the rate increase was formally passed. Like the two previous rate increases, I consider the passage of legislation to constitute “announcement”.

As was the case for the 1986 GST implementation before it, the 2010 rate increase coincided with a host of other tax and benefit reforms intended to compensate families for the rate increase. In particular, all personal income tax rates were reduced, while benefits, superannuation, and Working for Families payments were increased by 2.02 percent.[12] Despite the government’s intentions, however, some experts are skeptical as to whether lower and middle class households were sufficiently compensated for the rate increase. If this were true, total consumption may not have risen as a result of the tax mix switch.

[11] The survey is not available prior to 1987 Q3, and as a result we cannot gauge expectations around the time of GST implementation.

[12] Additional changes included alignment of the top personal and trust tax rate at 33 percent, a reduction in the company tax rate from 30 percent to 28 percent, and changes in depreciation allowances.

Full pass through of the October 2010 rate increase would imply a price increase of 2.22 percent on goods and services subject to GST. Given that GST covers nearly 90 percent of household consumption, the benefit increase of 2.02 percent upon implementation suggests that the government's expectation was that consumers would bear the full burden of the rate increase in the form of higher prices. Data from the 2010 Q3 Survey of Expectations shows that business managers expected the 2010 Q4 price levels to jump by only 1.6 percent on the previous quarter, less than would be the case under full forward shifting. Taking first-differences of quarterly price expectations implies that managers expected the GST hike to lead to a one percent increase in the price level, which is similar to the 1989 case. Table III.1 shows that the actual price impact of the 2010 rate increase was just under two percent. Again, this finding is consistent with full forward shifting.

4. Data[13]

The data used for this analysis is Statistics New Zealand's Retail Trade Survey (RTS), which collects monthly sales data from businesses undertaking retail activities or specified service activities. The retail sector is defined as those businesses primarily selling goods and services to final consumers. In addition to expenditures by households, final consumption includes expenditures by non-private households living in hotels, boarding houses, etc.; businesses, clubs, trusts, and other purchasers outside the household sector; and overseas residents visiting New Zealand. Specifically, the RTS collects sales data from businesses that fall under the Australia New Zealand Standard Indusrial Classification divisions of Retail Trade, Accommodation, and Personal Services, which can be found in Appendix Table III.A.3.[14] Of the roughly 50,000 retail outlets in New Zealand, the RTS uses a postal questionnaire to collect sales figures from approximately 3,500 enterprises operating between 9,000 and 10,000 geographic

[13] Section 3 content is derived from the following sources: "Information About the Retail Trade Survey", available at http://www2.stats.govt.nz/domino/external/omni/omni.nsf/outputs/retail+trade+survey; "Retail Trade Survey: Implementation of New Survey Design", located at http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/web/Hot+Off+The+Press+Retail+Trade+Survey+-+Survey+design+Information+Paper+Information+Paper?open; Statistics New Zealand (2010). *Implementing ANZSIC 2006 in the Retail Trade Survey*. Wellington: Statistics New Zealand; and Graham, Philippa (2001). "Seasonal Adjustment within Statistics New Zealand". Wellington: Statistics New Zealand.

[14] The RTS does not include expenditures on property and dwelling rents, purchase of houses, property maintenance services, electricity and gas, public transport (local and overseas), medical services, leisure and recreational services, insurance services, and enterprises that do not meet the significance criteria in terms of GST turnover (i.e. enterprises with turnover not exceeding $30,000 NZD).

units (retail outlets), while GST returns are used to obtain sales figures for 37,000 smaller enterprises in order to minimize their compliance costs. Selection into the sample is based on an enterprise's industry, which is chosen based on their predominant activity, and size, with the probability of selection increasing in size, and large retailers facing a 100 percent chance of selection. To ensure the sample accurately depicts the current population distribution, selected businesses within an industry are weighted according to their size. Furthermore, businesses can be reweighted from month to month as their size changes, or if they are reclassified as belonging to another industry. In addition, new businesses enter the sample over time, while businesses that cease operation are removed. Nevertheless, 99 percent of the sample remains the same from one month to the next, and the sample reselection methodology does not significantly impact sales movements.

Monthly current price sales figures are then compiled for each industry. While the current price data does not remove the effects of price movements over time, it does exclude GST. Sales for each industry are then seasonally-adjusted using the U.S. Census Bureau's X-12-ARIMA program (X-11-ARIMA prior to August 1998). Quarterly constant price data is also available. Prior to September 1995, it was generated by summing the seasonally-adjusted monthly data, and then using quarterly retail trade deflators to put the data into constant prices. Since then, a reverse approach has been used, whereby the quarterly current price data is first deflated, and then seasonally-adjusted, which Stats NZ claims removes residual seasonality introduced by the deflators. The monthly current price sales figures are used to estimate the intertemporal substitution effects resulting from the GST rate increases, while the quarterly constant price figures are used to estimate the income effects. Monthly data is used to estimate the intertemporal substitution effects because these effects are likely heavily concentrated in the months just before and after a rate increase, and thus quarterly data will have difficulty capturing these effects. The downside to using the monthly data to identify the intertemporal substitution effects is that it is in current prices, but the empirical methodology described below should mitigate the effects of price changes from month to month.

Two separate RTS series are used for the analysis. Intertemporal substitution and income effect estimates for the October 1986 GST implementation and the July 1989 rate increase are derived from the RET series, which was available from April 1976 to March 1990, while estimates for the October 2010 rate increase are derived from the most recent RTT series, available from May 1995 through December 2010. The series differ slightly in their classification of industries, as recent samples are designed to reflect the changing composition of New Zealand's retail sector. In the RTT series, an enterprise is placed into its respective industry based on the ANZSIC06 classification scheme laid out in Appendix Table III.A.3. Appendix Table III.A.4 provides the classification scheme for the earlier RET series, and it should be noted that the category "Automotive, Fuel, and Repairs", which includes both durable and non-durable goods, was separated into three industries beginning in May 1982: motor vehicles and other transport equipment, petrol stations, and repair of motor vehicles and motor cycles.

As mentioned above, the magnitude of the intertemporal substitution response should be larger for both durable and storable non-durable goods and services. Unfortunately, given the RTS industry classifications, in most cases it is not possible to separate storable non-durables from non-storable non-durables, since, for example, storables such as laundry detergent and non-storables such as fresh fruit are both sold at a supermarket. As a result, each industry is placed into either the "Durable" or "Non-durable" category. Appendix Table III.A.5 provides a list of the industries that comprise the "Durable" and "Non-durable" categories for both the RET and RTT series.

Table III.2 provides summary statistics for the four datasets used in the analysis, while Figures III.3A and III.3B plot monthly current price and quarterly constant price seasonally-adjusted retail sales for the RET series. Figures III.4A and III.4B do the same for the RTT series. For the RET series, note that there are fewer observations for the durable and non-durable categories than there are for the total category. This is due to the fact that the category "Automotive, Fuel, and Repairs" was not separated until May 1982. In regards to the RTT series, the quarterly constant price data is only available from 2003 Q3, when a survey redesign took place. Also note the large spike in retail sales prior to both the October 1986 GST implementation and July 1989 rate increase, which suggest significant amounts of intertemporal substitution prior to those events. Conversely, there appears to be little change in retail sales prior to the October 2010 rate increase.

5. Empirical Methodology

5.1. Baseline Model

The empirical strategy employed for this study largely mirrors that used in Cashin and Unayama (2011). Based on the standard LCPIH with a taste shifter, retail sales can be written in a simple form. The logarithm of retail sales in year y and period t are expressed as follows:

$$E_{y,\mathrm{t}} = \delta_t + T_{y,\mathrm{t}} + B_{y,\mathrm{t}}$$

where δ_t is a seasonal effect, $T_{y,t}$ is a tax effect, and $B_{y,t}$ is an effect for all other factors that determine expenditure independent of the tax change and season (e.g. price movements).[15] Consistent with the LCPIH, tax effects are allowed for only after "announcement" has occurred, where "announcement" is defined to be the period in which legislation was formally passed.

The tax effect can be further decomposed into the period-specific intertemporal substitution effect, $\gamma_{y,t}$, and the income effect, α, which is assumed to be constant over time. That is,

$$T_{y,\mathrm{t}} = \alpha + \gamma_{\mathrm{y,t}} \qquad \text{following announcement}$$

5.2. Identifying the intertemporal substitution effect

This section considers identification of the intertemporal substitution effects. The main idea of the identification strategy is the following: by taking first differences of monthly retail sales data, we can cancel out the income effect in all months save the month in which the income effect first appears, since the income effect is assumed to be constant once it has appeared. Formally, taking the first difference of monthly retail sales yields

$$E_{y,\mathrm{m}} - E_{y,\mathrm{m-1}} = \delta_m - \delta_{m-1} + T_{y,\mathrm{m}} - T_{y,\mathrm{m-1}} + B_{y,\mathrm{m}} - B_{y,\mathrm{m-1}}$$

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[15] For estimation of the intertemporal substitution effects, the period t is one month, while for estimation of the income effects, period t is one quarter.

Since the RTS data used for this analysis is seasonally-adjusted, we can rearrange the above expression as

$$\tilde{E}_{y,m} - \tilde{E}_{y,m-1} = (E_{y,\mathrm{m}} - E_{y,\mathrm{m}-1}) - (\delta_m - \delta_{m-1}) = T_{y,\mathrm{m}} - T_{y,\mathrm{m}-1} + B_{y,\mathrm{m}} - B_{y,\mathrm{m}-1}$$

Suppose $B_{y,m}$ follows either of the two conditions listed below:

1) There is no change in $B_{y,m}$ from one period to the next.
2) $B_{y,m}$ follows a linear trend.

Under condition (1), the term $B_{y,m} - B_{y,m-1}$ cancels out, while under condition (2), the term $B_{y,m} - B_{y,m-1}$ yields a constant, c. More generally, if there is little change in $B_{y,m}$ other than the linear trend, the first differences can be approximated as

$$\tilde{E}_{y,m} - \tilde{E}_{y,m-1} \approx c + \gamma_{y,m} - \gamma_{y,m-1} + \alpha I,$$

where I is an indicator function that takes on a value of 1 in the month when the income effect appears and zero in others. Accordingly, the empirical specification is as follows:

$$\Delta\tilde{E}_{y,m} = c + \Delta\tilde{T}_{y,m} + \Delta u_{y,m}$$

where $\tilde{T}_{y,m}$ is a coefficient associated with an indicator function that takes on a value of 1 in month m of year y, and $u_{y,m}$ represents unobservables affecting expenditure in month m of year y.

Figure III.5 graphically depicts identification of the monthly tax effects using the above first differenced specification. The top figure presents seasonally-adjusted retail sales, where the rate increase causes a deviation in spending from the trend level, E^*, in periods $y, m-1$ and y, m, with the tax effects in the two periods given by $T_{y,m-1}$ and $T_{y.m}$, respectively. Once we take first differences (depicted in the bottom figure), in order to identify the coefficient $T_{y,m}$, we must also difference out the coefficient for the previous month, $T_{y,m-1}$.

To keep the empirical specification as parsimonious as possible, a decision must be made on which months to allow for intertemporal substitution effects. To do so, the following approach was used. The logarithm of seasonally-adjusted monthly retail sales for each of the three categories was regressed on a flexible time trend polynomial, which should remove long-term economic trends. The residuals from these regressions were then plotted over time. The months which allow for tax effects are the months between announcement and implementation for which there is a clear upward trend in retail sales (including at least the final month prior to implementation), and the months including and following implementation for which sales remain below the long-term trend (including at least the month of implementation and the two subsequent months). Appendix Table III.A.6 lists the months used to estimate the intertemporal substitution effects for each rate increase and sales category. Not surprisingly, the number of months required to capture the intertemporal substitution effects for durables exceeds that of non-durables.

One might worry that this approach misses intertemporal substitution that occurs in months following announcement but prior to the final few months before implementation, perhaps because it is hidden by removal of the trend. This possibility cannot be ruled out, but plots of the lower frequency quarterly retail sales data suggest there was little to no intertemporal substitution during the periods immediately following announcement.

With the specification above, the period-specific intertemporal substitution effects before and after the tax changes can be identified. If the income effect appeared in a month *m* immediately following announcement, but prior to the months for which coefficients for the tax effect are included, the coefficients $\tilde{T}_{y,m}$ will capture the period-specific intertemporal substitution effects. If the income effect instead appeared in the same month in which a coefficient for the tax effect is first included, that coefficient would capture both the period-specific intertemporal substitution effect as well as the income effect, while the coefficients for subsequent months would capture only the intertemporal substitution effect. Given this possibility, it seems reasonable to believe the coefficients for the months prior to the rate increase provide a lower bound on the intertemporal substitution effects associated with a GST rate increase. That is, the coefficients represent a lower bound on the percentage change in household spending in the months leading up to the GST rate increases that would not have been observed had a rate increase not been implemented.

5.3. Identifying the Income Effect

To identify the income effects associated with the GST rate increases, a log-level specification for deflated and seasonally-adjusted quarterly retail sales data is used. The basic identification strategy is the following: choose a time interval that begins in the quarter following announcement and extends for a period beyond implementation that is long enough for all intertemporal substitution to have occurred. Provided this is the case, the pre-tax change and post-tax change intertemporal substitution effects will cancel out. Additionally, so long as there are no other significant changes in factors affecting retail sales relative to the quarter of announcement (i.e.$B_{y,q}$), any deviation in sales during this time interval from sales in the quarter of announcement are attributed to the income effect.

The assumption that all intertemporal substitution occured during the time interval of interest can be tested using the results from the intertemporal substitution effect analysis. To minimize the potential change in $B_{y,q}$ relative to the "announcement" date, the estimation period must cease prior to other major events which had the potential to significantly impact retail sales. For example, 1987 Q3 is the final quarter used for estimation of the income effect resulting from GST implementation, since the stockmarket crash of 1987 Q4 likely depressed retail sales, and it is not possible to disentangle the impact of the crash from the impact of GST on sales.

