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Essays in Open Economy Macroeconomics

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ESSAYS IN OPEN ECONOMY MACROECONOMICS

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by

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To: Dean Kenneth Furton
College of Arts and Sciences

This dissertation, written by Umut Unal, and entitled Essays in Open Economy Macroeconomics, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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The dissertation of Umut Unal is approved.

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Florida International University, 2012

DEDICATION

I dedicate this dissertation to my fiancée Gülin. Without her patience, understanding, love and support the completion of this work would not have been possible. I would also like to dedicate this doctoral thesis to my mother who is no longer physically with me. My mother was the person on Earth who taught me that even the largest tasks can be succeeded if it is done one step at a time. This dissertation is also dedicated to my father. There is no doubt that I could not have completed this process without his support and presence. Finally, I would like to dedicate this contribution to the economics science to my beloved sister and my niece who will be born shortly.

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ABSTRACT OF THE DISSERTATION

ESSAYS IN OPEN ECONOMY MACROECONOMICS

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Miami, Florida

Professor Cem Karayalcin, Major Professor

This dissertation raises a number of policy concerns from a macroeconomic policy point of view and provides additional insights and implications in terms of the effects of fiscal policy and its macroeconomic effects that have kept the open economy macroeconomics literature busy since the early 2000s.

The first essay develops a dynamic stochastic general equilibrium (DSGE) model for analyzing the impact of various capital income tax policies in a small open economy that is populated by households possessing endogenous time preferences. I contribute to the literature by studying the impacts of: i) anticipated tax shocks under stochastically growing output, ii) stochastic tax shocks under deterministic output, on a dynamic general equilibrium framework. With the model's specifications, this is the first attempt to integrate uncertainty in the study of taxation and welfare. The results suggest that under certain conditions welfare paradoxes may exist, in the sense that increases in tax instruments may improve welfare.

The second essay characterizes the dynamic effects of net tax and government spending shocks on prices, interest rate, GDP and its private components in four OECD countries using structural vector autoregressive regressions (SVAR) approach. For the

first time in this literature, I propose a structural decomposition of total net taxes into four components: corporate income taxes, income taxes, indirect taxes and social insurance taxes. The paper provides estimates of the responses of macroeconomic aggregates to innovations in these net tax components. Decompositions of total net tax innovations show that net tax components have different impacts on economic variables. Moreover, the size and persistence of these effects vary across countries depending upon the strength of wealth, substitution, and income effects reflecting the structure of the economies.

The last essay estimates the wealth effects of housing and stock market wealth using time-series data for eight developed countries. In estimation I employ the SVAR, which articulate the dynamic interactions of shocks to housing prices, stock values, and disposable incomes. The results show that for these countries the initial consumption response to housing price shocks is greater than to stock market capitalization shocks, but the long-run consumption response to the latter is more persistent than to the former. My findings suggest balanced monetary policies for the developments of housing markets and equity markets.

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AIC	Akaike Information Criteria
CPI	Consumer Price Index
DSGE	Dynamic Stochastic General Equilibrium
FPE	Final Prediction Error
GDP	Gross Domestic Product
IE	Income Effect
IMF	International Monetary Fund
LC	Life Cycle
MMI	Mortgage Market Index
MPC	Marginal Propensity to Consume
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PIH	Permanent Income Hypothesis
RBC	Real Business Cycle
SE	Substitution Effect
SVAR	Structural Vector Autoregression
UK	United Kingdom
US	United States
VAR	Vector Autoregression
VECM	Vector Error Correction Model

CHAPTER I

CAPITAL INCOME TAXATION AND WELFARE UNDER DSGE FRAMEWORK

I.I. Introduction

"It is often said that nothing is certain in life except death and taxes. While death is undoubtedly certain, there is, in fact, considerable uncertainty with respect to tax rates".[1] As Sialm (2006) points out, there has been a significant fluctuation in marginal income tax rates in United States from 1913 to 1999[2] which implies that there is tax policy uncertainty.

This paper is the first attempt to include stochastic taxation in a dynamic general equilibrium framework with endogenous rates of time preference, even though there are many studies existing in both finance and public economics literature. For instance, Stiglitz (1982) discusses the welfare impacts of random taxation. According to Skinner (1988), "tax policy is often unpredictable because of factors beyond the control of government". He shows the considerable variability of tax rates in US during the period 1929-1975. By studying the additional excess burden of uncertain tax policy, he computes that uncertainty in tax policy led to $12 billion extra burden for the US economy in 1985. In addition, Hassett and Metcalf (1999) use a model with an uncertain investment tax credit to study the effects of tax policy uncertainty on aggregate investment. They find that, under a continuous time random walk, tax policy uncertainty causes a delay in investment. This result is also in line with the findings of Agliardi

[1]Hassett and Metcalf (1999).

[2]That is also valid for OECD countries. For more information see OECD tax database.

(2001). Yet, by extending Hassett and Metcalf's (1999) model, Bohm and Funke (2000) demonstrate that the effects of tax policy uncertainty must be very limited because of various modelling assumptions.

On the other hand, recent literature on fiscal economics points towards the effects of different types of government spending versus tax shocks on GDP and its components. Alesina, Ardagna, Perotti and Schiantarelli (2002) investigate the effects of a change in fiscal policy on private investment using a panel of OECD countries. They find that taxes do have negative impact on output, as do Blanchard and Perotti (2002). Moreover, the latter concludes that private consumption increases follow an increase in tax rates. In both these studies, it is shown that any increase in taxes will crowd out private investment. In addition, Perotti (2004) points out that the impact of any change in tax policy on GDP and its components have become weaker over time. Mountford and Uhlig (2008) try to distinguish the effects of fiscal policy shocks for US economy between 1955-2000.

The objective of this paper is to contribute to the literature by focusing on the impacts of anticipated tax shocks under stochastically growing output, and stochastic tax shocks under deterministic output, in a dynamic general equilibrium framework with endogenous rates of time preference. As pointed out above, the empirical studies indicate that tax rate changes are frequent and, in most cases, future tax changes cannot be predicted. This basically implies that tax changes can be an element of uncertainty. For instance, since the 1990s, there has been a tax competition in the sense that countries cut tax rates to attract investment which makes firms operate in a tax-cut scenario because of the possibility of further future reductions. Thus, whatever the sign of the tax rate change is, tax rate uncertainty is an important issue that must be analyzed (Fedele, Panteghini and Vergalli, 2009). Or to put it differently, it is important to see how the agents react if there is an uncertainty about tax levels in the economy. It is worth noting that over the last two decades, most of the studies in the literature use either real option models to study the effects of tax rate uncertainty on investment or econometric/numerical techniques to see the impact and/or international transmission of any shock in an economy. Here, we deviate from these studies by setting up a stochastic dynamic general equilibrium model to focus on the welfare effects of various capital tax instruments in a small open economy populated by infinitely-lived households possessing endogenous time preference that is in line with Epstein and Hynes (1983).[3] The model also assumes that the households can borrow or lend freely in the world capital market. Perfectly competitive firms produce one good that can be used for consumption and investment which is subject to adjustment costs in the sense that the firm has to pay an installation cost. We, then simulate the model and show that: (i) under a deterministic setup, a permanent expected increase in any of capital income tax will lead to a change in welfare that depends on whether the marginal productivity of capital exceeds or falls short of the real rate of interest; (ii) when output is stochastically growing, any increase in tax levels causes a decrease in welfare regardless of where the economy stands; (iii) when there is a stochastic change in tax levels, the change in welfare will depend on the change in the type of the capital income tax, in the sense that a stochastic negative change in corporate income tax and tax on capital gains will lead to an increase in welfare because of the increase in wealth.

[3]For empirical findings, also see Obstfeld (1990).

The model we present in the next section also predicts the effects of any change in tax levels on consumption, capital stock, shadow price of capital and the current account. Unlike most intertemporal equilibrium models, our model leads to non-monotonic adjustment of the current account in response to various policy changes. This finding implies that, if adjustment costs are beyond a certain threshold, there will be an initial decrease in both savings and investment when investment is at its lowest level. Thereafter, savings will increase parallel to low levels of disinvestment.[4]

There are three theoretical papers closely related to our paper in terms of the questions having light shined on them: Bizer and Judd (1989), Nielsen and Sorensen (1991) and Karayalcin (1995). Bizer and Judd (1995) made a seminal contribution by highlighting the uncertainty in tax policy under a dynamic general equilibrium framework by implementing Markov process. Their model is relatively straightforward since only two types of taxes (investment tax credit and income tax rate) are included.

To examine the dynamic macroeconomic effects of capital income taxation, Nielsen and Sorensen (1991) develop a small open economy with perfect mobility of financial capital as possessing time-additive (exogenous) preference. Although various forms of capital income taxation are included in the model, the changes in taxes are deterministic. Therefore, here we depart from Nielsen and Sorensen (1991) in extending the model by including both endogenous time preference and adding a stochastic framework. The former is adopted because, if the constant-discount rate does not match with the parametric world interest rate, a stationary equilibrium does not exist. On the

[4]See Karayalcin (1994).

other hand, if that rate diverges from the parametric world interest rate, the time additive preferences will cause hysteretic adjustment towards the steady state[5], rendering the analysis dependent on initial conditions.

Finally, by combining endogenous time preference and adjustment costs, Karayalcin (1995) builds a model that focuses on the welfare effects of capital tax instruments in a small open economy. In that framework, because of the adjustment costs, he ended up with a lower degree of consumption smoothing since agents will no longer be able to undertake a frictionless adjustment in the capital stock. Another significant difference is that his study concentrated on unanticipated tax shocks and their welfare effects. Here, we deviate from Karayalcin (1995) in enhancing the model by involving both stochastically growing output and stochastic taxation. Also, we differ from all three papers cited above by incorporating numerical analysis which measures the magnitudes of effects due to variation in capital income taxes.

The paper proceeds as follows. The next section sets up a model with stochastically growing output in a small open economy with perfect capital mobility of financial capital. The setup is one with infinitely-lived households possessing endogenous rate of time preference and adjustment costs in investment. The effects of changes in tax policy instruments will be studied in section three and section four concludes the paper.

I.II. The Model

Consider an economy that produces a single good that may be used for consumption as well as investment. For simplicity, it is assumed that firms produce in a

[5] See Karayalcin (1995), Sen and Turnovsky (1990).

competitive market. The economy is populated by infinitely-lived households possessing endogenous time preferences. The number of households are normalized to one without loss of generality. Government collects taxes by following a balanced budget policy in the sense that the tax revenue is used to finance the households via transfers.

Households

The welfare of households is taken to depend on consumption of the good in the market. Also, the households receive the wage w_t by inelastically supplying one unit of labor services per unit of time. We denote the world interest rate by r, the interest income tax rate by t_r and the household's net assets by a_t, that is the sum of the value of domestic equity and the value of foreign assets. Thus, $r(1-t_r)a_t$ is the net interest income. According to equations (1)-(3) below, the consumer is maximizes expected discounted lifetime welfare subject to the constraint that the current increase in non-human wealth is equal to the sum of after tax income from wealth, from labor and from government transfers minus consumption.

We also adopt the endogenous rate of time preference structure proposed by Epstein and Hynes (1983). Other than the time-additive models, in this setting, time preference imply a well-defined long-run target level. Therefore, lifetime welfare, U, is maximized over consumption path, C, by

$$U(C) = -E_t \sum_{t=0}^{\infty} exp(-z_t) \frac{1}{1+(1-t_r)r} \tag{1}$$

subject to

$$z_{t+1} - z_t = u(c_t) - r, \tag{2}$$

$$a_{t+1} - a_t = (1 - t_r) r a_t + w_t - c_t - t_t, \tag{3}$$

$$z_0 = 0, \tag{4}$$

where $u(c) > 0$ is required to be a strictly increasing and strictly concave felicity function in the sense that $u' > 0$ and $u'' < 0$ and t_t is the lump-sum government transfer.

Following Obstfeld (1990) and Epstein and Hynes (1983), one can argue that the lifetime welfare functional U deviates from the time-additive utility functionals by its recursivity. As is widely known, additivity implies that the marginal rate of substitution between times t_1 and t_2 is independent of consumption at any $t \neq t_1, t_2$. However, here, recursivity allows this marginal rate of substitution to be independent of consumption before t_1 but not after t_2 in order to make future consumption weakly sepereable from past consumption levels. Therefore, the variable rate of time preference Ω at time s has the following form:

$$\Omega_s = \left\{ \sum_{s=v}^{\infty} exp\left[- \sum_{s=v}^{t} u(c_s) \right] \right\}^{-1}. \tag{5}$$

Ω at time s is the following function of the utility functional $U(C)$

$$\Omega(\phi_s) = -\phi_s^{-1} \tag{6}$$

and

$$\phi_s = U({}_sC) \tag{7}$$

where U represents positive discounting of future consumption and ϕ_s denotes aggregate future consumption (or lifetime welfare at time s). It should be noted that the rate of time preference is not constant as will be the case in the additive model. On the other hand, as in the steady state, if the consumption path is globally constant, $c_{t+1} = c_t$ for all t and $c_t = \bar{c}$. In this case, the rate of time preference is given by

$$\overline{\Omega}(\bar{\phi}) = u(\bar{c}) \tag{8}$$

where upper-bars describe long-run equilibrium.

Even though there is significant dispute on whether impatience to consume has to increase or decrease as current consumption goes up, since it is assumed that $u'(c) > 0$, in our framework increasing marginal impatience will take place as in Lucas and Stokey (1984) who basically emphasize that a kind of diminishing private returns to saving is required to have local stability. Therefore, the felicity function is specialized to:

$$u(c_t) = lnc_t + \omega \tag{9}$$

where ω stands for a parameter to measure generalized time preference.

By using equations (1-4) and (9), the standard solution of the life-time welfare maximization problem yields:

$$E_t(c_{t+1}) = [(1 - t_r)r + 1 - \Omega(\phi_t)]c_t. \tag{10}$$

On the other hand, by differentiating (1) with respect to time, we can obtain the dynamics of lifetime welfare:

$$E_t(\phi_{t+1}) = 1 + \phi_t(u(c_t) + 1), \tag{11}$$

Firms

Competitive firms employ capital, k_t, and labor to produce the single good which is used for both consumption and investment. The production function is

$$f(k_t) = \theta_t^y k_t^\alpha \tag{12}$$

where θ_t^y is the aggregate productivity shock which follows a stochastic autoregressive process[6] with the disturbance term ε_t assumed to be normally distributed with mean zero and variance σ_y^2 i.e. $\varepsilon_t : N(0,\sigma_y^2)$.

We assume that the firm finances a fraction $(1-\varepsilon)$ of new investment by debt issues and the remaining fraction, ε, by retained earnings as:

$$b_t^c = (1-\varepsilon)k_t \tag{13}$$

and

$$b_{t+1}^c - b_t^c = (1-\varepsilon)(k_{t+1} - k_t) \tag{14}$$

After corporate income tax is applied, the remaining profits are distributed as dividends to equity holders. Therefore, before personal tax, total dividends, π_t, are:

$$\pi_t = \left[f(k_t) - w_t - rb_t^c - T\right](1-t_c) + b_{t+1} - b_t - (1-t_l)i_t \tag{15}$$

where t_c and t_l stand for the corporate income tax rate and the rate of investment tax credit respectively and T denotes the adjustment cost. If the firm changes its capital, it is subject to adjustment costs in the sense that the firm has to pay a deadweight installation cost other than the actual cost i_s. The installation cost[7] must be an increasing function of i in relation to k, which should have the following properties:

$$T(0) = 0, \quad T' > 0, \quad 2T' + (i/k)T'' > 0. \tag{16}$$

[6] The details can be seen in the next section.

[7] Note that adjustment cost depends on gross investment rather than net investment. Yet, since we ignore depreciation, those terms can be treated as same.

In our framework, the installation cost function is specialized to $T(i_t/k_t) = (\chi/2)(i_t/k_t)$ so that, in order to increase the capital stock by i units, the representative firm needs to pay $i_t\left[1+(\chi/2)(i_t/k_t)\right]$ units of output.

Foreign bonds, b_t^f, and corporate bonds, b_t^c, are treated to be perfect substitutes. Thus, they have to pay the same expected after tax return. If V_t denotes the market value of outstanding equity, t_r stands for the personal interest income tax rate and t_g is the capital gains tax rate, for all t the arbitrage condition therefore will be:

$$r(1-t_r) = \frac{\pi_t}{V_t} + \frac{(1-t_g)\left[E_t(V_{t+1}) - V_t\right]}{V_t} \tag{17}$$

where the term on the left-hand side is the after tax income on foreign bonds, whereas the right-hand side delineates the after tax equity return, consisting of current yield and capital gains. The market value of equity at time zero will therefore be:

$$V_s = E_s \sum_{s=1}^{\infty} \theta_{g_{(s)}}^{-1} \pi_s \left(\frac{\theta_g}{\theta_g + r\theta_r} \right)^{s-1} \tag{18}$$

where $\theta_i = 1 - t_j$, $j = c, g, r$. Firms choose to maximize the present discounted value of V_s subject to the constraint $i_s = k_{s+1} - k_s$. The solution yields,

$$E_s(q_{s+1}) = \frac{q_s(r\theta_r + \theta_g)}{\theta_g} - \frac{\theta_c}{\theta_g}\left[E_s(f^{'}(k_{s+1})) - r(1-\varepsilon) + E_s\left[(\frac{i_{s+1}}{k_{s+1}})^2 T^{'}(\frac{i_{s+1}}{k_{s+1}}) \right]\right] \tag{19}$$

$$q_s = \frac{1}{\theta_g}\left\{ (\varepsilon - t_l) + \theta_c (T + (\frac{i_s}{k_s})^2 T^{'}(\frac{i_s}{k_s}) \right\} \tag{20}$$

$$w_s = f(k_s) - f^{'}(k_s)k_s \tag{21}$$

where the shadow price of capital at time s is given by q_s. Following Hayashi (1982), we can define q_s as the ratio of market value of firm's equity to the replacement cost of capital. Thus, q_s in equaation (20) can be considered as a variant of Tobin's Q. Equation (21) is the equilibrium condition for the labor market while the law of motion for the shadow price of capital is given by equation (19).

Equation (20) can be used to denote the rate of investment, i_t/k_t, as the following function of q_t:

$$i_t = k_{t+1} - k_t = k_t \gamma(q_t) \tag{22}$$

where $\gamma^{'}(q_t) = (\theta_g/\theta_c)\chi > 0.$ Equation (22) simply expresses investment as an increasing function of the shadow value of capital, q_t. Here, it should be noted that both q and i are independent of the consumption and saving decisions of the households.

The Current Account

In this part, by recalling the government's balanced budget policy, in order to acquire the dynamics of the current account, let us use equations (3), (15)-(22) and $a_t = b_t^f + q_t k_t + b_t^c$. We therefore obtain

$$b_{t+1}^f - b_t^f = r b_t^f + f(k_t) - i_t(1+T) - c_t \tag{23}$$

which states that the increase in foreign asset holdings equals the difference between the sum of output and interest earnings of the representative household less the sum of consumption and investment expenditures.

Characterization of the Equilibrium

It is convenient to describe the economy's steady state before characterizing the equilibrium behavior of our model. The market clearance and optimality conditions will give the long-run relations in this economy. We can easily obtain the steady state value of the shadow price of capital, $\bar{q}$, by using equations (19) and (22), and imposing the stationarity conditions. At steady state

$$\bar{q} = \frac{\varepsilon - t_l}{\theta_g}, \quad \bar{q} = q^*(t_g, t_l), \quad q_1^* > 0, q_2^* < 0, \tag{24}$$

where, in order to guarantee a positive value of $\bar{q}$, it is assumed that the replacement cost of capital is higher than the debt issue per unit of capital, $1-\varepsilon < 1-t_l$, which indicates that the firm does not overfinance its investment.[8]

Similarly, it yields[9]

$$f'(\bar{k}) = r\left[(1-\varepsilon) + \frac{\theta_r(\varepsilon - t_l)}{\theta_c\theta_g}\right] \quad \bar{k} = k^*(t_g, t_c, t_r, t_l), \quad k_1^* < 0, k_2^* < 0, k_3^* > 0, k_4^* > 0, \tag{25}$$

$$r\bar{b}^f = \bar{c} - f(\bar{k}) \quad \bar{b} = b^*(t_g, t_c, t_r, t_l), \qquad b_1^* > 0, b_2^* > 0, b_3^* < 0, b_4^* < 0, \tag{26}$$

$$u(\bar{c}) = r\theta_r, \quad \bar{c} = c^*(t_r), c^{*'} < 0, \tag{27}$$

$$\bar{\phi} = -\left(\frac{1}{r\theta_r}\right), \quad \bar{\phi} = \phi^*(t_r), \phi^{*'} < 0 \tag{28}$$

[8]For more information, see Nielsen and Sorensen (1991).

[9]The derivatives can be seen in appendix.

Thus, one can obtain the steady state values of ($\bar{q}$, $\bar{k}$, $\bar{b}$, $\bar{c}$, $\bar{\phi}$) by using equations (24)-(28).

Since we do have the steady state values of all the variables, it is convenient to follow Schmitt-Grohe (2005) and solve our system by perturbation methods. Before doing so, let us briefly discuss this method. The first-order perturbation method is similar to linearization of the Euler equations around steady state. Essentially, with the help of the techniques for forward looking rational expectations, the linear model is solved. One of the main requirements we need to satisfy is the Blanchard-Kahn (1980) condition: that is the number of the roots larger than 1 in modulus has to match the number of forward looking variables in the model.[10] Or, to put it differently, for the system to be locally saddlepath stable, it has to be the case that three of the eigenvalues have to be larger than 1 in modulus, since the system has three predetermined (backward looking) (k, θ^{y}, b) and three control (foreward looking) variables (c, ϕ, q). It is straightforward to show that this is the case here.

I.III. Various Fiscal Shocks and Their Effects on Economy

In this section, we examine the outcomes of the model under different types of shocks. Before moving onto that part, although actual tax systems differ, let us define the case where $t_g = t_r$ and $t_c = t_l = 0$; in other words, an economy under a uniform, comprehensive income tax, no investment subsidies and with fully integrated corporation taxes. Therefore, in this case we will end up with $f'(\bar{k}) = r$ equivalence confirming the

[10]For details, see Judd (1998), Sims (2002), Judd (1996) Kim and Kim (2003), Schmitt-Grohe and Uribe (2004) and Collard and Juillard (2001).

Schanz-Haig-Simons result which argues for the neutrality of income tax with respect to investment.

Yet, in a real world tax system, $\bar{q}$ and $\bar{k}$ will be affected by tax factors because generally neither the investment tax credit is equal to zero, and nor is the effective tax rate on interest earnings less than the tax rate on accrued capital gains. Thus, there occurs a distortionary wedge between the world interest rate and the marginal productivity of capital in the home country. Suppose, initially, that the former exceeds the latter. In this case, any policy that shrinks the home capital stock will, by increasing its marginal productivity, reduce the distortion and raise lifetime welfare. Thus, in order both to analyze our model more concretely and to investigate the outcomes of different scenarios more profoundly, two countries, Canada and Sweden, are included. Among our countries, Canada represents the $f'(\bar{k}) < r$ case, whereas Sweden embodies $f'(\bar{k}) > r$ case given the initial values.

Deterministic Tax Shocks and Their Effects on Welfare

Since the welfare effect is going to play an important role in the next section, in order to be able to compare and contrast, we will start out considering the effects of an expected permanent increase in the corporate income tax rate. As seen in equation (25), this will reduce the long-run capital stock of the economy and therefore the effect on consumption on impact will be positive. However, since the long-run foreign asset holdings increase, there is expected to be an increase in savings as well, which causes a negative effect on consumption on impact. The net effect is determined by the inital condition of the economy i.e whether $f'(\bar{k}) > r$ or $f'(\bar{k}) < r$. Following Karayalcin

(1995), we can infer that ϕ on impact yields the present discounted value of the future felicity stream as of time $t = 0$. Thus, the difference between ϕ on impact and initial $\bar{\phi}$ is a measure of the welfare effects of the policies under consideration. To summarize, if, initially $f'(\bar{k}) > r$, we can expect a drop in consumption on impact so will lifetime welfare because the decline in capital stock caused by the rise in t_c will accentuate the distortion by increasing the marginal product of capital.

Figures (1.1)-(1.4) show the simulation results for an increase in t_c and t_g both for Canada and Sweden. We find that under an expected permanent increase in the corporate income tax or tax on capital gains, lifetime welfare increases in Canada, whereas Sweden will suffer from the rise in taxes due to the reasons mentioned above. To place the discussion in a familiar setting, let us examine the Canadian, $f'(\bar{k}) < r$, case. An expected permanent rise in the corporate income tax[11] will cause an increase in welfare. This is mainly because of the required long-run decrease in the domestic capital stock and the long-run increase in foreign asset holdings. If the interest earned on foreign bonds, r, is less than the long-run effect of the decline in the capital stock on income $(i.e. f'(\bar{k}) < r)$, the decrease in the capital stock caused by the rise in t_c will reduce the distortion and increase lifetime welfare.[12]

Let us turn to the effects of an increase in the investment tax credit. As seen in equation (26), there will be a decrease in long-run foreign asset holding and a rise on the

[11] Same result is valid for the tax on capital gains.

[12] On the other hand, if $f'(\bar{k}) > r$ initially holds, an increase in t_c will give rise to a fall in capital stock which will accentuate the distortion and reduce lifetime welfare.

long-run capital stock because of the decline in the replacement cost of capital for both countries. Thus, for Canada, the distortion will be accentuated and there will be a decrease in welfare on impact as seen in figures (1.5) and (1.6). On the other hand, since $f'(\bar{k}) > r$ holds for Sweden, the lifetime welfare will increase because of the reduction in the distortion.

Finally, we will consider the effects of a rise in the tax rate on interest income, t_r. Such a policy will make ownership of real capital more attractive relative to the ownership of bonds. Thus, there is expected to be an increase in the long-run level of capital and a decrease in the steady state level of foreign asset holdings. It should also be noted that the increase in k will take place until the equity price returns to its initial level.[13] As can be seen in figure (1.8), lifetime welfare increases in Sweden because of the rise in capital stock which will reduce the distortion. On the other hand, as the increase in tax rate discussed above indicate, if initially $f'(\bar{k}) < r$ holds, the same policy will accentuate the distortion and reduce lifetime welfare.

Mixed Shocks and The Model

In this section[14], we begin analyzing the model under a stochastic productivity shock and considering that model as the benchmark. Thereafter, the shocks will be mixed in the sense that the stochastic productivity shock will be kept while the anticipated

[13]The details can be seen in the next section.