The following empirical specification will allow for identification of the income effect associated with the GST rate increases and any coinciding tax reforms:

$$\tilde{E}_{y,q} = \tilde{E}_{\mathrm{a}} + \boldsymbol{B_o} + T_{pa} + \epsilon_{y,q},$$

where $\tilde{E}_{y,q}$ is the logarithm of deflated and seasonally-adjusted quarterly retail sales in quarter q of year y, $\tilde{E}_a$ is the logarithm of deflated and seasonally-adjusted quarterly retail sales in the quarter of announcement (the omitted quarter), $\boldsymbol{B_o}$ is a vector of coefficients associated with indicator functions that take on a value of 1 in years or quarters which were neither the quarter of announcement nor the quarters being used to estimate the income effect, T_{pa} is a coefficient for an indicator function that takes on a value of 1 in each quarter q following announcement and up to a specified number of quarters following implementation, and $\epsilon_{y,q}$ accounts for unobservables affecting expenditures in each quarter q of year y.

To clarify how the empirical specification above is able to identify the income effect associated with a rate increase, the baseline specification for GST implementation is given as an example. Year indicators are included for 1976 to 1984 and 1988 to 1990. Year-quarter specific dummies are included for 1985 Q1, 1985 Q2, and 1987 Q4. An indicator is also included for 1985 Q4-1987 Q3, the period of interest. Thus, the omitted time period is 1985 Q3, which coincided with "announcement" of GST implementation. This time period becomes the constant in the specification above, and the coefficient associated with the 1985 Q4-1987 Q3 indicator provides average percentage deviations in retail sales in those periods relative to 1985 Q3.

Provided the aforementioned assumptions hold, T_{pa}, the coefficient of interest, will yield the average change in quarterly spending resulting from a GST rate increase and any coinciding tax and benefit reforms.

5.4 Standard Error Corrections

Household decisions regarding period-specific outlays on durable and non-durable goods and services are not necessarily made independent of one another. As a result, one might expect contemporaneous correlation between the error terms for durable and non-durable retail sales in both the intertemporal substitution (first-difference) and income (level) effect estimates. Indeed, in several of the specifications, independence of the residuals from the durable and non-durable equations is rejected. In addition, classical measurement error in the retail sales data will yield negative serial correlation in the first-difference specification, and this holds true for the first-differenced aggregate retail sales figures used in this study. Finally, given that most firms in the Retail Trade Survey samples remain in the sample from one month to the next, one might worry about serial correlation in the error terms for the log-level specification due to firm-specific fixed effects. This appears to be less of an issue than is serial correlation in the first-differenced specification.

Where evidence of these problems exists, the following corrections are made:

1) If independence of the residuals from the durable and non-durable regressions is rejected, but there is no evidence of serial correlation, a seemingly unrelated regression is used.

2) If we cannot reject independence of the residuals from the durable and non-durable equations, but there is evidence of serial correlation, Cochrane-Orcutt AR(1) regression estimates are generated.
3) If independence of the residuals from the durable and non-durable equations is rejected, and there is evidence of first-order serial correlation, generalized least squares estimates that control for contemporaneous correlation and first-order autocorrelation specific to the durable and non-durable equations are used.
4) Otherwise, estimates are derived from ordinary least squares regressions.

5.5 Robustness Checks and a Note on the Income Effect Estimation

Recall that the specification to identify the intertemporal substitution effects allows for a linear trend in$B_{y,m}$. If this trend is not linear, the intertemporal substitution estimates could be biased upwards or downwards depending on whether the trend in $B_{y,m}$ in the period in which intertemporal substitution occurs is greater than or less than the linear trend estimate (as given by the constant in our baseline specification). As a result, an additional specification for identifying the intertemporal substitution effects includes year dummies, which allows for year-specific linear trends in$B_{y,m}$.

In regards to the income effect estimation, a major concern for our empirical model is what constitutes “announcement”. As mentioned above, the LCPIH predicts that the income effect will appear when a rate increase is announced. However, in practice, it is difficult to determine the timing of announcement since there is heterogeneity of information and/or awareness. As discussed in Section 3, I consider final passage of the GST rate increases to constitute “announcement”. However, other dates could be considered. For example, in July 1986, the government reconfirmed that the GST implementation set for October 1986 would go through as planned. As a robustness check, I will carry out the income effect estimation for other dates that could have potentially been considered “announcement” dates.

There is also a tradeoff inherent in the number of quarters following a GST rate increase that are used to estimate the income effect. On the one hand, including more quarters yields an income effect result that is closer to the true long run income effect. On the other hand, inclusion of more quarters makes it more likely that $B_{y,q}$ changes significantly relative to the quarter of announcement, which will bias the income effect result. For this reason, where possible, income effect estimates are generated using a varying a number of quarters following a rate increase.

In addition to the difficulty of determining the “announcement” date, there is a growing literature that suggests the income effects associated with tax changes are absent until the tax change is implemented. Watanabe et al. (2001) examine the spending responses of Japanese households to more than 40 changes in national income tax, local income tax, consumption tax, and social security contributions that occurred between 1975 and 1998. The authors find that over 80 percent of Japanese households respond to tax changes at the time of implementation, as opposed to the time of announcement, and conclude that most Japanese households follow a “near-rational” decision rule, in which the costs of obtaining and processing information associated with a policy announcement outweigh the benefits from improved consumption smoothing.[16] Recent work by Mertens and Ravn (2010) using U.S. quarterly GDP data further supports this finding.[17] If this were true in the New Zealand case, the income effect estimates will be biased towards zero, and the bias will increase in the number of quarters between announcement and implementation.

6. Results

6.1 Descriptive Results

Figure III.6A plots the residuals from a regression of the logarithm of seasonally-adjusted current price monthly retail sales on a flexible time trend polynomial for the months surrounding the October 1986 GST implementation. The time trend polynomial should capture long-term economic trends, so the residuals are interpreted as the percentage deviation in retail sales from the detrended average. The plots strongly suggest that the prospect of GST implementation induced households to engage in a significant amount of intertemporal substitution prior to implementation, as total retail sales in September 1986 were more than 20 percent above the detrended average, with durable retail sales over 30 percent above average in that same month. Non-durable retail sales also appear to have significantly exceeded trend, though the magnitude

[16] The authors define “announcement” as the date which the Liberal Democratic Party (LDP) Tax Committee submits a proposal report to the government. This is followed by Cabinet approval of the proposal, which is then followed by Diet approval. They consider submission of the report to be “announcement” because Cabinet and Diet approval are virtually guaranteed following the Tax Committee’s submission.
[17] Previous work by Poterba (1988), Parker (1999), and Souleles (1999, 2002) also finds that U.S. household spending does not respond to anticipated tax changes until the tax change is implemented.

of intertemporal substitution is much smaller than for durables. The plots also suggest that nearly all of the pre-rate increase intertemporal substitution occurred in the month just prior to implementation, while the intertemporal substitution effects following implementation died out within three months of implementation.

Figure III.6B plots the percentage deviation in deflated and seasonally-adjusted quarterly retail sales for the quarters 1985 Q4 – 1987 Q4 relative to 1985 Q3, the quarter of announcement. Other than the spike and trough in sales resulting from intertemporal substitution around the time of implementation, retail sales in quarters following announcement remain quite similar to sales in the quarter of announcement, suggesting that GST implementation had no impact on retail sales over a longer period of time. It is perhaps worthy to note, however, that while there was no change in overall retail sales, the composition of sales does appear to have changed, with retail sales of durable goods falling below their level at the time of announcement, while sales of non-durables exceed their announcement level, a phenomenon that was also observed in Cashin and Unayama (2011).

Figure III.7A plots the percentage deviation in seasonally-adjusted current price monthly retail sales from the detrended average in the months surrounding the July 1989 GST rate increase. A pattern quite similar to what was observed around the time of GST implementation emerges, with a concentrated buildup in retail sales the month prior to implementation, followed by a sharp fall in sales in the month of implementation, and a return to trend over the course of the next three months. As discussed above, the 1989 rate increase was expected to lead to a price increase of roughly one-half the size of the 1986 GST implementation. What is noticeable in these plots is that the June 1989 intertemporal substitution response also appears to have been approximately one-half the size of the September 1986 response.

Figure III.7B provides the percentage deviation in constant price quarterly retail sales from sales in 1989 Q1, the quarter of announcement. Unlike the 1986 GST implementation, these plots suggest that the July 1989 GST rate increase depressed retail sales over a longer time period. The trough in sales in the quarter of implementation exceeds the spike in the prior quarter, and sales remain below the 1989 Q1 level over the next two quarters. This is true for both durable and non-durable sales, though non-durable sales in March 1989 were uncharacteristically high (for a reason not yet determined), which could bias the result downwards.

Figure III.8A plots the percentage deviation in current price monthly retail sales from the detrended average for the months leading up to and immediately following the October 2010 GST rate increase. What is striking about these plots is how muted the intertemporal substitution response appears to be in the month prior to implementation. Even durable retail sales, which were more than 30 percent above trend in the month prior to GST implementation, and more than 15 percent above trend in the month prior to the 1989 rate increase, jumped only slightly in September 2010. Furthermore, non-durable retail sales actually fell throughout the period between announcement and implementation, and then jumped in the month of implementation, the opposite of what one would otherwise expect to observe.[18]

6.2. Regression Results

The regression results confirm what was observed in the plots discussed in Section 5.1. Table III.3 presents the percentage change in monthly retail sales that would not have been observed had the GST rate increases not been implemented. Specification (1) allows for a linear trend in $B_{y,m}$, while specification (2) includes year indicators which allow for year-specific linear trends in $B_{y,m}$. Table III.4 lists the RTS industries from the RET and RTT series, and highlights those for which a significant amount of intertemporal substitution was observed in the month prior to the rate increase. Table III.5 tests the null hypothesis that all intertemporal substitution occurred within the months for which intertemporal substitution effects were allowed. That is, it tests the null hypothesis that the positive pre-rate increase and negative post-rate increase intertemporal substitution effects sum to zero, a key assumption for identification of the income effects. Finally, Table III.6 provides various estimates of the income effect associated with each GST rate change (and other simultaneous tax and benefit reforms) in terms of the average percentage deviation in quarterly retail sales relative to the quarter of "announcement".

As seen in Table III.3, most intertemporal substitution prior to GST implementation took place in September 1986. Under specification (1), I find that total retail sales in that month were 21 percent higher than they would have been in the absence of a rate increase, due largely to a drastic increase in outlays on durable goods and services, which were 31 percent higher than they

[18] A plot of the percentage deviation in retail sales relative to 2010 Q1 has not yet been generated, as I am waiting for 2011 Q1 data to become available before doing so. The 2011 Q1 data will likely be misleading, however, given the negative impact of the February 2011 Christchurch earthquake on retail sales.

otherwise would have been.[19] As shown in Table III.4, every RTS industry assigned to the durable category experienced a significant increase in retail sales in September 1986. Non-durable sales were also significantly above trend in September 1986, six percent higher than they otherwise would have been. As expected, the non-durable RTS industries that experienced significant increases in retail sales in September – liquor and licensed accommodations, petrol stations, and supermarkets and groceries – were those selling goods characterized by storability. Oddly, sales in the "chemist" category, which covered storable items such as pharmaceutical supplies, cosmetics, and toiletries, did not increase significantly in September 1986. Cashin and Unayama (2011) show that outlays on these types of goods increased significantly prior to the 1997 VAT rate increase in Japan.

The larger is the intertemporal substitution response to an increase in the rate of GST, the larger are the revenue losses sustained by the government as a result of pre-announcement. The results imply that retail sales were 548 million NZD higher in the two months preceding GST implementation than they would have been had a rate increase not been implemented. If one uses the government's conservative assumption that GST implementation would result in an increase in the price level of five percent, this would suggest that the government lost at least 27.4 million NZD of revenue as a result of pre-announcement, which amounts to XX percent of fiscal year 1987 GST revenue.[20]

As discussed above, one of the key assumptions for identification of the income effects is that all intertemporal substitution occurred within the period used to estimate the income effect. Table III.5 tests whether this assumption is violated by adding up the estimated intertemporal substitution effects prior to and following the rate increases to see whether the sum differs significantly from zero. For all three events, we cannot reject the null hypothesis that all intertemporal substitution occurred within the months immediately preceding and following the GST rate hikes, which strengthens the claim that the estimates in Table III.6 capture the income effects resulting from the rate increases.

Total retail sales were not affected following announcement of the October 1986 GST implementation, which was intended to be compensated. Under the baseline specification, I find

[19] Estimates using specification (2) do not differ markedly from those generated by the more restrictive baseline specification.
[20] I have yet to receive numbers from New Zealand's Inland Revenue Department with historical fiscal year revenue, so I cannot calculate the percentages.

that the 1986 tax reform was responsible for average quarterly retail sales that were 0.34 percent higher than in the period of announcement, which is not significantly different from zero. Alternative specifications, which use fewer quarters following implementation and allow for the possibility that “announcement” actually coincided with the government’s reconfirmation of GST implementation in 1986 Q3, yield similar results.

Interestingly, despite the stability in total retail sales, durable retail sales fell by 1.5 percent following announcement, while non-durable retail sales increased by a significant 2.6 percent under the baseline specification. One must view these results with some suspicion, however, as the decline in durable sales and increase in non-durable sales are greatly reduced under the alternative specification that defines 1986 Q3 as the quarter of announcement.

Moving on to the July 1989 GST rate increase, Table III.3 shows that retail sales in June 1989 were nearly eleven percent higher than they would have been, again largely as a result of a sizeable increase in spending on durable goods and services, which were 5 and 16 percent higher in May and June 1989 than they would have been in the absence of a rate increase. Retail sales in nearly every industry assigned to the durable category increased significantly in June 1989 save the “motor vehicle repair” and “other stores” industries, which included jewelers, watch dealers, music shops, etc. Non-durable retail sales also exhibited significant increases in retail sales in June 1989, exceeding trend by nearly five percent. Unlike the 1986 GST implementation, however, only petrol sales increased by a significant amount prior to the July 1989 rate increase. Liquor and grocery sales also increased in June 1989, but there was a great deal of variability in sales of these goods around this time, so their increase was not statistically significant. The regression results further confirm that the intertemporal substitution response to the July 1989 rate increase was roughly half the size of the response to the October 1986 GST implementation.