[14]It should be noted that the same stochastic productivity shock remains throughout this part although its level is kept small in order to avoid any outweighing effect in the sense that productivity shock never dominates the tax shock. Thus, it must be considering while evaluating the results.

permanent tax shocks will be added to see how the model reacts if agents began expecting higher tax rates.

In a stochastic framework, since the model needs to be made stationary around a steady state, permanent shocks cannot be placed. Moreover, shocks can only hit the system today and the expectation of future shocks has to be zero. However, by adding a latent shock variable (which has a normal distribution with zero mean), ε_t, it is possible to make the effect of the shock disperse slowly throughout the economy. Here, basically, ε_t is going to affect the model's true exogenous variable θ_t^y that is itself an AR(1) process (Griffoli, 2007).

$$\theta_t^y = \rho\theta_{t-1}^y + \varepsilon_t \tag{29}$$

Our results suggest that, under stochastically growing output any increase in tax level will worsen the economy and reduce welfare regardless of whether $f'(\bar{k}) \succ r$. For both countries, the results are in tables (1.1) and (1.2) and the impulse response analyses can be seen in figures (1.11)-(1.18).

We first discuss the simulation results when there is only a stochastic productivity shock. Figure (1.9) shows the results for Canada and figure (1.10) for Sweden. For both countries, our indicators show a similar trend in adjustment path when hit by a stochastic productivity shock. A 1% standard error increase in ε_t causes an increase in capital as well as consumption in the short run. The former is caused by the increase in the marginal product of capital whereas the latter is a result of an increase in output. On the other hand, there will be an increase in the rate of return on equity that leads to an immediate jump in the price of equity q, which will stimulate investment by causing a current account deficit. Since c jumps on impact as well, domestic absorption will increase which deteriorates the current account deficit in the short run. However, in the long run, investment starts to decrease along with the decrease in q which causes an improvement in current account balance. In addition, consumption adjusts much faster than the investment level. Thus, the accentuating effect of consumption on current account will die out, or, to put it differently, the current account balance will improve in the long-run by adjusting non-monotonically.

Next, as discussed above, we will mix the stochastic productivity shock and anticipated permanent tax shocks. In analyzing table 1.1, let us start out considering the effects of a foreseen rise in the corporate income tax rate under stochastic productivity shocks. Suppose the government announces that a corporate tax will be implemented at time $t = 20$. Anticipating a future reduction in the rate of return on equity, investors will decrease their demand for equity which will cause a drop in the price of equity q on impact along with a process of capital decumulation. It should be noted that, considering equation (22), as q remains below its long-run level along the adjustment path, investment will decrease. In the short-run, the decline in the rate of investment along with the reduction in consumption will improve current account balance. Yet, in the long-run, investment will increase to reach its long-run value in addition to a decline in savings that leads to a deterioration in the current account balance as in both figure (1.11) and (1.12). Therefore, the current account will adjust non-monotonically.

Under stochastic productivity shock, a foreseen increase in capital gains tax rate, t_g, will increase long-run foreign asset holdings and reduce the long-run domestic capital stock as well as lead to a rise in the long-run equity price q. Notice that the long-run changes in k and q, by putting opposing pressures on impact, determine the short-run adjustment of q. Although there is a jump in q on impact, there will be follow a process of capital decumulation, or, to put it differently, a decrease in investment occurs because of the increase in t_g which clearly outweighs the jump in q.[15] Afterwards, the capital stock will adjust to its new long-run level by giving rise to an increase in real investment. On the other hand, consumption drops on impact by strengthening the improving effects of decreasing investment on current account. Thus, current account will have an upward trend until the increasing effects of higher savings die out. Afterwards, the current account surplus starts to decrease along with an increase in investment and adjusts to its new steady-state level (see figures 1.13 and 1.14).

Conversely, under stochastic productivity shocks, an anticipated future increase in t_I has an expansionary long-run effect because the investment tax credit decreases the effective price of new capital goods relative to initial capital. Therefore, the long-run level of k will increase, whereas there will be a decline in the steady state level of foreign asset holdings. As in the case of an increase in t_g, there will be opposing pressures on the equity price q. On the other hand, because of the anticipated reduction in the effective price of new capital goods, a foreseen future tax credit is expansionary from the time it is expected until the time it takes effect. As is well-known, a higher rate of investment tax credit makes new capital cheaper relative to initial capital. Thus, there will be an increase in the domestic capital stock up until the implementation of new tax

[15] See equation (35) in appendix.

policy. To summarize, analyzing figures (1.15) and (1.16), we can say that capital stock per capita is increasing from the time of announcement of the new tax policy until the time it takes effect, whereas a contraction occurs after the new tax policy is introduced. On the other hand, as opposed to the case of an increase in t_g, we see an immediate jump in consumption on impact which will aggravate the domestic absorption, worsening the current account deficit. As the economy starts to increase its holdings of foreign assets (right after implementing the new tax levels), it has to run a current account surplus which implies a nonmonotonic adjustment of the current account balance.

Finally, let us examine the effects of a foreseen rise in the personal interest income tax rate, t_r, under a stochastic productivity shock. Note that an anticipated rise in the tax rate on interest income will lead to a higher demand for equity since there will be a reduction in the rate of return on foreign bonds. The excess stock demand for equity will be eliminated by an immediate jump in the price of q on impact. As a result, real investment will rise as q remains above its long-run level. Yet, as capital intensity rises we see that its marginal product declines, up until q and the rate of investment go back to their long-run values. On the other hand, since a rise in t_r will reduce the long-run utility target, households will reduce their long-run consumption. As a consequence, current account balance will deteriorate because of the rise in both investment and consumption levels. However, consumption will reach its steady state value sooner, and therefore, the accentuating effects of higher consumption on current account will disappear in parallel to the reduction in investment. Thus, there again occurs a non-monotonic adjustment of current account balance.

Last but not least, we will highlight the impacts of any changes in tax levels under stochastically growing output on welfare. Since the logic is, *mutatis mutandis*, same for the rest of the exercises, we will examine the effects of an increase in the tax rate on capital gains and investment tax credit. As seen in table 1.2, an increase in tax rate on capital gains will lead to a decrase in the long-run domestic capital stock and an increase in foreign asset holdings. Because of the reasons discussed in the previous part of the chapter, this change in tax level is expected to give rise to a reduction in lifetime welfare if, initially, $f'(\bar{k}) > r$. On the other hand, there will be an increase in welfare if $f'(\bar{k}) < r$ initially holds. However, here, for both of the countries, consumption drops on impact, so will lifetime welfare which is because of the uncertainty and the risk averse utility function.[16] When the effects of output shocks propogate over time, a risk averse utility function will lead to a cost called the cost of uncertainty. That is mainly why we ended up with the following: It is clear from table 1.1 and 1.2 that on impact consumption levels (so will lifetime welfare) are lower than the benchmark cases. On the other hand, an increase in the investment tax credit has an expansionary long-run effect on domestic capital stock and a contractionary long-run effect on foreign asset holdings. Therefore, a reduction in life-time welfare is expected for Canada whereas a rise in life-time welfare is anticipated for Sweden. However, in this case, although there is a jump on impact, life-time welfare reduces for both of the countries -when compared to the benchmark- regardless of where the economy stands. For instance, the on impact value of ϕ is -14.75 and -16.92 for Canada and Sweden respectively (see table 1.1). Yet, as a response to a

[16]Risk aversion simply implies that individuals strictly prefer to take the expected value of a lottery to than the lottery itself.

change in various type of tax instruments, in none of the cases, we are able to have a higher ϕ on impact value. Thus, under stochastically growing output, a welfare paradox does not exist.

The Stochastic Tax Shocks and Their Effects

In this part, we will put the model to work by considering the effects of stochastic tax shocks.[17] With having the following structure, we assume that the economy has been experiencing a deterministic tax structure and expects it to last forever. Then, we change the tax policy by introducing some uncertainty but keeping the mean tax rate constant after an initial decrease in tax levels. For this purpose, we have δ's such that $\delta_t^i = \theta_j e^{z_t}$ where $j = c, g, l, r$ and z_t is the tax shock which follows a stochastic autoregressive process $z_t = \mu z_{t-1} + \zeta_t$ with the disturbance term ζ_t assumed to be normally distributed with mean zero and variance σ_z^2 i.e. $\zeta_t : N(0, \sigma_z^2)$. As in the case of stochastic productivity shock discussed above, similarly, here we do shock the system today by dispersing its effect slowly throughout the economy. It is worth noting that an increase in δ_t^i on impact means a reduction in tax levels. Thus, throughout this part, the shocks hitting the system today are negative tax shocks.

Let us start out by considering the effects of a stochastic change in the corporation tax. On impact, this will increase dividends and the rate of return on equity. The expectations of capital gains will rise and there will be an immediate jump in the price of equity, q, leads to an immediate increase in investment which will cause a current

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[17]Throughout this part, productivity parameter is normalized to one without loss of generality. In other words, productivity is constant.

account deficit.[18] Since c jumps on impact, we will end up with an increase in domestic absorption which accentuates the current account deficit in the short run. Towards steady state, this process reverses and continues until the rate of return on foreign bonds equal the rate of return on equity. In other words, right after an initial jump in q, investment starts to decrease along with the shrink in q which causes an improve on current account balance. Moreover, consumption adjusts much quicker, or, to put it differently, the accentuating effect of higher consumption on current account will disappear. Therefore, in the long-run, that will improve the current account balance as well, besides the shrink in investment.

Next, consider the effects of a stochastic change in the capital gains tax. As opposed to the previous case, here, what we see is an initial drop in q along with an increase in domestic capital stock. We can explain this situation by combining[19] equations (18) and (19). Depending on the corresponding equation, a decrease in capital gains tax rate, θ_g, will lead to a decrease in q on impact. However, although we expect (and also see) an increase in investment level, here, q declines. This situation can be explained by equation (22) which basically indicates that the change in θ_g outweighs the decline in q and therefore, even though q drops on impact, there is an increase in the invesment level. In the short-run, an increase in the rate of investment along with an increase in consumption will deteriorate current account balance. On the other hand, in

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[18] It should also be noted in figure 1.19 that k rises/declines as soon as q exceeds/falls behind its steady state value.

[19] The corresponding equation can be seen in appendix.

the long-run, the accentuating effect of c on current account will disappear in addition to the decrease in investment that leads to an improve in current account balance as seen in figure 1.20.

Conversely, a stochastic change in invesment tax credit causes a jump in q on impact. Yet, here, investment is decreasing in the short-run which can be explained by equation (20). It is straightforward in the equation that we will end up a decrease in investment level at least in the short-run because the change in t_l has a dominating effect on the increase in q. Therefore, k goes up in the medium-run. However, since the shock on t_l dies out over time, towards steady state the increase in q offsets the change in investment tax credit which will give rise to an increase in k (so will investment). The decrease in investment, along with declining consumption, will improve current account balance in the short-run. However, in the long-run, consumption will adjust before domestic capital stock. Thus, the improving effect of higher savings on current account will disappear in conjuction with the increase in investment level causing a deterioration in current account balance. Here, again, this implies a non-monotonic adjustment of the current account (see figure 1.21).

Finally, let us consider the effects of a stochastic change in the tax rate on personal interest income. It should be noted that, initially, the rate of return on foreign bonds will increase. On impact, there will be a decrease on demand for equity, which will be absorbed by an immediate drop in the price of equity which increases the yield on it. In the medium run, the investment will decrease caused by the reduction in domestic capital stock. Therefore, the marginal productivity of capital will decrease up until the equity price, q, and the investment level will reach their initial levels in the long-run. On the other hand, since there is a drop in consumption on impact and a decrease in the rate of investment in the short run, the current account balance will improve. However, again, that process reverses in the long-run, indicating a deterioration in the current account balance before it reaches its long-run level, or, to put it differently, an implication of a non-monotonic adjustment of the current account.

Next, we will briefly point out the welfare impacts of stochastic tax changes. As seen from figures (1.19) to (1.22), while a stochastic change in corporate income tax and the tax rate on capital gains cause an increase in consumption on impact (so will welfare), a stochastic change in investment tax credit and the tax rate on personal interest income lead to a drop in welfare. Here, since long run values do not change, we need to provide an alternative explanation. As known, wealth is roughly equal to qk. Thus, an increase in wealth level will give rise to an increase in consumption level which will also cause an increase in welfare. For instance, it is obvious from figure (1.19) that, as a response to a stochastic corporation tax shock, both k and most of the time q remains above their steady-state level that makes individuals wealthier and leads to a rise in consumption. On the other hand, the opposite holds for a stochastic interest income tax shock. As a response to a capital gains tax shock, while k stays above its long-run level because of the reasons explained above, q is below its steady state level. Here we can conclude that the increase in domestic capital stock, k, outweighs the decline in q. Thus, consumption increases since there is an increase in wealth level.[20]

[20] Again, the opposite holds for a stochastic investment tax credit shock.

I.4. Conclusion

In this paper, we have examined the dynamic macroeconomic effects of different capital income taxation methods in a model of a small open economy with endogenous recursive time preferences and adjustment costs in investment where perfectly competitive firms produce one good that can be used for consumption and investment. We have shown the adjustment paths of consumption, lifetime welfare, equity prices, current account and investment in response to various tax shocks. Our results suggest that welfare paradoxes may exist only under deterministic output and anticipated tax shocks. Unlike most intertemporal equilibrium models, our model leads to non-monotonic adjustment of the current account in response to various policy changes.

Our model can be generalized in numerous ways. For instance, it is worthwhile to generalize to see the outcomes of any change in tax policy or, in other words, how the tax policy might be adjusted in an economy. It may also be interesting to enhance our analysis by allowing the households to supply their labor elastically to study the impact of tax policy changes on wages and consumption. Our model can also be extended to a two-country framework to analyze the international transmission of shocks.

Table 1.1. Foreseen Tax Shocks under Stochastically Growing Output and Their Impacts (Sweden)

	$\bar{c}$	$\bar{\varphi}$	$\bar{q}$	$\bar{k}$	$\bar{b}$	c^{+}	φ^{+}
A rise in							
t_c	0.4587	-48.07	0.9285	25.98	-61.78	0.4405	-60.46
t_g	0.4587	-48.07	0.9352	26.18	-61.96	0.4054	-84.17
t_l	0.4587	-48.07	0.9	27.29	-62.98	0.496	-22.93
t_r	0.4585	-49.01	0.9285	26.95	-62.67	0.4713	-40.76
Benchmark for Sweden							
	0.4587	-48.07	0.9285	26.39	-62.15	0.5047	-16.92

Note: + above a variable indicates on impact value for the parameter.

Table 1.2. Foreseen Tax Shocks under Stochastically Growing Output and Their Impacts (Canada)

	$\bar{c}$	$\bar{\varphi}$	$\bar{q}$	$\bar{k}$	$\bar{b}$	c^{+}	φ^{+}
A rise in							
t_c	0.4617	-36.76	0.7971	23.58	-59.4	0.4408	-46.07
t_g	0.4617	-36.76	0.8092	23.54	-59.36	0.4122	-58.79
t_l	0.4617	-36.76	0.7681	24.95	-60.73	0.4855	-26.2
t_r	0.4615	-37.3	0.7971	24.33	-60.14	0.4822	-28.25
Benchmark for Canada							
	0.4617	-36.76	0.7971	23.94	-59.76	0.5112	-14.75

Note: + above a variable indicates on impact value for the parameter.

Figure 1.1. The welfare effect of a 3% increase in corporate income tax for Canada

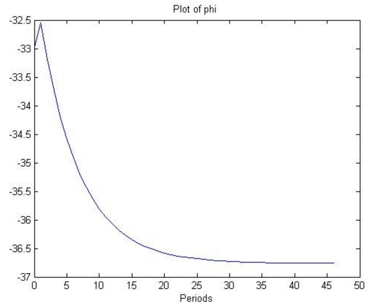


Figure 1.2. The welfare effect of a 3% increase in capital gains tax for Canada

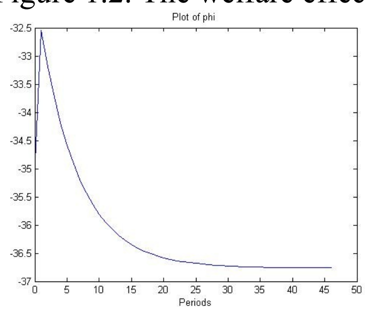


Figure 1.3. The welfare effect of a 3% increase in corporate income tax for Sweden

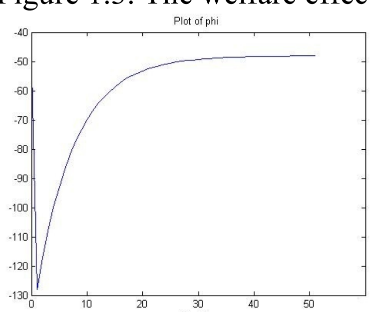


Figure 1.4. The welfare effect of a 3% increase in capital gains tax for Sweden

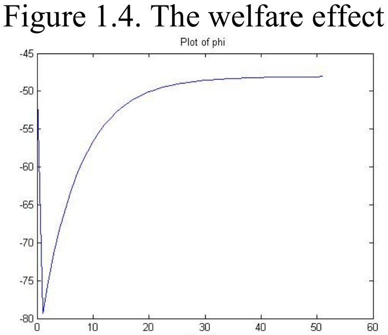


Figure 1.5. The welfare effect of a 3% increase in investment tax credit for Canada

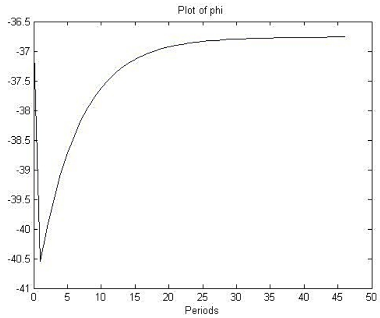


Figure 1.6. The welfare effect of a 3% increase in investment tax credit for Sweden

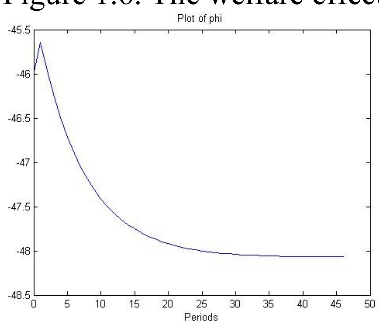


Figure 1.7. The welfare effect of a 3% increase in interest income tax for Canada

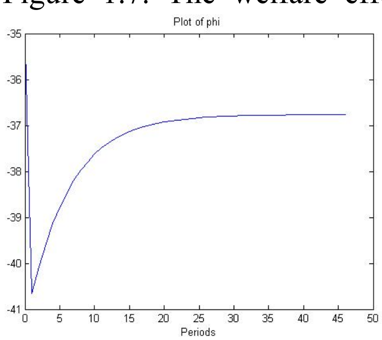


Figure 1.8. The welfare effect of a 3% increase in interest income tax for Sweden

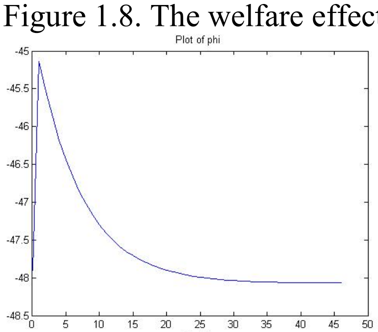
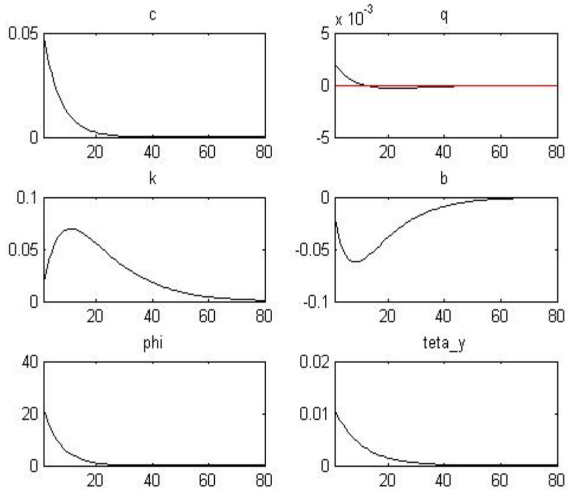
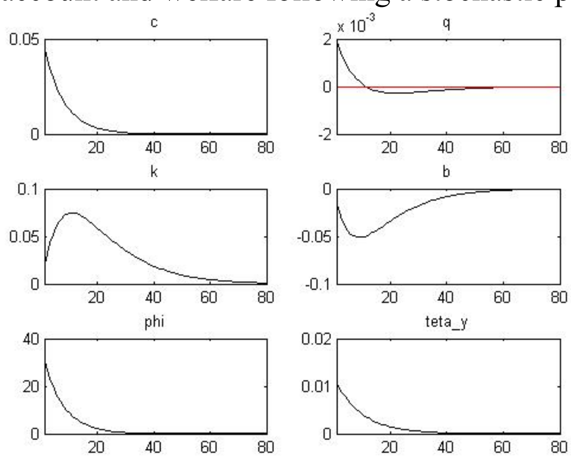


Figure 1.9. The transient paths of consumption, equity price, capital stock, current account and welfare following a stochastic productivity shock for Canada.



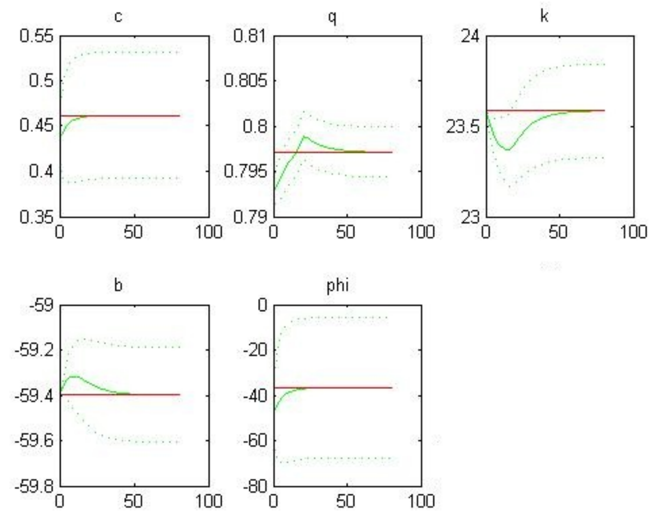
Note: Figure depicts the deviations from steady-state.

Figure 1.10. The transient paths of consumption, equity price, capital stock, current account and welfare following a stochastic productivity shock for Sweden.



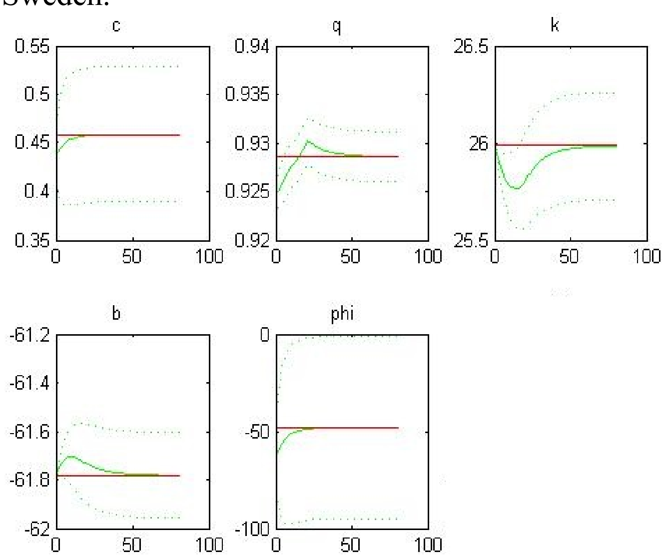
Note: Figure depicts the deviations from steady-state.

Figure 1.11. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_c under stochastically growing output for Canada.



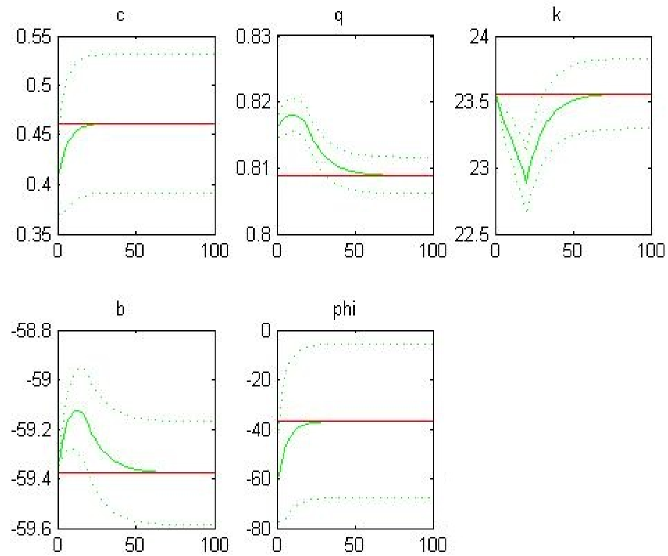
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.12. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_c under stochastically growing output for Sweden.



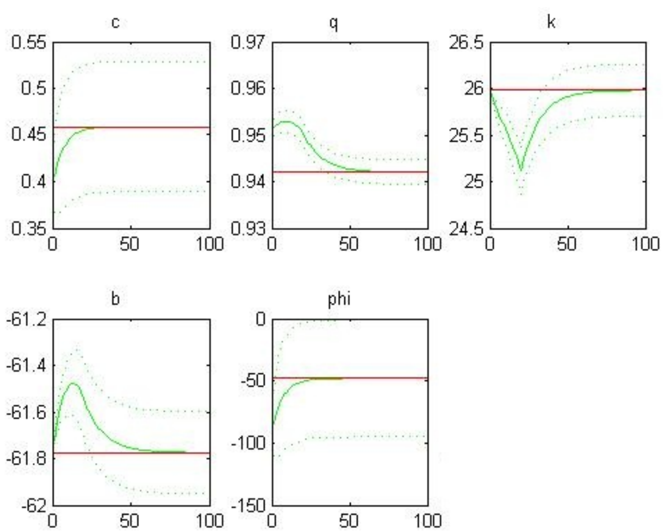
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.13. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_g under stochastically growing output for Canada.



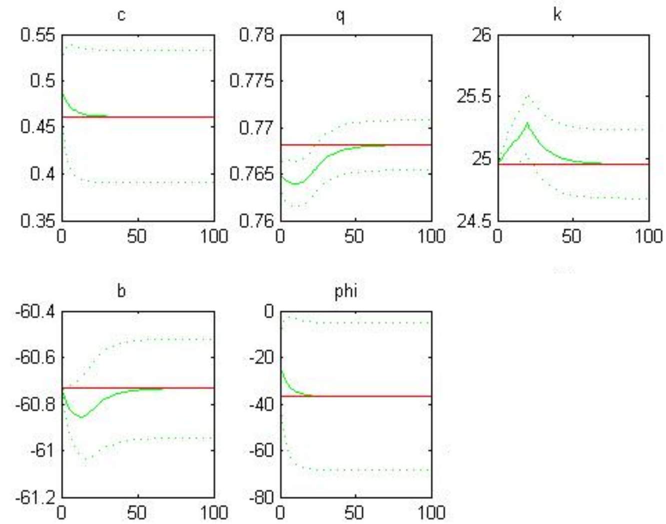
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.14. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_g under stochastically growing output for Sweden.