The total increase in retail sales in the two months prior to the July 1989 rate increase that would not have been observed in its absence was 277 million NZD. Assuming full forward shifting of the rate increase, which implied an increase in the price level of 2.27 percent, pre-announcement resulted in a revenue loss to the government of 7.5 million NZD, or XX percent of fiscal year 1989 GST revenue.

Recall that the GST rate increase in 1989 was uncompensated, so there is potential for a negative income effect, and thus a decline in retail sales. Indeed, that is what is observed, as average quarterly retail sales fell by over two percent following announcement of the rate hike, a result that is robust to estimation periods that differ in the number of quarters used following implementation, though it is not statistically significant. And whereas durable sales declined and non-durable sales increased following announcement of the compensated 1986 GST implementation, both durable and non-durable sales decreased by similar magnitudes following announcement of the July 1989 rate increase.

Finally, as suggested in the plots discussed in Section 6.1, the October 2010 rate increase provides a stark contrast to the July 1989 rate increase with regards to intertemporal substitution. Retail sales in September 2010 were only 1.43 percent higher than they would have been in the absence of a rate increase, due to a significant, though moderate, increase in durable retail sales of four percent. As seen in Table III.4, unlike the initial GST rate increases, the only two industries assigned to the durable category that exhibited significant increases in retail sales in September were the “electrical and electronic goods” and “furniture” industries. Meanwhile, non-durable retail sales were actually below trend in September 2010, and significantly above trend in October 2010.

Average quarterly retail sales fell slightly following announcement of the (compensated) rate increase, as sales in 2010 Q3 and Q4 were 0.6 percent lower than in 2010 Q2. Furthermore, like the compensated rate increase in 1986, durable retail sales fell by a greater magnitude than non-durable retail sales.

7. Discussion

7.1. Heterogeneity of the 1989 and 2010 Intertemporal Substitution Responses

This section attempts to interpret and rationalize the results presented above. Perhaps the most puzzling result is the muted intertemporal substitution response prior to the October 2010 GST rate increase, a result made more surprising by the fact that the 2010 rate increase was compensated and was nearly identical in size to the uncompensated 1989 rate increase, which did induce a significant amount of intertemporal substitution among both durable and non-durable goods and services. These disparate findings beg the question of what factors are responsible for the heterogeneity in the intertemporal substitution responses. There are several potential explanations, some of which can be evaluated to an extent and some for which I can only speculate.

The first explanation that I investigate is whether a wealth shock and the ensuing adjustment in durable stocks provide a plausible explanation for the difference in the 1989 and 2010 intertemporal substitution responses. As theory predicts, and the results above confirm, intertemporal substitution is largely driven by increased outlays on durable goods and services. In September 2010, durable retail sales were a modest 4 percent above trend, as opposed to 16 percent in June 1989. One explanation for this lack of a response may have been the negative wealth shock that resulted from the recession that began in New Zealand in late 2008, accompanied by the tendency of durable stocks to adjust slowly to these shocks. On the heels of the global financial crisis, New Zealand fell into a recession in late 2008 as the result of drought, falling home prices, and high petrol prices (Bollard, 2009). In fact, data from the RBNZ show that household wealth as a percentage of disposable income fell by over ten percent from 2007 to 2008, the largest decrease in the 30 years for which data is available.

A frictionless LCPIH model would predict that households immediately adjust their durables stock downward in response to this reduction in wealth. However, as Caballero (1990, 1993) highlights, households are slow to adjust their durable stocks due to adjustment costs such as secondary market imperfections. As a result, following a negative wealth shock such as the 2008 recession, one might expect households to reduce their durable stock not by selling off their stock of durables and purchasing cheaper versions of the goods that made up the durable stock prior to the shock, but rather by holding onto the existing stock and postponing purchases of new goods. In fact, anecdotal evidence suggests this was the case in New Zealand, as the average age of cars and vans on the road in New Zealand hit an all time high of 13 years in 2011, which was attributed to the recession (Stock, 2011). Figure III.4B provides further evidence of this phenomenon, as durable retail sales began to decline markedly after peaking in 2007. Provided the wealth shock brought on by the 2008 recession induced a large proportion of households to gradually deplete their durable stock, one would expect that a relatively small proportion of households were in a position to take advantage of the intertemporal substitution incentives offered by the prospective rate increase.

Working against this explanation, however, is the fact that prior to the 1989 GST rate increase, New Zealand households were faced with a negative wealth shock of a similar magnitude to the 2008 recession. The stock market crash of October 1987 arguably had a deeper and more prolonged impact on New Zealand than any other developed economy. As the RBNZ data cited above shows, household wealth as a percentage of disposable income fell by eight percent from 1986 to 1987, by another three percent the following year, and by nearly two percent from 1988 to 1989. Furthermore, Figure III.3B exhibits the same gradual decline in durable retail sales following the crash that was observed following the 2008 recession. Thus, the argument that a negative wealth shock followed by a delayed adjustment in durable stocks was responsible for the heterogeneity in the intertemporal substitution responses is not completely convincing, and is even less convincing given that durable retail sales again began to rise in 2009, suggesting any delayed adjustment of the durable stock was complete.

Another potential line of reasoning for the heterogeneity in the 1989 and 2010 intertemporal substitution responses is that households expected retailers to largely absorb the October 2010 GST rate increase. Indeed, the Warehouse, a discount store similar to Wal-Mart and the largest department store retailer operating in New Zealand, announced that it did not intend to increase prices when the 2010 rate increase took effect (McKentee, 2010). However, other anecdotal evidence, remarks by government officials, the level of compensation provided to households for the rate increase, and surveys of price expectations suggest that consumers expected to bear a substantial portion of the burden imposed by the rate increase. In addition to its discussion of Warehouse's pricing strategy, the McKentee article also mentions that several other retailers intended to increase their prices by no more or less than the 2.2 percent price increase implied by the GST rate increase, explaining that profit margins were too thin not to increase prices, but that competition was too fierce to increase prices by more than that amount. The words and actions of government officials also suggest that full forward-shifting was to be expected. An August 2010 speech by RBNZ Governor Alan Bollard, and a subsequent September 2010 RBNZ monetary policy statement make clear that the Bank expected the GST rate increase to coincide with a one-off spike in inflation. Finally, as discussed above, the government's decision to compensate beneficiaries with a 2.02 percent increase in benefits at the time of the GST rate increase, along with the fact that inflation expectations in 2010 Q3 for 2010 Q4 spiked, and then subsequently fell for quarters following 2010 Q4, lead me to conclude that backward shifting of the GST rate increase is not a compelling argument for the differences in the 1989 and 2010 intertemporal substitution responses.

A third argument for heterogeneity in the intertemporal substitution responses is the impact of liquidity/borrowing constraints. If households lack liquid assets and find it difficult to borrow against future earnings, their consumption behavior should deviate from the predictions of the frictionless LCPIH in the sense that they will underreact to an anticipated price increase such as that brought on by a hike in the GST rate. In fact, Vissing-Jorgensen (2002) finds that the IES differs significantly for households that hold assets and those that do not, and further that the IES does not differ signicantly from zero for households without assets.

Figure III.9A presents a time series of household savings relative to disposable income. While this measure does not perfectly capture liquid assets, one can argue that it serves as a useful proxy. Note that household savings were positive in 1989, but negative throughout the previous decade, including 2010, which suggests that it was easier for households to bring forward purchases in 1989 than 2010 by simply drawing down savings. Even without liquid assets available, however, it is possible that the GST rate increase was large enough to provide the incentive for households to borrow against future earnings through credit card purchases. However, Figure III.9B, which presents a RBNZ time series of credit limits in New Zealand, and Figure III.9C, which presents credit card usage as a percentage of total electronic card transaction values, suggest that households have been credit constrained over the past few years. In Figure III.9B, August 2008 marked an abrupt reduction in New Zealanders' total credit limit, which has yet to recover, while Figure III.9C shows that credit card usage has declined markedly since its 2007 peak. As a result, it seems plausible that the combination of New Zealand's negative savings rate in the years leading up to and including 2010 and the credit crunch over the prior few years contributed to the muted intertemporal substitution response prior to the October 2010 rate increase.

However, other statistics suggest that in general, New Zealand households are much less borrowing constrained today than they were in the past. For example, Bollard et al. (2006) note that New Zealand households have increasingly 'cashed in' on rising home prices over the past decade by resorting to Housing Equity Withdrawals (HEW) to fund consumption. This would imply that despite the fact that household savings rates in New Zealand are negative, and financing consumption through credit card use has recently become more difficult, a large proportion of New Zealand households can still borrow with relative ease.

But it may no longer be in their interest to do so. Figure III.10 provides the annual percentage change in home prices, as well as the market value of the housing stock, from 1990 to 2010. Figure III.11 presents household debt as a percentage of disposable income over the same time period. What is immediately apparent from the two figures is the substantial increase in both the value of the housing stock and the level of household debt through 2007. After 2007, however, home prices leveled off, and then fell sharply in 2009. Perhaps not surprisingly, this period also coincided with what appears to be the beginning of deleveraging by households.

The argument for the muted intertemporal substitution response in September 2010 then goes as follows. Prior to 2007, households consumed as if their home prices would continue to appreciate into the foreseeable future, borrowing against the equity generated by their homes to finance current consumption. When home prices fell, households realized they were overleveraged, and devoted their resources to paying down debt. If the interest charged on a household's debt is great enough, the rational response is to continue paying down debt rather than take advantage of the intertemporal substitution incentives offered by the 2010 GST rate increase. The decline in the dissavings rate, credit card usage, and household debt after 2007 all suggest that debt repayment played a role in the muted intertemporal substitution response.

Finally, two other potential explanations exist for which I can only speculate, as data to evaluate these claims is not available to my knowledge. First, both the September 2010 RBNZ Monetary Policy Statement and a statement from New Zealand's ASB Bank regarding the potential impact of a GST rate increase emphasize that the frequency and depth of retailer discounting have increased over time, and therefore it might not be in a consumer's interest to make pre-GST rate increase purchases if the goods they plan to buy will be marked down by a greater percentage in the future. Second, the rise of e-commerce allows consumers to avoid the GST system entirely by ordering goods such as electronics, books, movies, and music offshore. Both arguments seem plausible, and the first, in particular, strikes me as a strong disincentive to bring forward purchases prior to the GST rate increase, especially given that persistent inflation is less of a problem in New Zealand today than it was throughout the 1980's.

7.2. Implications of the Results for Tax Policy and Consumer Preferences

The intertemporal substitution results provide several implications for tax policy and consumer preferences. First, the fact that intertemporal substitution for all three events was heavily concentrated in the month just prior to the rate increase, despite differences in the time interval between announcement and implementation, implies that intertemporal substitution is largely a function of the durability and storability associated with a good or service rather than a positive IES, which would instead imply an increase in consumption throughout the entire period between announcement and implementation. The finding also leads one to wonder whether previous studies that have found a positive IES using non-durable expenditure are instead capturing storability. Related to this point, because nearly all intertemporal substitution occurs in the month prior to a rate increase, and some delay between announcement and implementation is inevitable, a government is unlikely to be able to time announcement to minimize revenue losses. That is, providing a minimal time interval between announcement and implementation will not reduce revenue losses sustained as a result of pre-announcement. Finally, since the post-rate increase intertemporal substitution effects died out within three months of implementation for three rate increases of varying sizes, this suggests that households do not plan purchases more than three or four months in advance.

The income effect estimates provide some additional insights into consumer behavior, whether and when the revenue from the uncompensated rate increase was redistributed, and whether the compensated rate changes were truly compensated in the Slutsky sense. As mentioned earlier, an uncompensated increase in the GST rate that is rebated lump sum to households should not cause a percentage decline in retail sales that is equal and opposite to the percentage increase in the price level. On the other hand, this behavior could be observed for an uncompensated rate increase for which revenue is not transferred back to households, the IES is zero, and the period between announcement and implementation relative to the estimation period after is short. Given that the July 1989 rate increase was associated with a decline in retail sales equal and opposite to the increase in the price level, the implication is that the revenue generated by the rate increase was not rebated to households or that there was a lag in redistribution of the revenue to households (and also that Ricardian equivalence does not hold). The results further suggest that households did not initially increase their labor supply or draw down from a buffer stock of savings to maintain consumption at or near its level prior to the rate increase.

The fact that retail sales did not increase following the compensated rate increases suggests one of two things. First, the GST rate increases were not truly compensated in the present value sense. Since Slutsky-compensated changes in relative prices yield an unambiguous increase in household welfare, consumption should increase as a result of the change, and thus retail sales should increase in the long run following announcement. A second possibility is that the compensated GST rate increases did improve welfare and consumption, but that the estimation period following announcement is too short to capture the effect. This could be true given that compensation in the form of reductions in personal income tax rates mitigate the savings distortion associated with the taxation of the return to savings. As a result, if savings increased immediately after the change, consumption would not initially increase, but would do so over the long run.

8. Conclusion

The increasing reliance of governments on consumption taxation as a source of revenue begs the question "What is the macroeconomic impact of increases in consumption tax rates?" Using retail sales data from New Zealand surrounding the October 1986 GST implementation, July 1989 GST rate increase, and October 2010 GST rate increase to quantify the impact, the preceding analysis demonstrates that anticipation of higher prices in the future resulting from a consumption tax rate increase induces a statistically and economically significant amount of intertemporal substitution in the month immediately prior to and the quarter immediately following implementation, though this response is likely to be mitigated when households are overleveraged or expect prices to decline in the future. Furthermore, while the revenue losses sustained by governments as a result of intertemporal substitution are not negligible in absolute terms, they comprise a small share of total tax revenue, and in any case, the results suggest that there is little that governments can do to minimize the amount of revenue that is lost from announcing consumption tax rate increases prior to their implementation.