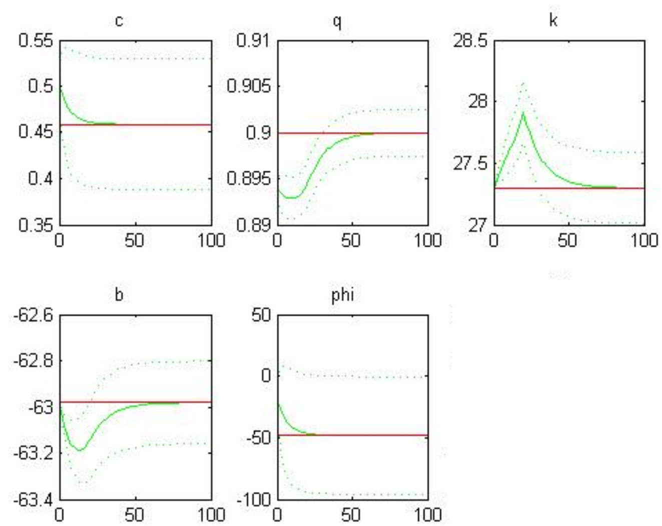
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.15. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_l under stochastically growing output for Canada.



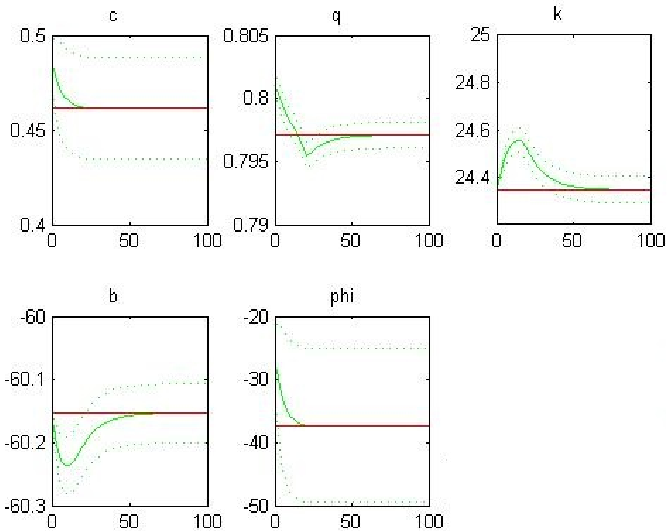
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.16. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_l under stochastically growing output for Sweden.



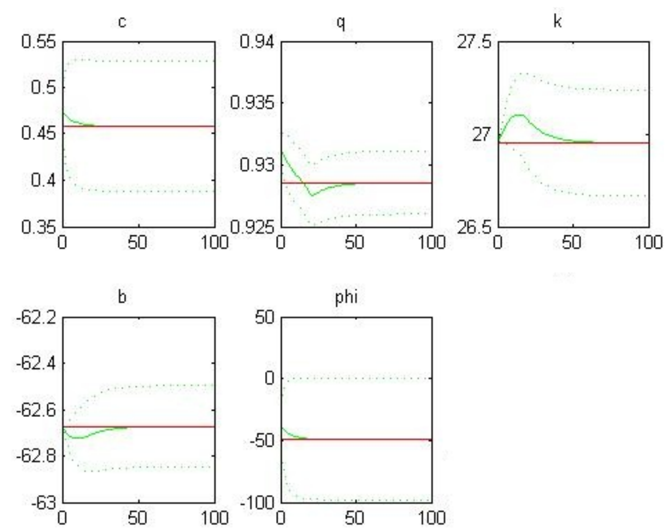
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.17. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_r under stochastically growing output for Canada.



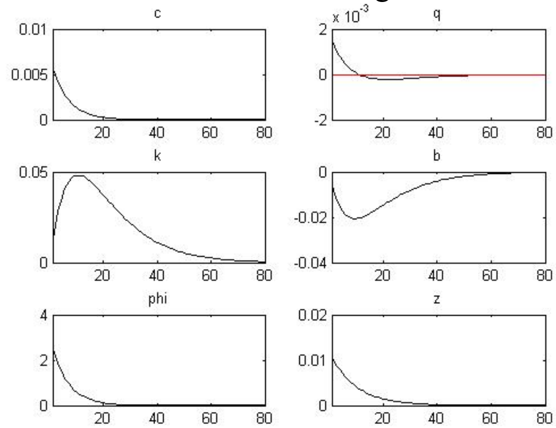
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.18. The transient paths of consumption, equity price, capital stock, current account and welfare after a 1% increase in t_r under stochastically growing output for Sweden.



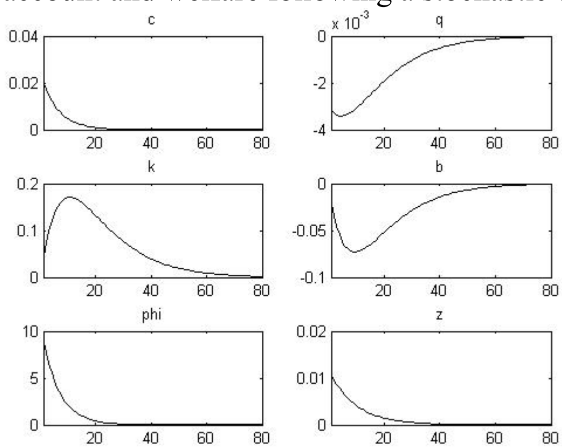
Note: Dotted lines in any figure indicate 90% confidence interval around the mean trajectory.

Figure 1.19. The transient paths of consumption, equity price, capital stock, current account and welfare following a stochastic corporation tax shock.



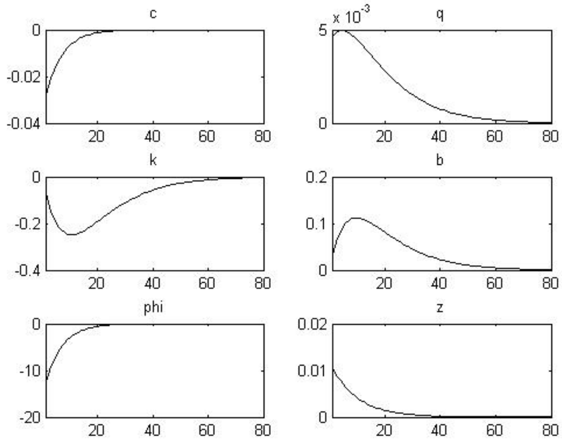
Note: Figure depicts the deviations from steady-state.

Figure 1.20. The transient paths of consumption, equity price, capital stock, current account and welfare following a stochastic capital gains tax shock.



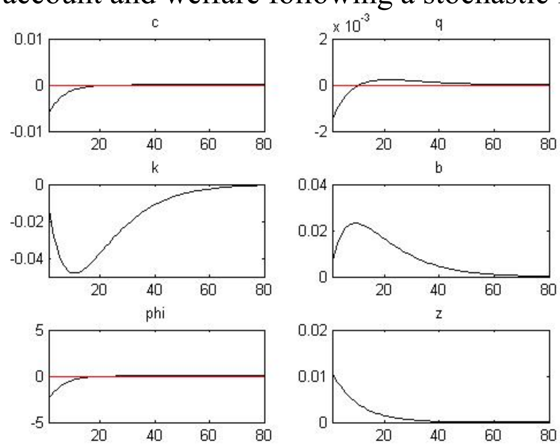
Note: Figure depicts the deviations from steady-state.

Figure 1.21. The transient paths of consumption, equity price, capital stock, current account and welfare following a stochastic investment tax credit shock.



Note: Figure depicts the deviations from steady-state.

Figure 1.22. The transient paths of consumption, equity price, capital stock, current account and welfare following a stochastic interest income tax shock.



Note: Figure depicts the deviations from steady-state.

CHAPTER II

RETHINKING THE EFFECTS OF FISCAL POLICY ON MACROECONOMIC AGGREGATES

II.I. Introduction

A common approach in both empirical and theoretical studies on fiscal policy shocks is to evaluate the response of macroeconomic aggregates to exogenous changes in the fiscal policy variables. From a theoretical point of view, the impacts of discretionary fiscal policy on the economy hinge on a number of key assumptions. For instance, in examining the transmission mechanism of fiscal policy, the presence or absence of forward-looking behavior plays a crucial role in that if agents do not look forward, expected future changes do not have any effect on current-period decisions. Agents with rational expectations, on the other hand, do look forward in anticipation of future changes in key macroeconomic variables.

The empirical evidence, however, does not provide a clear picture of the effects of fiscal policy. In particular, even though the most recent and standard strand of the literature, which started with Blanchard and Perotti (2002), shows positive short-term output multipliers resulting from government expenditure increases and tax cuts, the estimated size and duration of these effects vary across studies. In fact, the magnitude of the multiplier may depend on the specification and/or sample period employed. Interestingly, there is even evidence of negative government spending multipliers for Australia, Canada and the UK for some sub-sample periods (Perotti, 2004).

There is a substantial body of literature devoted to the effects of fiscal policy on key macroeconomic indicators using Structural Vector Autoregression (SVAR) models.

For instance, Alesina, Ardagna, Perotti and Schiantarelli (2002) investigated the effects of a change in fiscal policy on private investment using a panel of OECD countries. Their finding that increases in taxes have a negative impact on output is parallel to the findings of Blanchard and Perotti (2002).[21] In addition, the latter concludes that private consumption increases following an increase in tax rates.

Both of these studies demonstrate that any increase in taxes will reduce private investment. Further, Perotti (2004) points out that the impact of any change in tax policy on GDP and its components becomes weaker over time. Mountford and Uhlig (2008) try to distinguish the effects of fiscal policy shocks for the US economy between 1955 and 2000. They envisage three different scenarios: a deficit-financed spending increase, a balanced budget spending increase, and a deficit-financed tax cut. They conclude that among these three scenarios the deficit-financed tax cut is the most efficient one to help raise the gross domestic product. More recently, by employing a new database, Burriel et al. (2010) analyze the effect of fiscal policy for the US economy and Euro area as a whole. They find that GDP and inflation increase in response to government spending shocks even though the output multipliers are very similar and steadily increasing after 2000, possibly because of the "global saving glut," in both areas.

Alternatively, Burnside et al. (2004), Pappa (2009) and Ramey (2007) report a decrease in unemployment in response to a positive spending shock. On the other hand, a few studies consider the reaction of the real wage following an increase in government

[21] For a detailed discussion, see also Fatas and Mihov (2001), Tenhofen and Wollf (2007), De Castro and De Cos (2008), Mertens and Ravn (2009) and Romer and Romer (2010).

spending. Among those, Pappa (2009) documents an increase whereas Burnside et al. (2004) report a decrease in the real wage in response to an expansionary fiscal policy.

Some of the stylized facts above appear to contradict either neo-classical theory, real business cycle (RBC) model or the Keynesian approach. In other words, the sign and magnitude of the effect of discretionary fiscal policy on macroeconomic aggregates often offers opposite conclusions. For instance, following a positive government spending shock, New Keynesian theory tends to predict an increase in output, real wages and interest rate and a decrease in consumption and private investment. Yet in RBC models, the expansionary fiscal policy will lead to a decrease in real wages and an increase in private investment.

Additionally, economic theory suggests that different forms of taxation have different impacts in macroeconomic activity. For instance, Barro (1990) points out that while non-productive expenditures financed by a distortionary tax have an unambiguously negative growth effect, non-distortionary tax-financed increases in productive expenditures are predicted to have a positive impact upon the growth rate. Baxter and King (1993) point out that financing government spending with lump-sum taxes and distortionary taxes have different effects on economy. Gordon et al. (2004 and 2004a) analyze the impact on revenue and costs of a substantial change in fiscal policy, such as the effects of switching from capital income taxation to consumption-based tax system. They both find that consumption taxes and income taxes have different impacts on saving and investment decisions.

In view of these discrepancies, the central message of this paper is that different tax groups have different effects on macroeconomic aggregates, depending on the underlying cause of the tax increase. Our results suggest that analyzing the fiscal policy by decomposing total net taxes and examining their effect on the aggregate economy provide a more accurate picture than treating total net taxes as the fiscal policy variable. To this end, under the Blanchard and Perotti (2002) identification scheme, a five-variable VAR model, which includes total government spending, total net taxes, GDP, a measure of inflation and the interest rate is used as a benchmark for Canada, France, the UK and the United States. Thereafter, I propose a structural decomposition of total net taxes into four components: corporate income taxes, income taxes, indirect taxes and social insurance taxes. The paper provides estimates of the responses of macroeconomic aggregates to innovations in different tax groups by replacing total net taxes with each tax components separately. In a further step, the responses of the GDP components, private investment and consumption, to a shock to each tax component will be examined.

Decompositions of total net tax innovations will help us assess the macroeconomic implications of fiscal policy shocks for four major economies with different economic structures. In this context, corporate income tax shocks, for instance, will have a very different impact on macroeconomic indicators than an indirect tax innovation. It is, therefore, important that we understand the extent to which increases in net taxes are driven by one shock or another, before concerning ourselves possible policy responses.