Over a longer time frame, the New Zealand experience suggests that uncompensated increases in consumption tax rates depress retail sales in proportion to the increase in the price level, which provides evidence against Ricardian equivalence. Compensated rate increases, on the other hand, had little discernible impact on total retail sales. In particular, the fall in retail sales resulting from the October 2010 GST rate increase seems to lend some credence to the claims of some experts that compensation for the most recent tax change was inadequate. The results further indicate that in addition to greater volatility in sales around the time of the rate increase, industries specializing in the sale of durable goods may also suffer a decline in sales over a longer time frame.

Because this analysis utilized aggregate retail sales data, there is little to be said regarding the distributional consequences of uncompensated and compensated increases in consumption tax rates. An empirical analysis of the distributional consequences of such changes is a promising area for future research. Finally, an attempt should be made to quantify the welfare costs of such changes using the results from this exercise and Cashin and Unayama (2011), which I leave for future work.

Table III.1. Estimated Impact of GST Rate Increases on Price Levels

Category	Rate Increase 1986 Q4	Rate Increase 1989 Q3	Rate Increase 2010 Q4
Overall	6.53	2.31	1.99
Food	9.95	5.65	1.25
Alcohol & Tobacco	9.90	3.09	0.74
Footwear	5.88	1.84	0.23
Vehicles	6.03	1.29	0.11
Floor coverings	8.35	0.77	1.62
Household textiles	10.57	1.76	5.51
Clothing	8.80	1.66	-0.38
Furniture	N/A	N/A	2.99
Household appliances	N/A	N/A	1.21

The above table provides estimates of the percentage increase in price levels resulting from increases in GST rates. To generate the estimates, the percentage change in price level on the previous quarter was regressed on a flexible time trend polynomial, quarter dummies (if seasonality was present), and an indicator for the quarters in which the GST rate increase occurred. The time trend polynomial allows for a moving average in price changes, while the indicator functions capture any deviation from the average, which I attribute to the GST rate increase.

Table III.2. Retail Trade Survey Summary Statistics						
Data Series	**Category**	**Obs.**	**Mean***	**Std. Dev.**	**Min**	**Max**
RET Monthly Current Price	Total	168	1,443	576	579	2,532
April 1976 - March 1990	Durable	95	1,030	160	708	1,567
	Non-durable	95	851	172	566	1,121
RET Quarterly Constant Price	Total	56	3,333	153	3,015	3,760
1976 Q2 - 1990 Q1	Durable	31	1,886	116	1,667	2,181
Base period: 1980 Q4	Non-durable	31	1,518	57	1,391	1,584
RTT Monthly Current Price	Total	188	4,098	912	2,927	5,532
May 1995 - December 2010	Durable	188	1,832	340	1,347	2,449
	Non-durable	188	2,267	592	1,501	3,323
RTT Quarterly Constant Price	Total	30	16,034	797	14,041	17,192
2003 Q3 - 2010 Q4	Durable	30	6,636	409	5,957	7,488
Base period: 1995 Q3	Non-durable	30	9,398	522	8,073	10,092

*Millions of New Zealand dollars

Table III.3. Percentage Deviation in Retail Sales from Trend*							
		Total		Durable		Non-durable	
Event	**Period**	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**
GST Implementation October 1986	Aug-86	3.22	3.03	4.33	4.08		
		(2.15)	(2.07)	(2.65)	(2.57)		
	Sep-86	**20.90**	**20.43**	**30.61**	**29.98**	**6.18**	**5.95**
		(2.34)	**(2.22)**	**(3.11)**	**(2.99)**	**(1.83)**	**(1.81)**
	Oct-86	**-14.50**	**-15.17**	**-21.62**	**-22.59**	**-6.99**	**-7.37**
		(2.54)	**(2.47)**	**(3.36)**	**(3.30)**	**(1.92)**	**(1.93)**
	Nov-86	**-7.38**	**-8.24**	**-10.59**	**-11.92**	**-3.93**	**-4.47**
		(2.54)	**(2.55)**	**(3.38)**	**(3.42)**	**(2.06)**	**(2.14)**
	Dec-86	-2.70	-3.87	-2.31	-3.96	**-3.60**	**-4.32**
		(2.34)	(2.44)	(3.14)	(3.33)	**(1.92)**	**(2.08)**
	Jan-87	-2.86	-3.37	-2.52	-3.52	**-3.23**	**-3.63**
		(2.15)	(2.18)	(2.82)	(2.86)	**(1.82)**	**(1.88)**
Rate Increase July 1989	May-89	1.86	1.49	**5.24**	**5.16**		
		(2.15)	(2.05)	**(2.65)**	**(2.54)**		
	Jun-89	**10.53**	**10.64**	**15.74**	**15.74**	**4.71**	**4.72**
		(2.34)	**(2.16)**	**(3.08)**	**(2.89)**	**(1.65)**	**(1.60)**
	Jul-89	**-8.66**	**-8.82**	**-12.20**	**-12.19**	**-4.58**	**-4.56**
		(2.54)	**(2.36)**	**(3.32)**	**(3.11)**	**(1.65)**	**(1.60)**
	Aug-89	-3.08	-2.87	**-8.04**	**-7.94**		
		(2.54)	(2.36)	**(3.19)**	**(3.01)**		
	Sep-89	**-4.01**	**-4.10**	**-6.66**	**-6.66**		
		(2.34)	**(2.16)**	**(2.95)**	**(2.78)**		
	Oct-89	-1.58	-1.13	-1.12	-1.08		
		(2.15)	(2.05)	(2.65)	(2.54)		
Rate Increase October 2010	Sep-10	1.43	1.72	**3.82**	**3.81**	-0.25	0.27
		(1.05)	(1.08)	**(1.85)**	**(1.93)**	(1.09)	(1.15)
	Oct-10	-0.99	-0.52	**-5.89**	**-5.90**	**2.17**	**3.00**
		(1.25)	(1.30)	**(2.20)**	**(2.33)**	**(1.28)**	**(1.38)**
	Nov-10	-0.14	0.56	-1.44	-1.46	0.68	1.91
		(1.49)	(1.63)	(2.63)	(2.93)	(1.53)	(1.73)
	Dec-10	-1.56	-0.66	**-4.99**	-5.01	0.63	2.21
		(1.68)	(1.90)	**(2.96)**	(3.42)	(1.71)	(2.02)

*Figures in bold indicate significance at the ten percent level. Standard errors are listed in parentheses.
Notes: The figures above are derived from a regression of the first difference of the logarithm of current price monthly retail sales on first-differenced year-month indicators for specification (1), and both year dummies and first-differenced year-month indicators for specification (2). The coefficients associated with the year-month indicators are interpreted as the intertemporal substitution effects resulting from the GST rate increases.

Regressions for total retail sales correct for first-order serial correlation. Regressions for durable and non-durable retail sales in the RET series correct for both contemporaneous correlation between the durable and non-durable equations, and first-order serial correlation in each of the equations. All regressions from the RTT series correct for only first-order serial correlation.

Table III.4. Retail Trade Survey Industries that Experienced a Significant Increase in Retail Sales the Month Prior to a GST Rate Increase*	
RET Series (May 1982-March 1990)	
Durable	**Non-durable**
Clothing and textiles	Butcher
Department store	Chemist (Pharmaceuticals)
Footwear	**Liquor & lic. accommodation**
Furniture	Other food
Hardware	***Petrol stations***
Household appliances	Restaurants and takeaways
Motor vehicles	**Supermarket and groceries**
Motor vehicle repair	Unlicensed accommodations
Other stores	
RTT Series (May 1995-December 2010)	
Durable	**Non-durable**
Clothing, footwear, and personal accessories	Accommodation
Department store	Food and beverage services
Electrical and electronic goods	Fuel
Furniture	Liquor
Hardware	Pharmaceutical and other stores
Motor vehicle and parts	Specialized food
Non-store and commission-based	Supermarket and groceries
Recreational goods	

*****Industries from the RET and RTT series that are listed in **bold** text experienced a significant increase (at the ten percent level) in retail sales in September 1986 and September 2010, respectively, while industries from the RET series listed in *italics* experienced a significant increase in retail sales in June 1989. Industries from the RET series listed in both **bold** and *italics* experienced a significant increase in retail sales in both September 1986 and June 1989.

Table III.5. F-tests of Null Hypotheses That All Intertemporal Substitution Occurred Within Specified Period									
	Total			**Durable**			**Non-durable**		
Event	**Test**	**Sum***	**p-value**	**Test**	**Sum**	**p-value**	**Test**	**Sum**	**p-value**
GST Implementation October 1986	$\sum_{1986,8}^{1987,1} T_{y,m} = 0$	18.3	0.90	$\sum_{1986,8}^{1987,1} T_{y,m} = 0$	70.4	0.58	$\sum_{1986,9}^{1987,1} T_{y,m} = 0$	**-100.4**	**0.07**
Rate Increase July 1989	$\sum_{m=5}^{m=10} T_{1989,m} = 0$	-87.4	0.53	$\sum_{m=5}^{m=10} T_{1989,m} = 0$	-33.0	0.79	$\sum_{m=6}^{m=7} T_{1989,m} = 0$	4.2	0.85
Rate Increase October 2010	$\sum_{m=9}^{m=12} T_{2010,m} = 0$	-18.2	0.93	$\sum_{m=9}^{m=12} T_{2010,m} = 0$	-169.1	0.30	$\sum_{m=9}^{m=12} T_{2010,m} = 0$	150.2	0.19

*Millions of New Zealand Dollars

Notes: Figures in bold denote significance at the ten percent level. The figures above are derived from F-tests for which the null hypothesis is that the coefficients, which are associated with year-month indicators from a regression of first-differenced retail sales on first-differenced year-month indicators, sum to zero. That is, all intertemporal substitution occurred within the months for which we conduct the F-test. Standard errors for these regressions were calculated in the same manner as described in the "Notes" section for Table 3 above.

Table III.6. Average Percentage Change In Quarterly Retail Sales Since "Announcement"*					
Event	**Announcement**	**Test**	**Total**	**Durable**	**Non-durable**
GST Implementation October 1986	1985 Q3	1985 Q4 - 1987 Q3	0.34	-1.49	**2.60**
			(3.35)	(4.12)	**(1.37)**
		1985 Q4 - 1987 Q2	0.44	-1.22	**2.48**
			(3.41)	(4.14)	**(1.37)**
		1985 Q4 - 1987 Q1	0.30	-1.23	2.17
			(3.49)	(4.18)	(1.32)
	1986 Q3	1986 Q3 - 1987 Q3	-0.04	-0.43	0.33
			(3.46)	(4.34)	(1.37)
		1986 Q3 - 1987 Q2	0.22	0.10	0.25
			(3.57)	(4.40)	(1.39)
		1986 Q3 - 1987 Q1	0.14	0.27	-0.17
			(3.74)	(4.55)	(1.41)
GST Rate Increase July 1989	1989 Q1	1989 Q2 - 1990 Q1	-2.17	-2.28	-2.12
			(3.43)	(4.39)	(1.29)
		1989 Q2 - 1989 Q4	-2.40	-2.56	**-2.32**
			(3.59)	(4.53)	**(1.33)**
GST Rate Increase October 2010	2010 Q2	2010 Q3 - 2010 Q4	-0.60	-0.93	-0.39
			(2.15)	(2.71)	(1.65)

*Figures in bold indicate significance at the ten percent level. Standard errors are listed in parentheses.
Notes: The coefficients above are derived from a regression of the logarithm of current price quarterly retail sales on an indicator that takes on a value of 1 in the quarters following "announcement" up to a specified number of quarters following implementation. Year dummies or year and quarter-specific indicators control for sales in periods that are of no concern, and the omitted time period is the quarter of "announcement". Thus, the coefficients of interest capture the average percentage deviation in quarterly retail sales following "announcement". Under our identification assumptions, these coefficients yield the income effect of the GST rate increase. The coefficients for "total" retail sales are derived from an Ordinary Least Squares regression, while the coefficients for "durables" and "non-durables" are derived from a Seemingly Unrelated Regression allowing for contemporaneous correlation between the residuals of the durable and non-durable equations.