The main conclusions of the analysis can be summarized as follows: 1) decompositions of total net tax innovations show that net tax components have different impacts on economic variables; 2) the size and persistence of these effects vary across countries depending upon the strength of wealth, substitution, and income effects reflecting the structure of the economies; 3) positive tax multipliers reported in previous studies are found only for the corporate income tax in the US, Canada, and France and for the social security tax in the US; 4) while we find that private investment is crowded out both by taxation and government spending in the UK and the US as consistent with the neo-classical model, our results for France and partially for Canada, indicate that there are opposite effects of tax and spending increases on private investment in line with Keynesian theory; and 5) private consumption is crowded in by government spending for all countries except the UK and crowded out by taxation in all countries except France. While the former result is consistent with a Keynesian model, the latter is in line with neo-classical theory.

The remainder of the paper is organized as follows. Section two focuses on the identification of the structural shocks, specification and data describing. Section three investigates the impacts of the shocks identified in Section two on macroeconomic aggregates of four countries. Section four provides some concluding remarks

I.II. Econometric Methodology and Data:

The Identification Strategy

Our identification strategy follows Blanchard and Perotti (2002). Denoting the vector of endogenous variables by X_t and the vector of reduced form residuals by U_t, the reduced form VAR can be represented as

$$X_t = A(L)X_{t-1} + U_t \quad (1)$$

where X_t is a $N \times 1$ vector of endogenous variables, $A(L)$ is a $N \times N$ matrix lag polynomial, and U_t is a $N \times 1$ vector of reduced-form innovations which are assumed to be independently and identically distributed with covariance matrix equal to the identity matrix. In our benchmark specification X_t and U_t consist of the following variables: $X_t = [g_t, T_t, y_t, p_t, r_t]'$ and $U_t = [u_t^g, u_t^T, u_t^y, u_t^p, u_t^r]'$.

I start by expressing the reduced form innovations of the government spending and net taxes equations as linear combinations of the structural fiscal shocks e_t^g and e_t^T to these variables and the innovations of the other reduced form equations of the VAR, namely: u_t^y, u_t^p and u_t^i. This leads to the following formal representation of the reduced form residuals:

$$u_t^T = \alpha_y^T u_t^y + \alpha_p^T u_t^p + \alpha_i^T u_t^r + \beta_g^T e_t^g + e_t^T \quad (2)$$

$$u_t^g = \alpha_y^g u_t^y + \alpha_p^g u_t^p + \alpha_i^g u_t^r + \beta_T^g e_t^T + e_t^g \quad (3)$$

As mentioned by Perotti (2004), in this framework, the coefficients α_j^i measure both the automatic response of fiscal variable i to the macroeconomic variable j and the systematic discretionary response of fiscal variable i to the macroeconomic variable j. The coefficients β_j^i capture the random discretionary fiscal policy shocks to fiscal policies; these are the "structural" fiscal shocks. It should also be noted that we avoid using the Cholesky decomposition method. Regardless of the order of fiscal variables, Cholesky orthogonalization will not provide consistent estimates of the structural shocks if, as is the case here, the α_j^k's are different from zero.[22]

Direct evidence on the conduct of fiscal policy suggests the existence of decision lags in the sense that it is not possible to learn about a GDP shock, decide what fiscal measures to take in response, pass these measures through the legislature and implement them within three months as pointed out by Blanchard and Perotti (2002). Thus, the

[22] For details, see Perotti (2004) and Blanchard and Perotti (2002).

discretionary change in variable i in response to a change in variable j is zero. As a consequence, in quarterly data the systematic discretionary component of u_t^T and u_t^g will be zero: the coefficients α_j^i's will only reflect the automatic response to economic activity. Because the reduced form residuals are correlated with the e_t's, it is not possible to estimate the α_j^i's by ordinary least squares.

We, therefore, need to construct the elasticities of fiscal variable i to the macroeconomic variable j to compute cyclically adjusted reduced form fiscal policy shocks:

$$u_t^{T,CA} = u_t^T - \alpha_y^T u_t^y - \alpha_p^T u_t^p - \alpha_i^T u_t^r = \beta_g^T e_t^g + e_t^T \quad (4)$$

$$u_t^{g,CA} = u_t^g - \alpha_y^g u_t^y - \alpha_p^g u_t^p - \alpha_i^g u_t^r = \beta_T^g e_t^T + e_t^g \quad (5)$$

The next step of the estimation procedure is to decide the relative ordering of the fiscal variables to identify the structural shocks to those. While imposing $\beta_g^T = 0$ postulates the priority of tax decisions, β_T^g can be set to zero if government spending decisions are deemed to come first. It might be hard to find plausible arguments that fully justify any of these orderings. In the baseline specification the latter assumption is employed. The reverse ordering does not affect the results given the low correlation between the two reduced form fiscal shocks.

Consequently, it is possible to estimate β_g^T by OLS from the following equations:

$$u_t^{g,CA} = e_t^g \quad (7)$$

$$u_t^{T,CA} = \beta_g^T e_t^g + e_t^T \quad (8)$$

Finally, the coefficients of the equations for the macroeconomic variables will be estimated recursively by means of instrumental variables regressions. With respect to real GDP, the following equation will be employed:

$$u_t^y = \gamma_g^y u_t^g + \gamma_T^y u_t^T + e_t^y \quad (9)$$

using e_t^T and e_t^gas instruments for u_t^T and u_t^g respectively. Likewise, the price equation

$$u_t^p = \gamma_g^p u_t^g + \gamma_T^p u_t^T + \gamma_y^p u_t^y + e_t^p \quad (10)$$

can be estimated by using e_t^T, e_t^g and e_t^y as instruments. Finally, the interest rate equation

$$u_t^r = \gamma_g^r u_t^g + \gamma_T^r u_t^T + \gamma_y^r u_t^y + \gamma_p^r u_t^p + e_t^p \quad (11)$$

can be estimated accordingly once e_t^p is recovered. After the reduced form of the VAR and all the coefficients are estimated, we can proceed to estimate the impulse responses using the structural moving average representation of the VAR.

The Data

Our sample comprises four countries: Canada, France, the United States and the United Kingdom. The benchmark specification of the VAR includes quarterly data on government spending (g_t), net taxes (T_t) and GDP (y_t) all in real terms[23]; the GDP deflator (p_t), and the Treasury bill rate (r_t).[24] The variable T_t is defined as public revenues net of transfers, whereas g_t includes both public consumption and public investment. All the variables, except the interest rate, are log-transformed. Since the availability of the quarterly fiscal variables, particularly for the net tax components, is a binding constraint, the sample runs from 1960:1 to 2000:4 for the US, 1961:1 to 2000:4

[23] Following the standard literature, the GDP deflator is employed to obtain the corresponding real values.

[24] The data source defines the Treasury bill rate as the rate at which short-term securities are issued or traded in the market.

for the UK and 1970:1 to 2000:4 for Canada and France. All variables have been seasonally adjusted by the original sources. For all countries, the Treasury bill rate and the GDP deflator data are obtained from the IMF International Financial Statistics database. The rest of the data have been taken from the Bureau of Economic Analysis for the US and OECD World Economic Outlook for the other countries.

The Specification

Equation (1) is estimated by OLS and the number of lags was set according to the information provided by likelihood ratio (LR) test, the Akaike, Schwarz and Hannan-Quinn information criteria and the final prediction error in general.[25]

In order to obtain the response of macroeconomic aggregates to various tax policy innovations, the VAR specification described in the previous section is estimated. Each model comprises of the following variables: government expenditures (g_t), tax revenue (T_T), measured by the tax revenue of the ith tax group), the GDP (y_t), the GDP deflator (p_t) and the Treasury bill rate (r_t). After the benchmark model (with total net taxes and government spending is estimated, we estimate the responses of macroeconomic aggregates to innovations in different tax groups by replacing total net taxes with each tax components separately. In a further step, we estimate a number of other specifications where GDP is substituted in turn by its private components.

[25] Most of the time, the information criteria suggest different results. For instance, while estimating the model with corporate income taxes for the US, Hannan Quinn and Schwarz criteria suggest 2 lags, whereas final prediction error and Akaike information criteria suggest 6 lags. Here, I choose 6 lags, since 2 lags is often regarded as too short to capture enough economic interpretations among variables for a model with quarterly data as also mentioned in Kim and Roubini (2008). However, as a robustness check, the model is also estimated with the alternative lags and led to very similar conclusions. For an extensive survey of model selection criteria, see also Lutkepohl (1991).

Following the leading studies in the literature[26], the elasticities of taxes to GDP is constructed from data provided by the Organization for Economic Co-operation and Development.[27] We also assume that, in quarterly data, the contemporaneous elasticity of government purchases with respect to output is zero. Given that interest payments on government debt are excluded from the definitions of government net taxes and spending, the semi-elasticities of these two variables with respect to interest rate, α_r^g and α_r^T, innovations are set to zero.[28] Finally, following Tenhofen et al. (2006), the GDP deflator elasticity is simply the real GDP elasticity of the fiscal variable less one.[29] Table 2.1 provides an overview of the quarterly elasticities in use.

II.III. Empirical Results

I compute the effects of various types of fiscal policy shocks on the basis of the estimated SVAR model. The figures depict the results displaying the impulse responses to a 1% exogenous increase in the corresponding fiscal variable. In all cases, impulse responses are reported for five years and the 90% confidence bands, corresponding to the 5th and 95th percentiles of the responses, have been obtained by bootstrapping with 200 replications. In this respect, it is worth noting that, the choice of the confidence interval width is wider than that of the 68% literature standard.

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26 For instance, Monacelli and Perotti (2010), Perotti (2007).

27 The calculations are based on Van den Noord (2000), Daude et al (2010).

28 This is again one of the standard assumptions in the literature. See Perotti (2004), Castro and De Cos (2008), Tenhofen et al. (2006).

29 The authors mainly follow the assumption that "the response of the nominal fiscal variable is the same to both price and real GDP movements, which is, in turn, given by the real GDP elasticity of the real fiscal variable. Provided nominal prices do not influence real GDP, the GDP deflator elasticity is the real GDP elasticity of the fiscal variable less 1".

Figures (2.1)-(2.4) display the impulse responses of the various macroeconomic indicators to a total net tax shock. Specifically, while the response of output in France is statistically insignificant, GDP falls on impact in response to net taxes innovations in the US, Canada and the United Kingdom. While the response of GDP in the European countries and Canada remains significant almost for a year, the significant decline of GDP in the US[30] appears to be more persistent, which is in line with the results of Burriel et al. (2010). Moreover, it should be noted that, in the UK, Canada and France, GDP tends to increase after ten quarters which is consistent with the findings of Perotti (2004).[31]

In France, private consumption is consistently crowded in even though the increase becomes significant after two years which is in line with a Keynesian model. Furthermore, we find that private consumption is crowded out by taxation in the US, Canada and the UK as is consistent with neo-classical theory. Here, it should also be noted that, due to the increase in taxes, as consumers reduce their consumption, the national savings will increase lowering the real interest rate in these countries in the medium-run.

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[30] Here, it is worth recalling that I have been working on 0.90 probability which indicates that the bands in this study are broader. Therefore, most of the results for US turn out to be significant in 0.68 probability (which is the common probability measure in the literature).

[31] Perotti (2004) finds positive tax multipliers for Australia, the UK and West Germany. According to him, it is because of the smaller output elasticities of net taxes. However, here, I did not identify any positive impact effect. What we are ending up with is that GDP tends to increase after three years in France and almost four years in UK which turns out to be rather counter-intuitive. Yet, even though the standard literature studies the effects of fiscal policy by employing conventional VARs, it should be noted that the forecasting limitations of this methodology for such long horizons advise against drawing conclusions from this result (De Castro and De Cos, 2008).

As regards investment, figures (2.1)-(2.4) and (2.5)-(2.8) point to the following results: In the standard Keynesian approach, an increase in spending may yield either an increase or a decrease in investment depending on the relative strength of the effects of the increase in output and the increase in the interest rate; but, in either case, increases in spending and taxes have opposite effects on investment as mentioned in Blanchard and Perotti (2002). While this is the case in our results for France and partially for Canada, we did not reach the same conclusion for the US[32] and the United Kingdom.

Figures (2.5)-(2.8) shows the responses of macroeconomic aggregates to an increase in government spending. The impact response of GDP is positive[33] and significant in all countries except the United Kingdom. While the size of the response is similar in the US, Canada and France, the shape of the impulse response of output is slightly different, in the sense that, after an initial rise, GDP starts declining and after about 10 quarters, it slightly rises again in France. In Canada, after an initial increase, there is a decrease in output, whereas in the US the increase in output is persistent. In the UK, the response of GDP is insignificantly negative which is consistent with the results of Perotti (2004) for this country.

In addition, the behavior of private consumption largely mimics that of GDP: it basically increases on impact in the US, Canada and France but decreases in the United Kingdom. While the former result is consistent with a Keynesian model, the latter is in line with neo-classical theory.

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[32] This is, again, supporting the results of Blanchard and Perotti (2002).

[33] For the US, this is in line with the positive response estimated by Blanchard and Perotti (2002), Burnside et al. (2004), Pappa (2009), Favero and Giavazzi (2007) and Fatas and Mihov (2001).

Government spending shocks have positive effects on the interest rate in three countries (Canada, France and the UK) and essentially no impact effect in the United States.[34] It is useful to note here that, the former result can be reconciled both with a neo-classical and a Keynesian model.

Figures (2.9)-(2.12) present the effects of a shock to social security contributions on macroeconomic indicators. As is widely known, social security taxes are levied on labor as a payroll tax. A priori, the impact response of output will, therefore, depend on two effects: the substitution effect and the income effect.