Figure III.1A. Uncompensated consumption tax rate increase with no lump-sum rebate

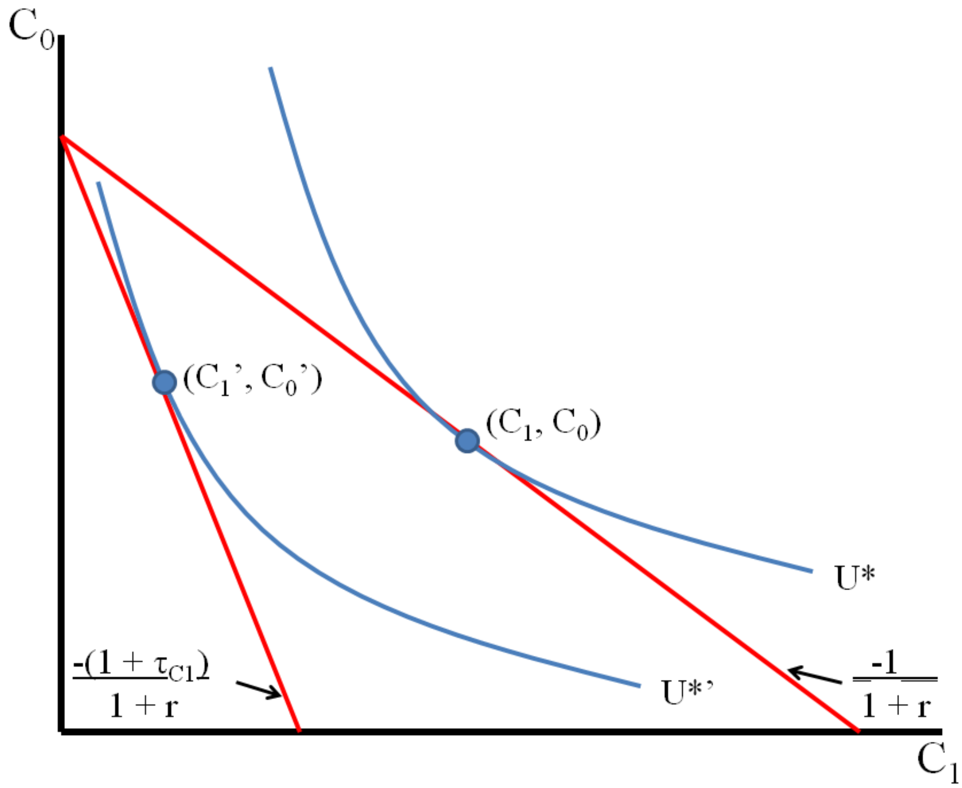


Figure III.1B. Uncompensated consumption tax rate increase with lump-sum rebate

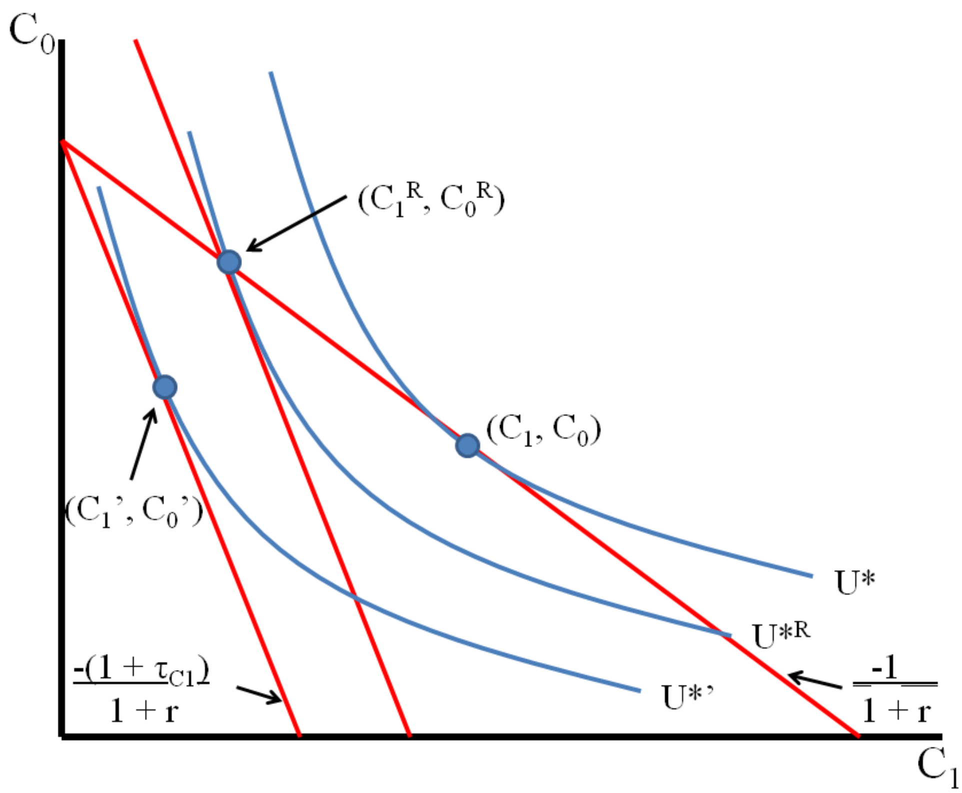


Figure III.2. Compensated consumption tax rate increase

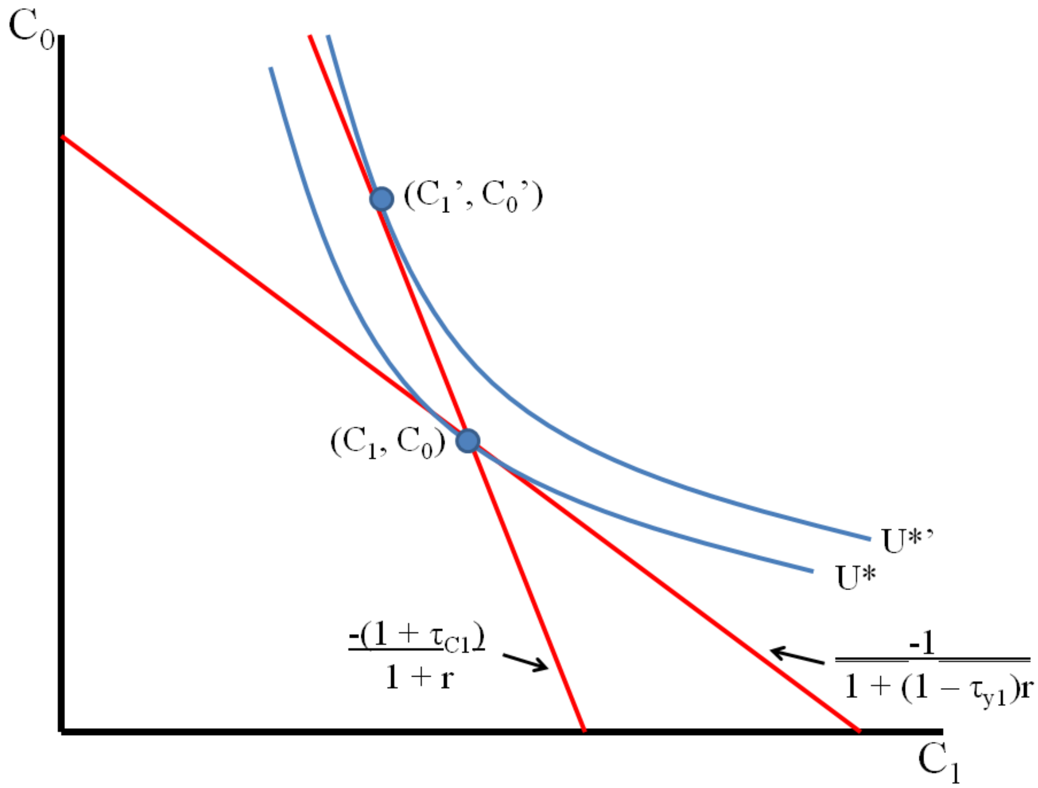


Figure III.3A. RET seasonally-adjusted monthly retail sales

Nominal dollars (excludes GST)

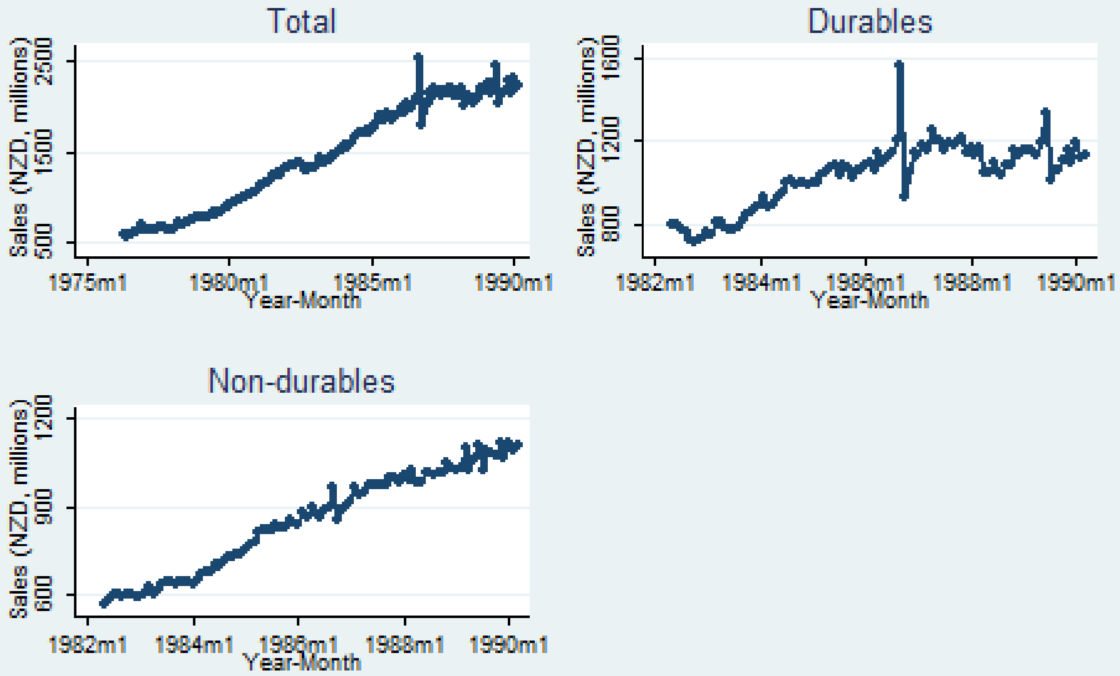


Figure III.3B. RET seasonally-adjusted quarterly retail sales

1980 Q4 dollars (excludes GST)

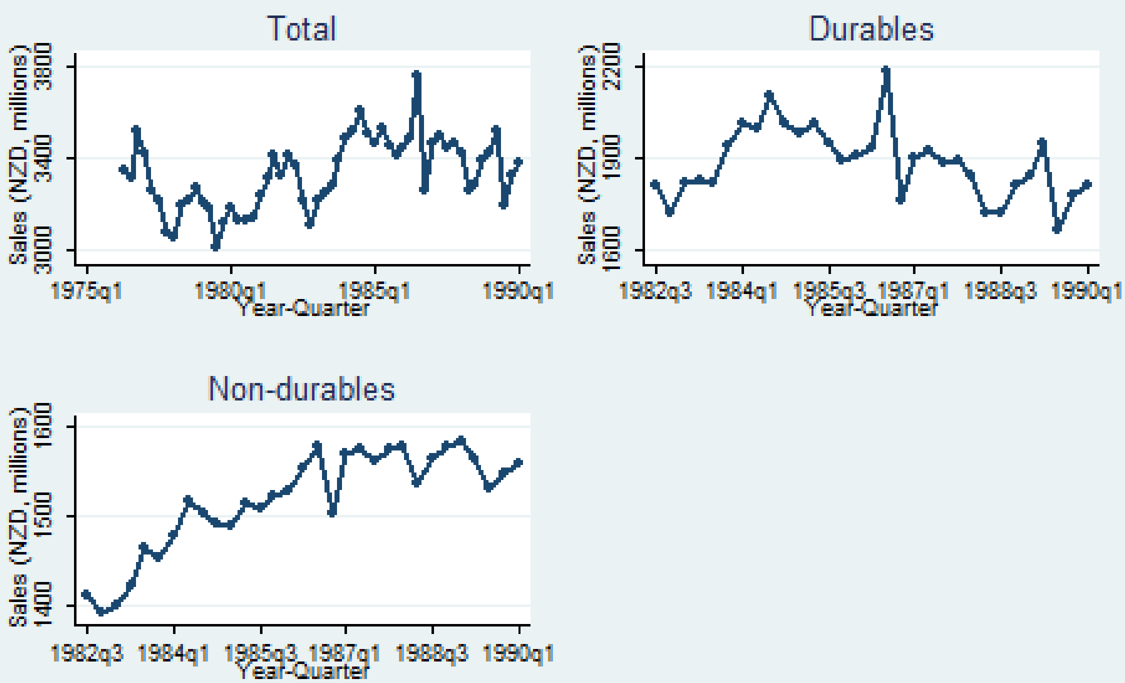


Figure III.4A. RTT seasonally-adjusted monthly retail sales
Nominal dollars (excludes GST)

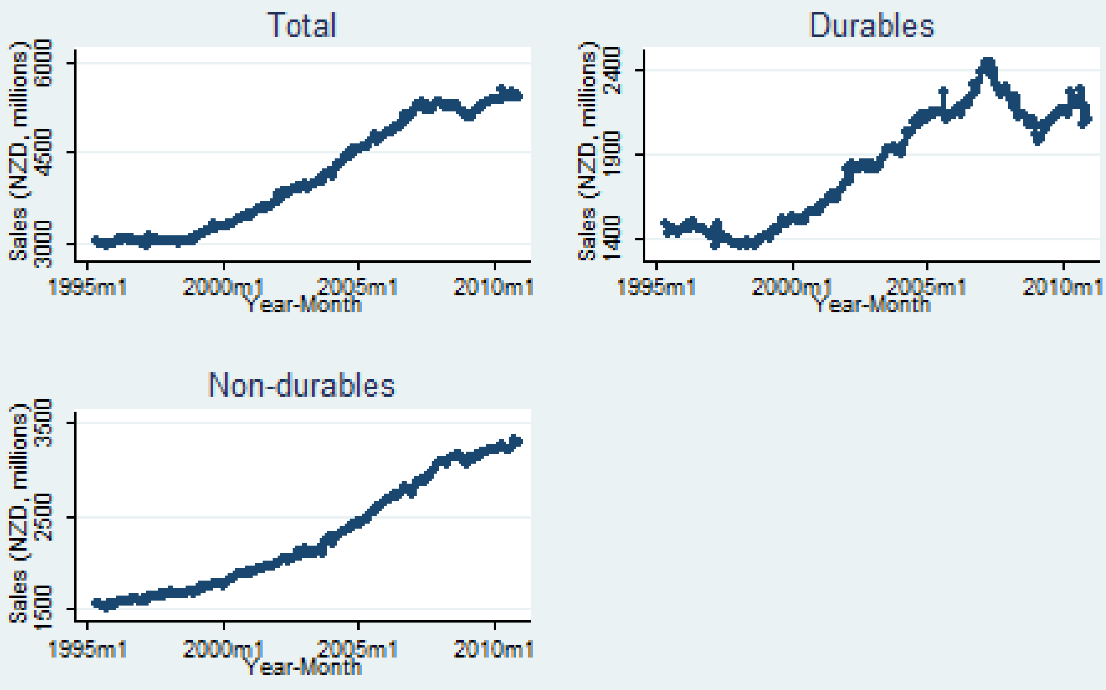


Figure III.4B. RTT seasonally-adjusted quarterly retail sales
1995 Q3 dollars (excludes GST)