Social security tax innovations will lead to a decrease in tax-payer's after tax reward for each extra hour worked, lowering the cost of leisure. Thus, via the substitution effect (SE), the individual will be willing to work less in response to lower reward. On the other hand, a decrease in the real wage will reduce household lifetime earnings and, thus, human wealth. So, households, via the income effect (IE), will not be able to afford additional leisure and, as a result, will supply more labor. The relative magnitude of the two effects depends on the circumstances such as the elasticities of labor supply and demand. Hence, the hours worked may increase, decrease or remain the same after the tax innovation.

It is seen from figure (2.9) that in the US, IE dominates SE yielding a significant increase in output on impact. It is also worth noting that the behavior of private investment and private consumption mimic that of GDP: it typically increases on impact in this country. For Canada, France and the UK, higher social security taxes decline output, which decreases significantly and remains significant for five years in France. As

[34] Note that the interest rate response in the US and UK are insignificant for the entire period.

far as GDP components are concerned, investment and private consumption responses, in general, mimic the GDP's one. Some slight differences may be observed though, particularly in the short-run behavior. The price level in Canada decreases significantly after four quarters and remains significant for five years due to the decrease in demand in response to a social security tax innovation in this country. However, the opposite behavior is observed in France in the sense that, after a significant decline in the short-run, prices insignificantly rise in the medium-run due to the 0.4 % decrease in output in response to a shock to social security contributions.

The impact effect of the social security tax innovation on the interest rate is positive in the US due to the increase in money demand and private investment, whereas the estimated impact effect on the interest rate is insignificant for the rest of the countries.

Figures (2.13)-(2.16) present the effects of a shock to indirect taxes on macroeconomic indicators. The response of each component is typically similar across countries, hence summarizing their shapes is not difficult. Over the whole sample, the impact response is negative for GDP in all countries. Because they lower the purchasing power of real after-tax wages, indirect taxes lead to a strong incentive to curtail investment as seen in figures. On the other hand, since the indirect taxes can be defined as the sales taxes, taxes on goods and services, there is a decrease in consumption in response to an increase in tax levels. Indirect tax innovations also lead to a decrease in the price level due to lower demand. Note that, with the partial exception of Canada and France (where we have seen an insignificant increase in the interest rate for three quarters), there is a decline in the interest rate on impact in response to an indirect tax innovation. This can be explained by the decrease in income and investment levels.

Figures (2.17)-(2.20) depict the responses of the endogenous variables to an income tax innovation. Here, two opposing effects need to be taken into account. First, an increase in income taxes reduces the household wealth by increasing the present value of household tax liabilities. Thus, consumption decreases while saving, interest rate and labor supply increases. However, the rise in hours worked will lead to a decline in real wages, therefore, investment and output increase. This is the wealth effect. Second, the same policy will slow down economic activity by decreasing output. Because the money demand depends on income, the decline in output decreases the interest rate which partially crowds in private investment. The degree of crowding in will hinge on the sensitivity of private investment to income and the interest rate. Yet, the final effect of the contraction will be a decline in consumption, investment and output. This is the output effect. Hence, the overall effect on macroeconomic indicators will depend on these two effects.

For the US, Canada and the UK, the output effect dominates the wealth effect and therefore the impact response of consumption, investment and output are negative. For France, although the impact response of output and investment are negative, the output persistently increases, and there is an insignificant increase in investment after the third quarter. On the other hand, it should be noted that consumption significantly rises in Canada and France. There are several ways to explain this.[35] For instance, Linnemann (2006) applies a non-seperable utility function in consumption and leisure in a RBC setup in which consumption and leisure are substitutes. The negative wealth effect of the fiscal

[35] Another plausible explanation takes place when habit formation is included in any model. For more details, see Ravn, Schmitt-Grohe and Uribe (2006), Bouakez and Rebei (2007). Alternatively, Corsetti, Meier and Muller (2009) modeled a spending reversal effect and ended up with the same conclusion.

contraction raises hours worked which decreases leisure. The marginal utility of consumption, therefore, increases. In order to lessen the negative wealth effect, individuals are willing to work more and to consume more which will lead to an increase in consumption.

Figures (2.21)-(2.24) display the responses of the macroeconomic indicators to a corporate income tax innovation. The impulse responses show a significant positive response of GDP on impact for all countries except the United Kingdom, which can, again, be explained by the negative wealth effect and output effect. Here, the wealth effect dominates the income effect for Canada, France and the United States. Moreover, it should be further noted that the increase in capital income tax will be reflected in the prices. It will lower the purchasing power of real after-tax wages and therefore the positive impact on output caused by the wealth effect will be accentuated. As a result, an increase in corporate income tax will lead to a positive impact effect on GDP and all the private components of gross domestic product. Thus, after an increase on impact, private consumption and private investment will fall in the medium and the long-run in the United States. However, the significant positive impact on investment persists for almost three years in Canada whereas there is an insignificant increase in consumption. Here, it should be noted that our results are in line with and Arin and Koray (2006) and Heppke-Falk et al. (2006).[36] It is also worth mentioning that corporate income tax innovations

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[36] The former study is done for Germany whereas the latter is for Canada. Both of the papers ended up with an increase in GDP in response to a corporate income tax innovation. According to Heppke-Falk et al. (2002), this might result from some sort of reverse causality stemming from identification difficulties due to problems with exogenous elasticities. However, this is not the case in this study. Although I am confident that the presented elasticities accurately capture the automatic stabilizers, as a

have positive effects on impact on the nominal interest rate in three countries (Canada, France and the US) due to the increase in income and investment on impact; and essentially an insignificant impact effect in the United Kingdom.

Robustness Checks

I performed a variety of robustness checks to our 5 variable VAR specification. First of all, a different ordering of the expenditure variables when identifying the shocks was employed. So far, government spending was ordered first. Yet, there is no basis for choosing one orthogonalization over the other as mentioned in Perotti (2004). Nevertheless, all the responses were re-estimated under the assumption that government spending was ordered after taxes. The results obtained with this alternative specification were very close to those of the benchmark model.

As mentioned in Perotti (2004), the implementation of lags of fiscal policy could undermine the predictability of the estimated fiscal policy shocks. It might require some time for fiscal policy changes to be implemented and according to the author, the private sector might anticipate these changes before the econometrician. However, it is shown in Blanchard and Perotti (2002) that allowing for anticipations of fiscal policy does not substantially alter the results. Nonetheless, in order to check the robustness of the baseline results, I tried some alternative lag lengths. Even though there were some minor differences in point estimates, the results were generally involved in the 68% bandwidth of baseline estimates.

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robustness check, I re-estimate the SVAR assuming slightly different elasticities, without any substantive change of the results.

In addition, although we were confident that the elasticities we used accurately capture the working of automatic stabilizers, we reassessed the sensitivity of the results was assessed by varying those values. First, following Perotti (2004), I assumed a -0.5 price elasticity of government spending. The results were, again, very close to the benchmark model. The differences were minimal in the sense that there was a slight change on point estimates of the impulse responses.

Finally, I evaluated the sensitivity of the results to different values for the output and price elasticity of various tax instruments. It is shown in Cohen and Folette (1999) that there has only been a slight fluctuation in tax elasticities over time in the United States. Therefore, to see whether there is a significant change in impulse responses, the benchmark elasticities were replaced with their 10% bandwidth values. The results obtained with these alternative elasticities were, again, very close to those of the benchmark model. There were only a few percentage points change in estimates of the impulse responses.[37]

II.IV. Conclusion

This paper characterizes the dynamic effects of total net tax and government spending shocks on GDP, prices and interest rates in four OECD countries using a structural Vector Autoregression approach with the Blanchard and Perotti (2002) identification scheme. Moreover, we propose a structural decomposition of net taxes into four components: corporate income taxes, income taxes, indirect taxes and social insurance taxes. Our results suggest that analyzing the fiscal policy by decomposing net

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[37] The results are available upon request.

taxes and examining their effect on the aggregate economy provide a more accurate picture than treating net taxes as the fiscal policy variable.

The main conclusions of the analysis can be summarized as follows: 1) Decompositions of total net tax innovations show that net tax components are found to have different impacts on economic variables; 2) The size and persistence of these effects vary across countries depending on different effects (i.e. negative wealth and output effects, substitution effect and income effect) resulting from the structure of these economies; 3) The positive tax multipliers reported in previous studies are found only for corporate income tax in the US, Canada and France and for social security tax in the US; 4) As regards macro theories, on the one hand, we find that private investment is crowded out both by taxation and government spending in the UK and the US as is consistent with the neo-classical model. On the other hand, our results for France and partially for Canada indicate that there are opposite effects of tax and spending increases on private investment that are in line with Keynesian theory; 5) Private consumption is crowded in by government spending for all countries except the UK, and crowded out by taxation in all countries except France. While the former result is consistent with a Keynesian model, the latter is in line with neo-classical theory.

My analysis sheds light on the interpretation of positive net tax multipliers found in the existing literature. Decompositions of net tax innovations will help us better assess the macroeconomic implications of fiscal policy shocks and, it is, therefore, important that we understand the extent to which increases in net taxes are driven by one shock or another.

The findings in this paper also indicate that existing approaches to modeling fiscal policy shocks have to be re-thought. First, the results suggest that the usefulness of the existing macroeconomic applied work built on the assumption of "total" tax changes may be unclear. In examining the transmission mechanism of fiscal policy shocks, it is seen from our results that the traditional priority on net tax shocks may be misleading. Instead, more attention needs to be paid to different tax policy instruments.

Table 2.1. Exogenous Elasticities

	United States	Canada	France	United Kingdom
α_y^{tc}	1.8	1	1.8	0.6
α_y^{ti}	0.6	1.2	0.6	1.4
α_y^{ts}	0.6	0.9	0.5	1.2
α_y^{tind}	0.9	0.7	0.7	1.1
α_y^{T}	1.1	1	1	1.1
α_y^{g}	0	0	0	0
α_p^{tc}	0.8	0	0.8	-0.4
α_p^{ti}	-0.4	0.2	-0.4	0.4
α_p^{ts}	-0.4	-0.1	-0.5	0.2
α_p^{tind}	-0.4	-0.3	-0.3	0.1
α_p^{T}	-0.1	0	0	0.1
α_p^{g}	-1	-1	-1	-1
α_c^{tc}	1.44	0.75	1.35	0.48
α_c^{ti}	0.48	0.9	0.45	1.12
α_c^{ts}	0.48	0.675	0.975	0.96
α_c^{tind}	0.72	0.525	0.525	0.88
α_c^{T}	0.88	0.75	0.75	0.88
α_c^{g}	0	0	0	0
α_{inv}^{tc}	0.36	0.25	0.45	0.12
α_{inv}^{ti}	0.12	0.3	0.15	0.28
α_{inv}^{ts}	0.12	0.225	0.125	0.24
α_{inv}^{tind}	0.18	0.175	0.175	0.22
α_{inv}^{T}	0.22	0.25	0.25	0.22
α_{inv}^{g}	0	0	0	0

T: total net tax
t_c: corporate income tax
t_i: income tax
t_{ind}: indirect tax
t_s: social security tax
inv: private investment
c: private consumption
g: government spending (public consumption + public investment)

Figure 2.1. Effects of total net tax innovations in the US

Figure 2.2. Effects of total net tax innovations in Canada

Figure 2.3. Effects of total net tax innovations in France

Figure 2.4. Effects of total net tax innovations in the United Kingdom

Figure 2.5. Effects of government spending shocks in the US

Figure 2.6. Effects of government spending shocks in Canada

Figure 2.7. Effects of government spending shocks in France

Figure 2.8. Effects of government spending shocks in the United Kingdom

Figure 2.9. Effects of social security tax innovations in the US

Figure 2.10. Effects of social security tax innovations in Canada

Figure 2.11. Effects of social security tax innovations in France

Figure 2.12. Effects of social security tax innovations in the United Kingdom

Figure 2.13. Effects of indirect tax innovations in the US

Figure 2.14. Effects of indirect tax innovations in Canada

Figure 2.15. Effects of indirect tax innovations in France

Figure 2.16. Effects of indirect tax innovations in the United Kingdom

Figure 2.17. Effects of income tax innovations in the US

Figure 2.18. Effects of income tax innovations in Canada

Figure 2.19. Effects of income tax innovations in France

Figure 2.20. Effects of income tax innovations in the United Kingdom

Figure 2.21. Effects of corporate income tax innovations in the US

Figure 2.22. Effects of corporate income tax innovations in Canada

Figure 2.23. Effects of corporate income tax innovations in France

Figure 2.24. Effects of corporate income tax innovations in the United Kingdom

CHAPTER III

VECTOR AUTOREGRESSION ESTIMATES OF THE HOUSING AND STOCK WEALTH EFFECTS: CROSS-COUNTRY EVIDENCE

III.I. Introduction

The wealth effect, defined as the change in consumption expenditure induced by an exogenous change in wealth, has profound implications for measurement, diagnosis, and forecast of economic activity. For countries including the United States, consumption expenditure comprises the bulk of gross domestic product. The analysis of wealth effects thus has garnered attention from market practitioners, policy makers, and academic researchers. There are various components of wealth, thus various wealth effects associated with each of them. Yet a large body of literature examines and compares the magnitude of wealth effects from housing and stock market wealth, presumably two of the most significant components of wealth for households in developed countries.