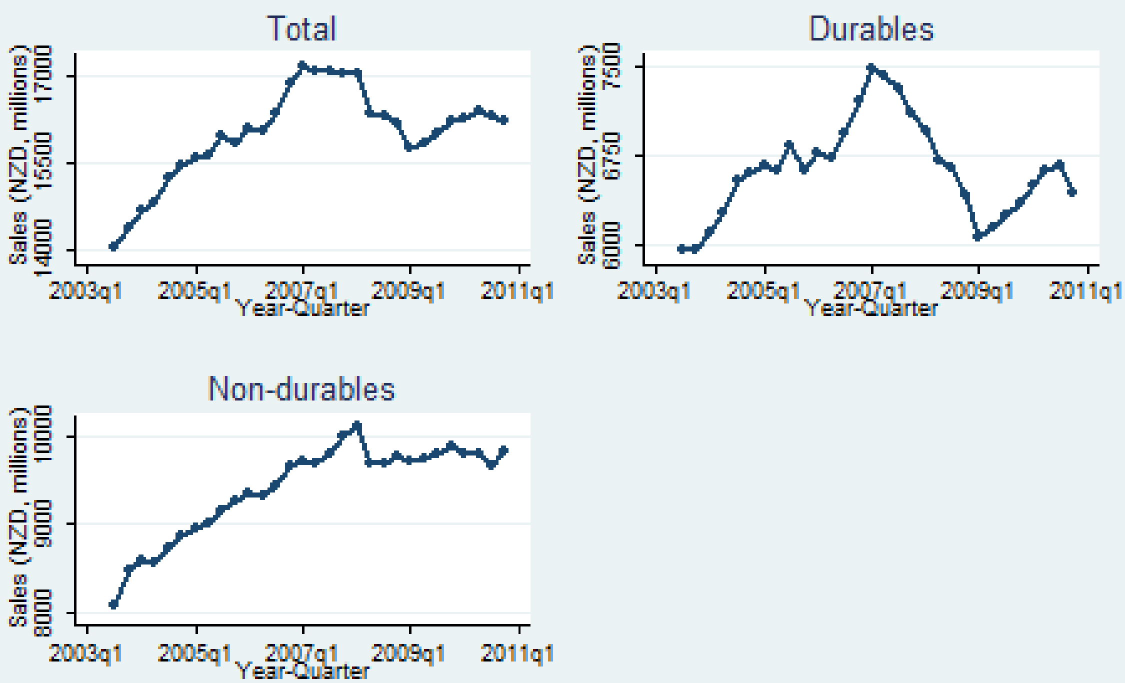


Figure 5. Identifying the intertemporal substitution effects of a GST rate increase on retail sales using a first-differenced specification

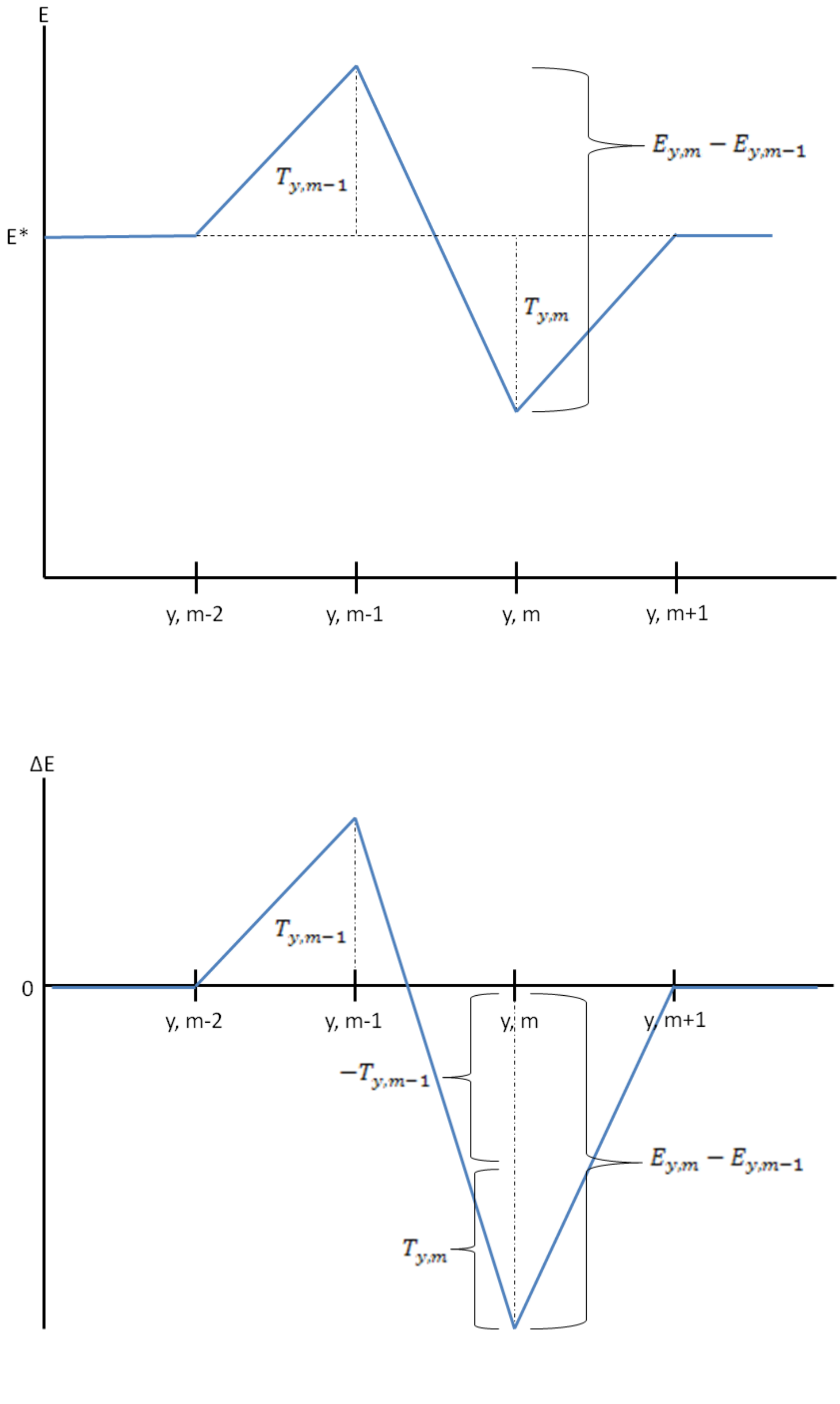


Figure III.6A. Percent deviation from detrended average

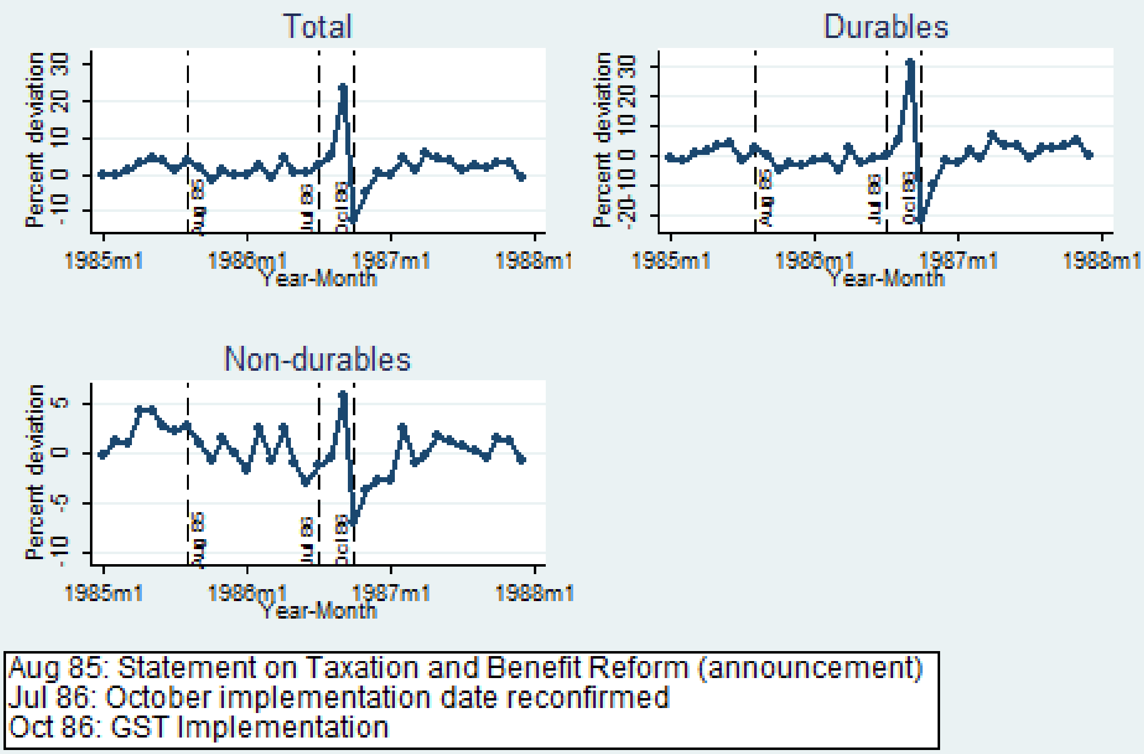


Figure III.6B. Percent deviation from 1985 Q3 retail sales

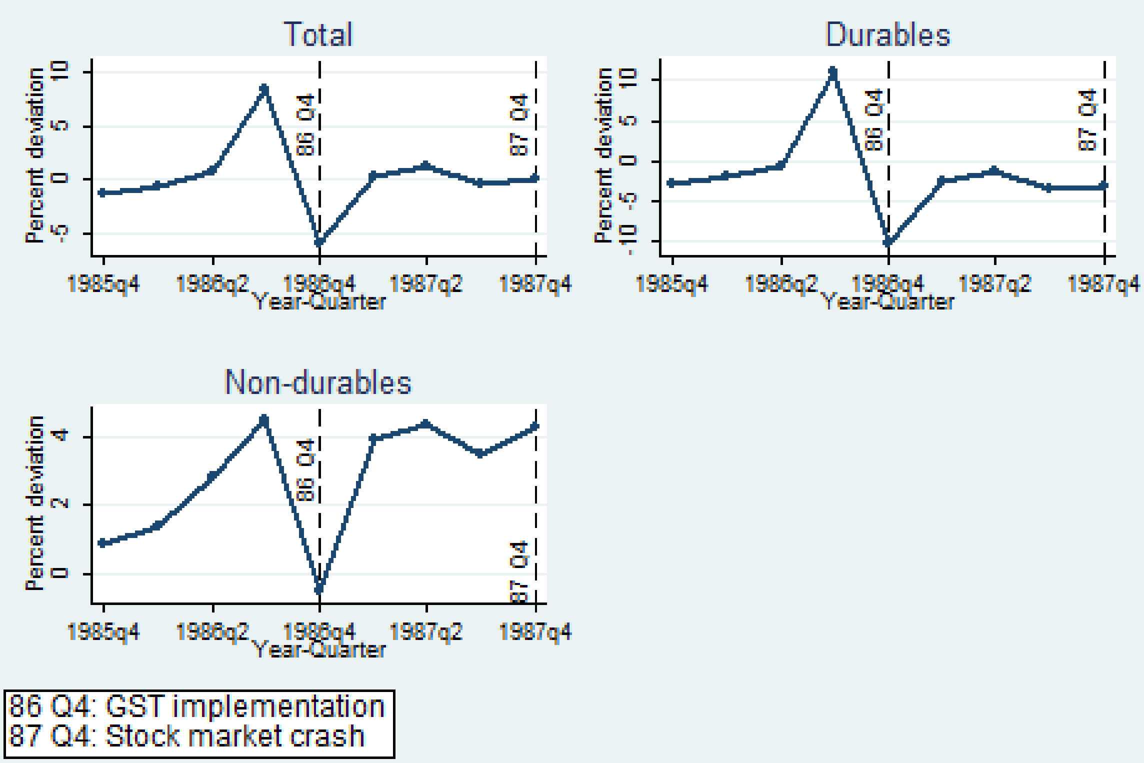


Figure III.7A. Percent deviation from detrended average

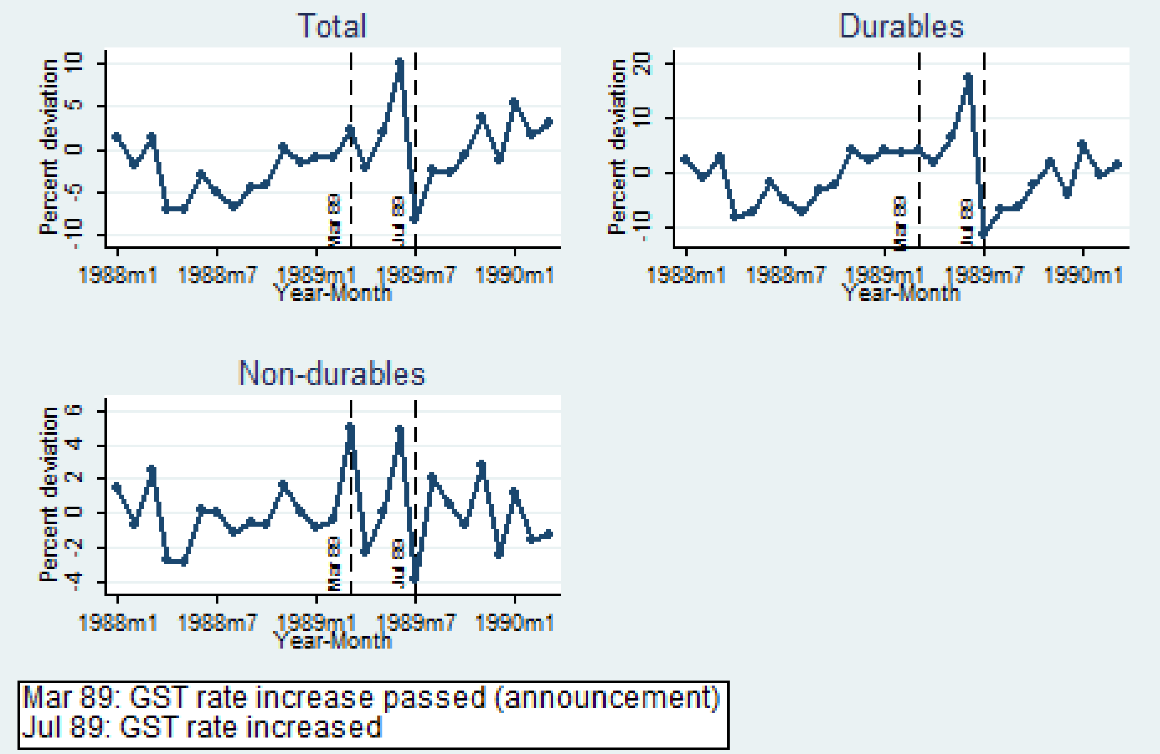


Figure III.7B. Percent deviation from 1989 Q1 retail sales

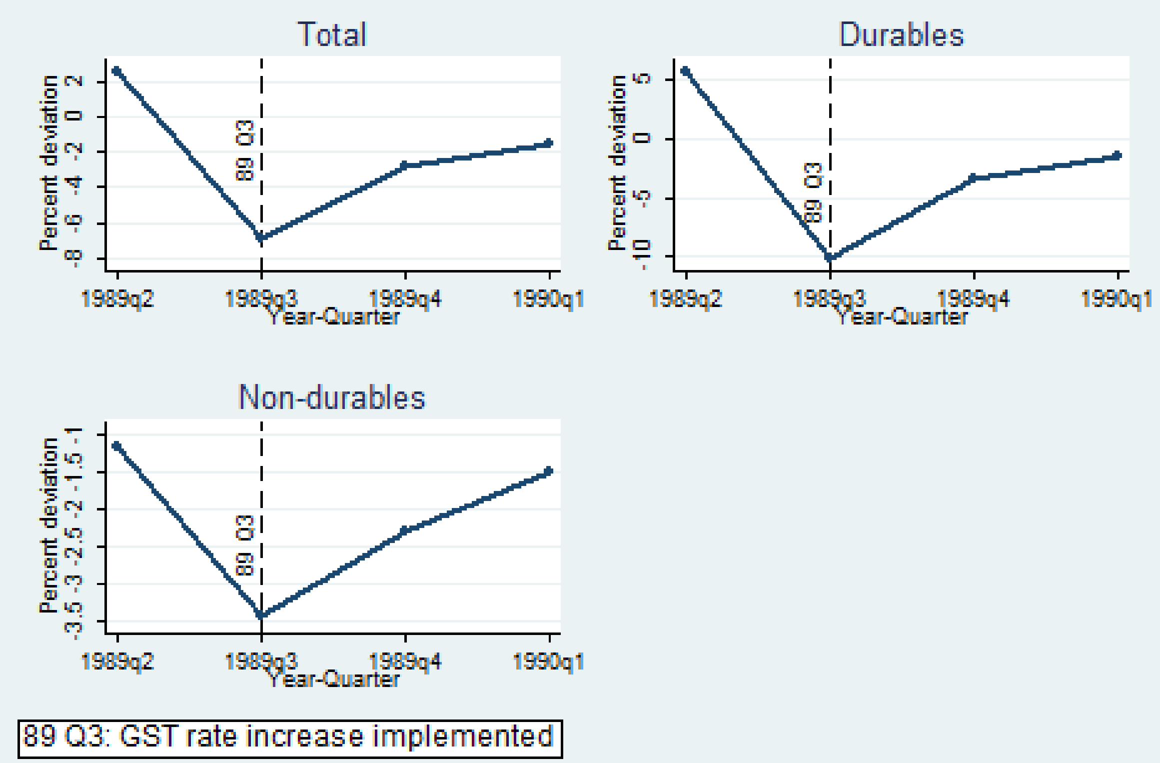


Figure III.8A. Percent deviation from detrended average

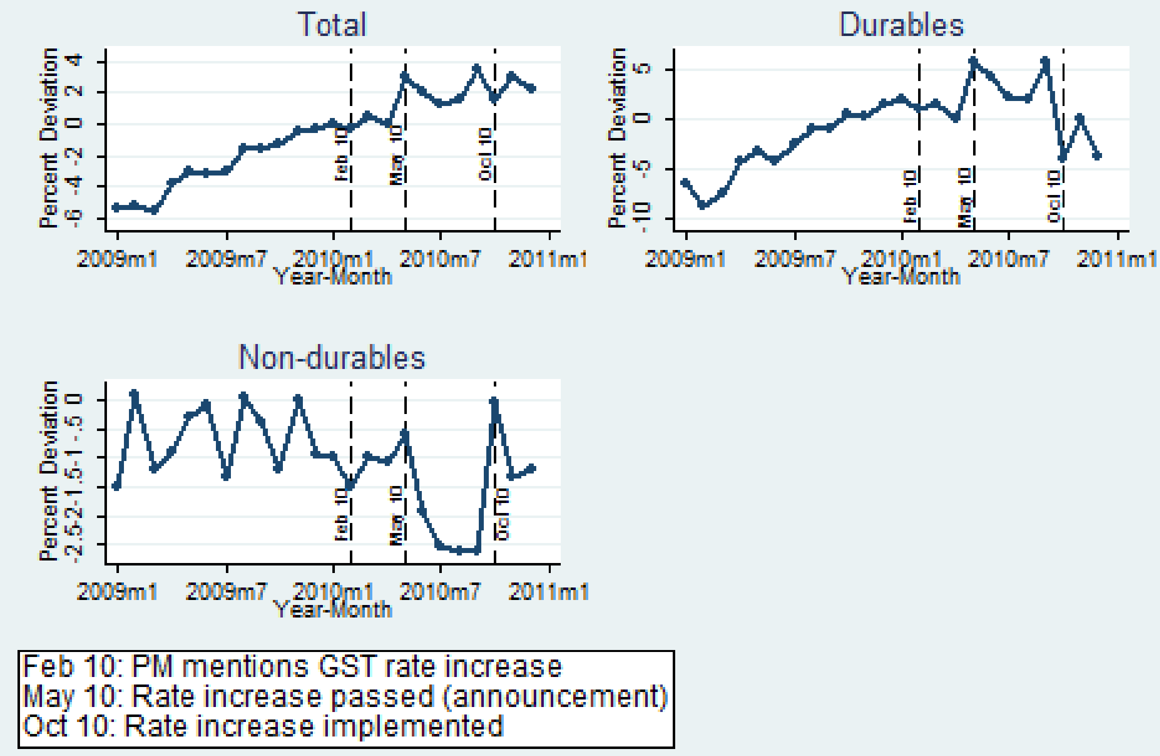
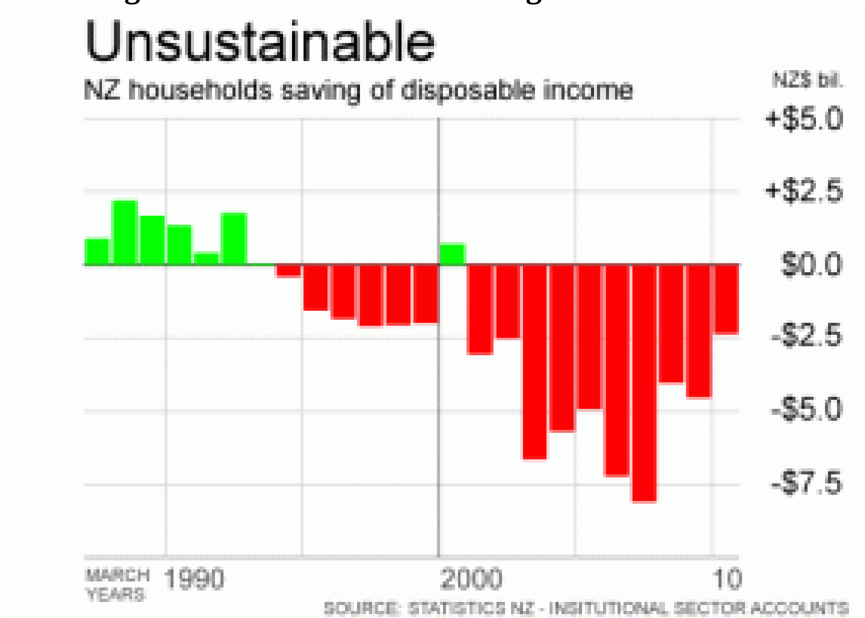


Figure III.9A. Household Savings in New Zealand



Source: Tarrant, Alex. (2010, December 16). "Kiwis still spending more than they earn, although dissavings are declining, new Stats NZ measure shows". Retrieved from http://www.interest.co.nz/news/51732/kiwis-still-spending-more-they-earn-although-dis-savings-are-declining-new-stats-nz-measure-shows

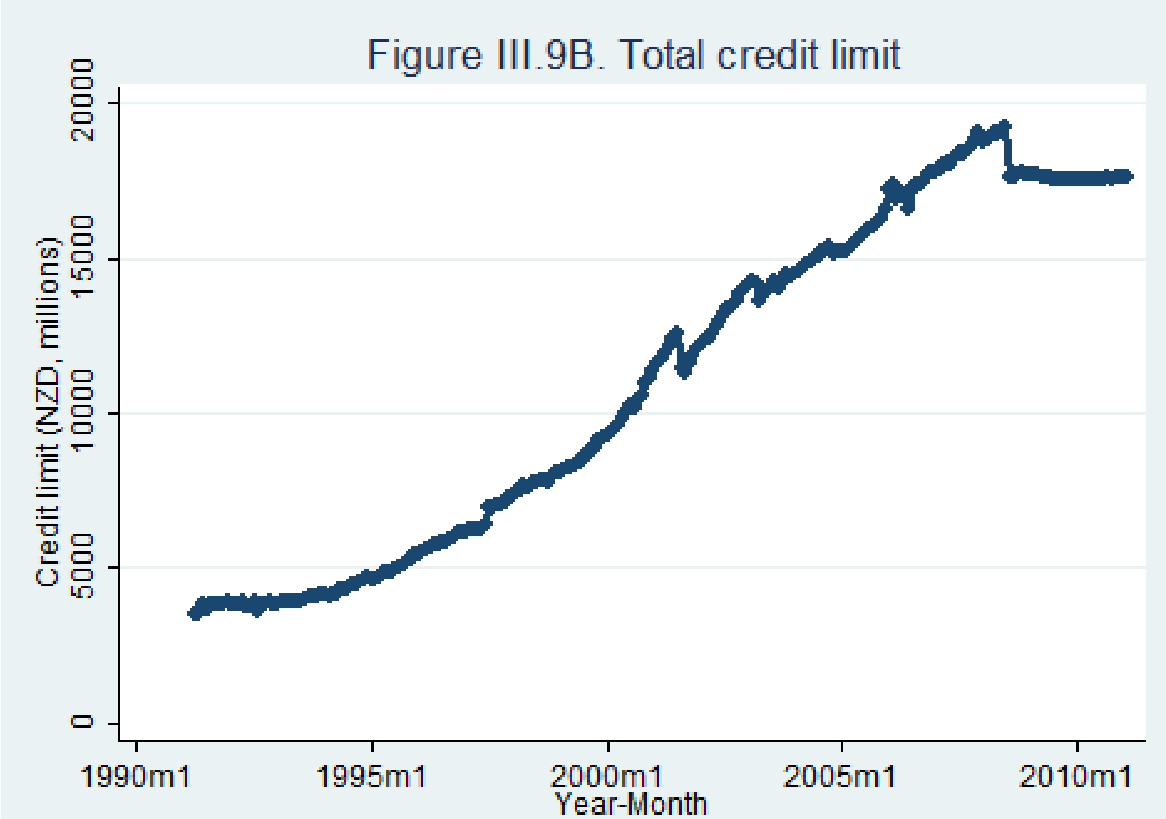


Figure III.9B. Total credit limit
Credit limit (NZD, millions)
0
5000
10000
15000
20000
1990m1
1995m1
2000m1
2005m1
2010m1
Year-Month

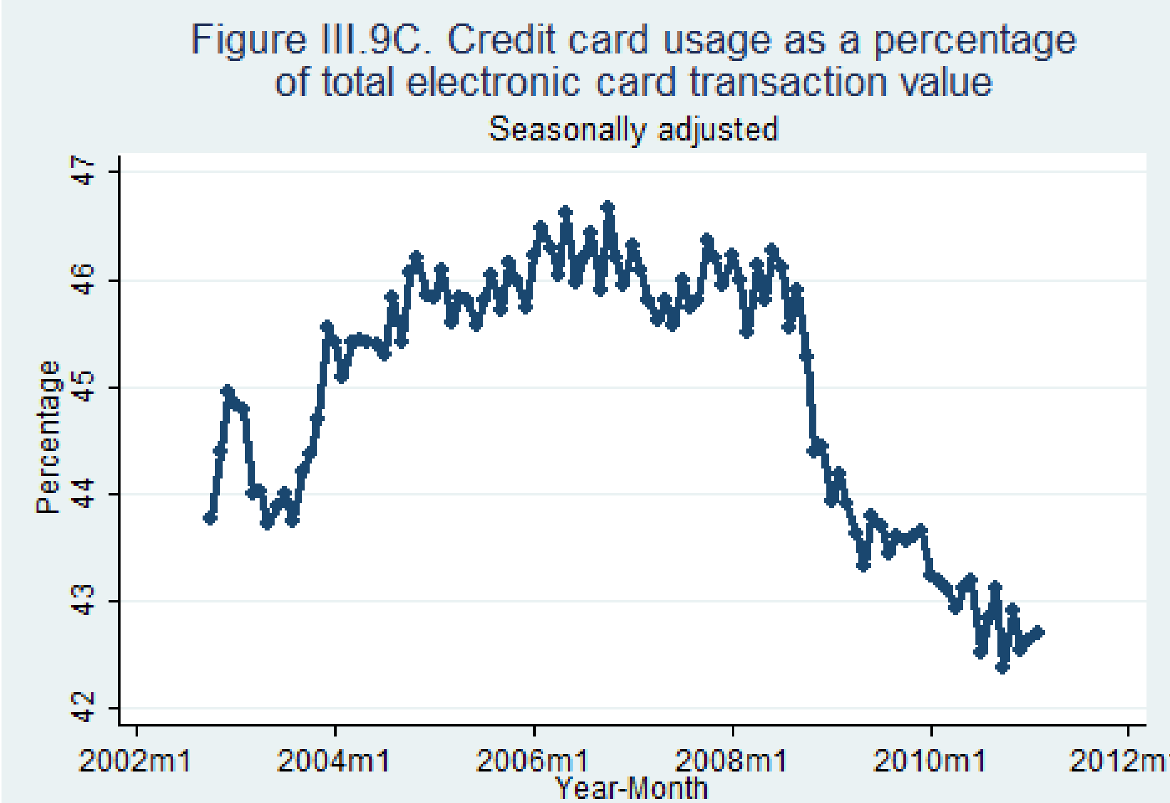
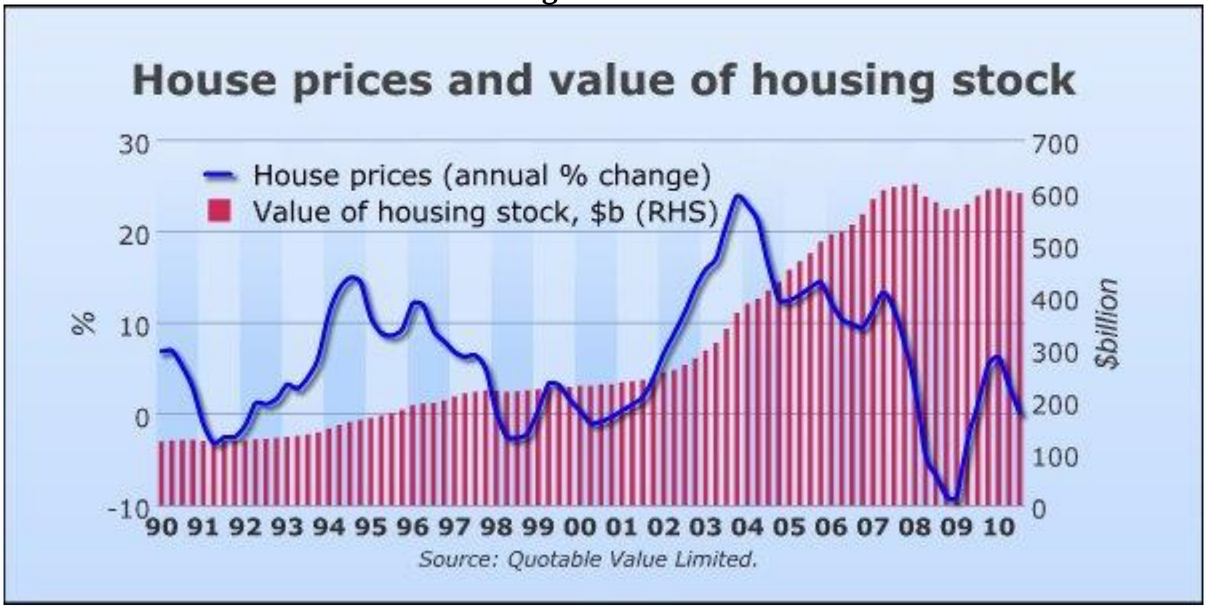


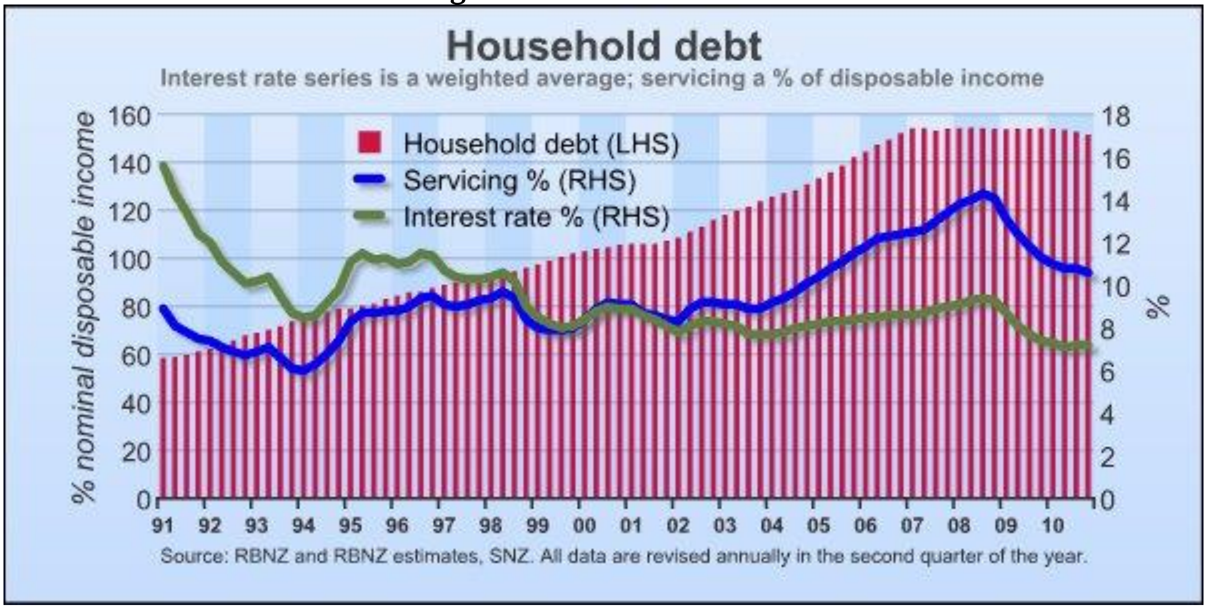
Figure III.9C. Credit card usage as a percentage of total electronic card transaction value
Seasonally adjusted
Percentage
42
43
44
45
46
47
2002m1
2004m1
2006m1
2008m1
2010m1
2012m1
Year-Month

Figure III.10



Source: Reserve Bank of New Zealand's "Key Graphs", obtained at
http://www.rbnz.govt.nz/keygraphs/Fig5.html

Figure III.11



Source: Reserve Bank of New Zealand's "Key Graphs", obtained at
http://www.rbnz.govt.nz/keygraphs/Fig5.html

Appendix III

Table III.A.1. Wholesale Sales Tax Rates Prior to Repeal

Selected goods and their rate of sales tax (December 1984)

Ad valorem rates	
10%	aircraft, heavy motor vehicles (gross weight over 3.5 tonnes) household utensils, lawn mowers, soap and other cleaners, toothpaste, most industrial machinery, computers, boats, caravans.
20%	standard rate applied to all goods unless exempted or subject to other rates — e.g. ice cream, tyres, stationery, toys, motor cycles, motor vehicle parts, grease and petroleum products, records and tapes, cosmetics.
30%	watches, photographic equipment, projectors, radios, TVs and stereos, motorcars (not exceeding 1350 cc), commercial motor vehicles of up to 3.5 tonnes gross weight.
33%	motorcars (over 1350 cc)
40%	jewellery, office machinery, copying equipment, perfume, cigarettes and other tobacco products, film.
50%	smokers' lighters, cameras, binoculars
Specific Rates	
$2.15 per litre	fortified wines
$1.32 per litre	table wines
$2.40 per litre	bitters and spirits less than 23% alcohol
$5.01 per litre	gin, vodka, schnapps
$7.47 per litre	whisky, brandy and other spirits
7.2c per litre	diesel oil (not including marine diesel oil), jet fuel
5.8c per litre	marine diesel oil
8.0c per litre	kerosene, home heating oil
5.0c per litre	other oils not subject to other rates of tax
$2.51 per gigajoule	natural gas
6.86c per litre	liquified petroleum gas

Source: Scott, Claudia and Howard Davis, 1985. "The Gist of GST: A Briefing on the Goods and Services Tax", The Institute of Policy Studies, Studies in Taxation Policy, April.

Table III.A.2. Goods and End Users Exempt from the WST	
Exempt goods	Animals Second-hand goods Food Clothing Building materials Medication Education material Ambulances Lifesaving apparatuses Fire engines Firefighting equipment Articles suited for impaired persons Goods used in funerals Religious goods Literature and printed books Craft goods Prizes and medals won overseas Child safety seats Certain imported goods
End user exemptions	Hospitals Education boards Government departments Charities

Source: New Zealand Inland Revenue Department

Table III.A.3

ANZSIC06 Retail Trade Survey industries and ANZSIC06 class codes and descriptions

ANZSIC06 RTS industry		ANZSIC06 class code and description	
G1110	Motor vehicle and parts	G391100	Car retailing
		G391200	Motor cycle retailing
		G391300	Trailer and other motor vehicle retailing
		G392100	Motor vehicle parts retailing
		G392200	Tyre retailing
G1120	Fuel	G400000	Fuel retailing
G1210	Supermarket and grocery stores	G411000	Supermarket and grocery stores
G1221	Specialised food	G412100	Fresh meat, fish, and poultry retailing
		G412200	Fruit and vegetable retailing
		G412900	Other specialised food retailing
G1222	Liquor	G412300	Liquor retailing
G1311	Furniture, floor coverings, houseware, textiles	G421100	Furniture retailing
		G421200	Floor coverings retailing
		G421300	Houseware retailing
		G421400	Manchester and other textile goods retailing
G1312	Electrical and electronic goods	G422100	Electrical, electronic, and gas appliance retailing
		G422200	Computer and computer peripheral retailing
		G422900	Other electrical and electronic goods retailing
G1313	Hardware, building, and garden supplies	G423100	Hardware and building supplies retailing
		G423200	Garden supplies retailing
G1321	Recreational goods	G424100	Sport and camping equipment retailing
		G424200	Entertainment media retailing
		G424300	Toy and game retailing
		G424400	Newspaper and book retailing
		G424500	Marine equipment retailing
G1322	Clothing, footwear, and accessories	G425100	Clothing retailing
		G425200	Footwear retailing
		G425300	Watch and jewellery retailing
		G425900	Other personal accessory retailing
G1330	Department stores	G426000	Department stores
G1340	Pharmaceutical and other store-based retailing	G427100	Pharmaceutical, cosmetic, and toiletry retailing
		G427200	Stationery goods retailing
		G427300	Antique and used goods retailing
		G427400	Flower retailing
		G427900	Other store-based retailing nec
G1350	Non-store and commission based retailing	G431000	Non-store retailing
		G432000	Retail commission-based buying / selling
H2110	Accommodation	H440000	Accommodation
H2120	Food and beverage services	H451100	Cafes and restaurants
		H451200	Takeaway food services
		H451300	Catering services
		H452000	Pubs, taverns, and bars
		H453000	Clubs (hospitality)

Source: Statistics New Zealand (2010). *Implementing ANZSIC 2006 in the Retail Trade Survey.* Wellington: Statistics New Zealand.

Table III.A.4. ANZSIC Industry Classification for RET Series

Storetype	Groups
Butcher	• Butchers • Delicatessen
Supermarket/Grocer	• Grocers • Dairies • Supermarkets
Other Food	• Fish Shops • Groceries and Other Food nec • Greengrocers and Fruiterers
Footwear	• Shoe Shops
Clothing and Textiles	• Textiles and General Softgoods • Wearing Apparel • Clothing Accessory Shops nec
Furniture	• Furniture, Soft Furnishings and Floor Coverings
Household Appliances	• Household Appliance, Radio and Television Stores
Hardware	• Paint and Wallpaper Shops • Hardware
Chemist	• Pharmaceutical Supplies, Cosmetics and Toiletries
Department and General	• Department Stores • General Stores
Automotive, Fuel and Repairs	• Motor Vehicles and Motor Cycles (inc parts and accessories) • Other Transport Vehicles nec • Petrol Stations • Repair of Motor Vehicles and Motor Cycles
Restaurants and Takeaways	• Takeaway Food Stores • Tea Rooms, Coffee Houses, Cafeterias, and Unlicensed Restaurants • Licensed Restaurants and Cabarets
Alcohol, (including licensed accommodation)	• Licensed Taverns and Chartered Clubs • Alcoholic Beverages • Licensed Hotels and Motels
Accommodation	• Unlicensed Motels • Private Hotels, Boarding Houses, Guest Houses, Hostels

	• Motor Camps, Caravan Parks, Cabins • Other Accommodation nec
Other Stores	• Agricultural and Gardening Supplies • Pet Shops • Printer Paper Products • Tobacconists • Photographic and Optical Goods Dealers • Watch and Clock Dealers and Jewellers • Music Stores • Sports Goods Dealers • Toys, Novelties, Souvenirs • Art Dealers • Second Hand Dealers

Source: Statistics New Zealand

Appendix Table III.A.5. Assignment of RTS industries to "durable" and "non-durable" categories	
RET Series (May 1982-March 1990)	
Durable	**Non-durable**
Clothing and textiles	Butcher
Department store	Chemist (Pharmaceuticals)
Footwear	Liquor & lic. accommodation
Furniture	Other food
Hardware	Petrol stations
Household appliances	Restaurants and takeaways
Motor vehicles	Supermarket and groceries
Motor vehicle repair	Unlicensed accommodations
Other stores	
RTT Series (May 1995-December 2010)	
Durable	**Non-durable**
Clothing, footwear, and personal accessories	Accommodation
Department store	Food and beverage services
Electrical and electronic goods	Fuel
Furniture	Liquor
Hardware	Pharmaceutical and other stores
Motor vehicle and parts	Specialized food
Non-store and commission-based	Supermarket and groceries
Recreational goods	

Table III.A.6. Months Allowing for Tax Effects in Intertemporal Substitution Estimation			
	GST Rate Increase		
Category	**October 1986**	**July 1989**	**October 2010**
Total	Aug 1986 - Jan 1987	May 1989 – Oct 1989	Sep 2010 – Dec 2010
Durable	Aug 1986 - Jan 1987	May 1989 – Oct 1989	Sep 2010 – Dec 2010
Non-durable	Sep 1986 - Jan 1987	Jun 1989 – Jul 1989	Sep 2010 – Dec 2010

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