Several reasons exist for us to expect a larger wealth effect coming out of housing than out of stock market wealth. First, the volatility of stock markets is much higher than that of housing markets.[38] *Ceteris paribus*, with higher volatility, gains and losses are less permanent, and households may accordingly exhibit a smaller propensity to consume out of stock wealth. Secondly, housing wealth is more evenly distributed among households than is stock wealth. For that reason, even if a household responds in the same way to both wealth shocks, in aggregate we may still observe a larger magnitude for housing wealth. Finally, in most economies, housing assets can be easily pledged as collateral to borrow funds, through mortgages or home equity loans. The same is less the case for

[38] See Figure 3.1 and 3.2 for demonstration of this point for countries in our sample.

stock assets. The increased use of homes as collateral has strengthened the positive effect of rising housing wealth on consumption as well as on the rest of the economy via household borrowing the “financial accelerator” effect (Aoki et al., 2002; Cardarelli et al., 2008).

Yet a couple of factors point to the opposite direction. First, as Poterba (2000) points out, the rise of house prices increases the implicit “user cost” of living in a house, which may undercut the boost to nonhousing consumption induced by rising wealth due to higher house value. Secondly, housing wealth is measured less precisely, which may lead a household's reaction to wealth change more lukewarm. Finally, transaction costs related to housing eat into a larger percentage of the housing value appreciation, discouraging homeowners from cashing out the increased equity. Thus which set of factors dominate the other is an empirical question.

We re-examine the housing and stock wealth effects by employing the vector autoregression (VAR) framework which incorporates the dynamic, interactive structure of variables with each other. Using macro time series for a group of developed countries, we estimate the VAR model with specified structural error terms. The model stipulates that the shocks specific to housing wealth precede those specific to stock markets and to personal income, and that the shocks specific to stock markets precede those to personal income. We shall discuss the justification of this recursive ordering after presenting the empirical specification, but we note here that the results obtained with other orderings are very similar.

Our findings can be summarized as follows: for all the countries in our sample except Australia, we find a larger initial wealth effect of housing than that of stock wealth. The on impact value of consumption to a 10% housing wealth shock ranges from 0.60% (Finland) to 6.42% (Sweden). Yet the long-run effects on consumption from housing and stock wealth vary considerably across countries. Despite the greater initial housing wealth effects, however, over time stock market wealth effects catch up and are mostly persistent, whereas housing wealth effects level off and may decline eventually. Our results suggest that, for monetary policy purposes, it would be oversimplifying to emphasize the immediate, higher impact on consumption from housing markets. Policymakers have to keep an open eye on the long-run, more persistent impact from equity markets.

Regarding the relative magnitude of wealth effects of housing and of stock wealth, empirical evidence is mixed. Previous works have found a larger wealth effect for housing from macro-level aggregate data for the US Benjamin et al., 2004; Case et al., 2005; Carroll et al., 2011), and from micro-level survey data for the US (Bostic et al., 2009), and for Spain (Bover, 2005). From these works, the marginal propensity to consume (MPC) from housing wealth is around 0.03-0.1, while that from financial wealth is around 0.02-0.08. However, Dvornak and Kohler (2007) find the opposite for Australia.

Fewer studies have compared both wealth effects from a cross-country perspective. Indeed, as a result of cultural, institutional, and market-related differences, a cross-country comparison might shed light on what may be the driving force behind the differences in wealth effects. Slacalek (2009, Figure 3.1) shows that there is a great deal of heterogeneity in MPC between countries. He incorporates the sluggishness of consumption in estimating MPC in a two-step empirical procedure. For the 16 countries in his sample, some countries (such as the US and the UK) have substantially larger housing wealth effect than financial wealth effect while the rest (such as Canada and Japan) do not, although these estimates are imprecise. Ludwig and Slok (2004) find a significantly positive relationship between stock prices and consumption for OECD countries in a pooled mean group analysis, but the relationship is insignificant between house prices and consumption. Edison and Slok (2002) focus on the stock wealth effects for eight countries and find that the wealth effect of the information technology stock market sector is smaller than that of other sectors.

As regards methodology, a strand of literature has used sophisticated models other than VAR in estimating wealth effects. Some studies have invoked panel data techniques in their estimation (Dvornak and Kohler, 2007; Slacalek, 2009). More closely related to our VAR approach is error-correction models that aim to capture long-run equilibrium effects. Case et al. (2005) employ an error-correction model in which only consumption and income have equilibrium errors while housing and stock wealth do not. Benjamin et al. (2004) carefully examines unit-root and co-integration issues in the US aggregate data (and differ from Case et al. (2005) in terms of sources and measurements) and arrive at the same conclusion. Ludwig and Slok (2004) and Cardarelli et al. (2008, Table 3.6) expand the accommodation of equilibrium errors to the housing and stock price variables, while still maintaining that consumption is the sole dependent variable responsive to changes in other variables. The closest in methodology to our paper is Edison and Slok (2002), though their research question, their employed variables and their Cholesky ordering are different.

Were cointegration an issue, our VAR model could be revised into the form of vector error-correction model (VECM), which would allow for equilibrium errors of the kind assumed by the aforementioned literature. Carroll et al. (2011) argue against the use of cointegrating/VECM models in estimating wealth effects, for neither theory nor evidence implies the existence of a stable cointegrating vector. Edison and Slok (2002) caution against the underlying restrictive assumptions and the demand for large sample size associated with cointegration estimation, even though all of the countries in their sample have one cointegration vector. For our data set, statistical tests indicate the cointegration is not a serious concern for the majority of countries.

The remainder of this paper proceeds as follows. Section two introduces the exact empirical specification we use under the structural VAR framework. Section three presents data. Section four discusses estimation results, and section five concludes.

III.II. Econometric Methodology and Data

The simplest specification for estimating various wealth effects takes the form

$$C_t = \alpha + \beta_h H_t + \beta_s S_t + \beta_y Y_t + \varepsilon_t \qquad (1)$$

where C_t stands for consumption of goods and services, H_t for housing wealth, S_t for stock wealth, and Y_t for personal disposable income. Such a specification can be derived from the Life-Cycle/Permanent Income Hypothesis (LC-PIH) consumption theories, as is shown in Benjamin et al. (2004), Dvornak and Kohler (2007), and other studies. As such, estimated coefficients of β_h and β_s measure the MPC out of housing wealth, and of stock wealth, respectively.

We extend the content contained in (1) into the VAR framework. One substantial advantage of the VAR is to bring forth the dynamic structure between variables. The reduced-form VAR is specified by the following equation:

$$\mathbf{Y}_t = \mathbf{B}_0 + \sum_{k=1}^{K} \mathbf{B}_k \mathbf{Y}_{t-k} + \mathbf{U}_t \tag{2}$$

where $\mathbf{Y}_t$ is the vector of variables (H_t, S_t, Y_t, C_t) , $\mathbf{B}_k$ is the matrix of coefficients for the k-th lag of $\mathbf{Y}_t$, and $\mathbf{U}_t$ is the vector of reduced form innovations. The value of K, the number of lags included in (2), is to be determined by the Akaike Information Criteria (AIC) and the Final Prediction Error (FPE).

It is well known that a reduced form VAR like (2) does not allow correlations among variables to be interpreted casually (see, e.g., Stock and Watson 2001). We need a structural VAR representation with "identifying assumptions" for that purpose:

$$\mathbf{A}(\mathbf{I} - \sum_{k=1}^{K} \mathbf{B}_k L^k)\mathbf{Y}_t = \mathbf{A}\mathbf{B}_0 + \mathbf{A}\mathbf{U}_t = \mathbf{A}\mathbf{B}_0 + \mathbf{B}\mathbf{e}_t \tag{3}$$

where the vector of structural shocks $\mathbf{e}_t : N(0, \mathbf{I}_4)$ and $E[\mathbf{e}_t \mathbf{e}'_s] = \mathbf{0}$ for all $s \neq t$. The matrix $\mathbf{A}$ describes the contemporaneous relation between the variables and the reduced form residuals $\mathbf{U}_t$. The matrix $\mathbf{B}$ specifies the linear relation between the orthogonal structural shocks and the reduced form residuals (Heppke-Falk et al., 2010). One version of the so-called Cholesky restrictions to achieve identification on the system is that $\mathbf{A}$ is a lower triangular matrix with ones on the diagonal, and $\mathbf{B}$ a triangular matrix.

By adopting this version of Cholesky restrictions, we assume that the components of $\mathbf{Y}_t$ enter in the order of (H_t, S_t, Y_t, C_t). This, coupled with the lower triangular matrix

$\mathbf{A}$, implies that the current shock to the housing wealth H_t precedes all other contemporaneous shocks, the shock to Y_t is affected by contemporaneous shocks to H_t and S_t, and the shock to C_t is affected by contemporaneous shocks to all the rest.

Our justification of the recursive ordering of shocks in the model, especially the contemporaneous housing shock being exogenous to other shocks, draws on recent literature on housing, business cycles, and the macro economy. Leamer (2007) argues that the housing sector cycle is one of the most important precursors of the US business cycle. He demonstrates that in the US, eight out of ten recessions are preceded by substantial problems in housing, and the residential investment contribution to the US recessions and recoveries (measured in the year before the business cycle peaks and in the subsequent two years) is substantial. Ghent and Owyang (2010) find no consistent statistical relationship between local housing and local business cycles by examining the Metropolitan Statistical Areas data for the US cities. Yet, they also find that national housing building permits are a leading indicator for local employment. Helbling and Terrones (2003, Figure 2.1) show that, even though both housing and equity prices have generally coincided or overlapped with recessions, half of all housing price busts in the post-war period overlapped with equity price crashes, while only one-third of all equity price busts overlapped with housing price busts. Additionally, during 1970–2002, the negative output effects associated with housing price busts were about twice as large as those of equity price busts.[39]

[39]Still, to guard against the possibility that our results hinge critically on this particular Choleski ordering, we also experiment with other alternative orderings. The results obtained with these alternative orderings are very similar.

The Data

We use quarterly data with different time coverage for the following countries: Australia, Belgium, Canada, Finland, the United Kingdom, the United States, Sweden, and Switzerland.[40] The data include following variables: housing price index, stock market capitalization, consumption expenditure, and household disposable income. We obtain the stock market capitalization from Thomson Reuters Datastream as the measure of stock wealth. Consumption is the measure of private final consumption expenditure as is defined in the System of National Account used by OECD, including goods and services.[41]

Conceptually, a natural candidate for measuring housing wealth is home value. Practically, we can obtain the value of real estate owned by households only for the United States. For other countries, the relevant data available is the housing price index, and following the practice of existing literature in this field, we use it as a proxy for housing wealth for these countries.[42] Yet by using housing prices we fail to pick up the change in the size or quality of the housing capital stock per capita caused by the change in housing prices. However, Cardarelli et al. (2008) argue that monetary policy now

[40]Table 3.5 summarizes the time coverage as well as the number of observations for analysis for each country in our data. In Organization for Economic Co-operation and Development (OECD) countries, quarterly house price index is available only for the countries in our sample, plus New Zealand. However, disposable income (or industrial production as its proxy) is not available for New Zealand. Therefore we do not include New Zealand in our analysis. Ludwig and Slok (2004) include more countries than ours due to the fact that they interpolate quarterly housing prices via annual observations.

[41]The consumption measure includes both durable and non-durable components. Mehra (2001) points out that the total consumption is indeed the variable of interest in estimation of the long-term consumption-wealth relationship.

[42]Exceptions exist. Case et al. (2005) adjust the housing price index by the homeownership rate and the number of households for a country. Slacalek (2009) constructs a measure of housing wealth from a combination of first and secondary data sources.

transmits more through the price of houses than through residential investments. Thus, omitting the change in the housing capital stock due to residential investments may not be as damaging as it sounds.

That being said, for the US, both housing value and housing price index are available. We compare the results of estimated impulse response functions by separately employing these two data series for the US, and find quantitatively small differences between these two. In particular, for the US, the comparison between the values of impulse response functions for housing and for stock value does not change, no matter which data series we use for the housing value.

All variables are adjusted to real terms according to the respective Consumer Price Index (CPI) for each country. Except for the housing price index, all variables are on a per capita basis. If not already so in the original data, they are seasonally adjusted by the X12-ARIMA method. Finally, we use the natural logarithm of these variables in estimation, for it would be inappropriate to put housing price indexes with other values on the same footing in levels. Accordingly, our interpretation of the estimates would be in elasticities, rather than in marginal propenstity to consume. Later we convert estimates of elasticities back into MPC for comparison with the existing literature.

If VAR contains non-stationary variables, VECM is needed to specify a linear combination of integrated variables that is stationary. We employ the maximum eigenvalue test and the Johansen trace test to detect cointegrating relationships between the variables. Lutkepohl et al. (2001) provide evidence that these two tests may end up with different results for short samples, which is indeed the case for Belgium in our data set: according to the maximum eigenvalue test, there is no cointegrating relationship;

according to the Johansen trace test, we find a maximum of two cointegrating relationships. For Finland and Australia, both maximum eigenvalue and trace tests suggest that a maximum of one cointegrating relationship exists. We provide the results of Johansen trace test in Table 3.1. The table shows that cointegration is strongly rejected (at significance level 1%) for other five of the eight countries. Even for the countries with suspected cointegration vectors, our sample period is not long enough to impose robust long-run relationships between the variables, the same point noted by Edison and Slok (2002).[43] Thus we still apply the same structural VAR analysis to these countries.

Furthermore, we run stability tests to see whether the estimated VAR is stable, in the sense that the variables are covariance stationary. The results show that the eigenvalue stability condition is satisfied for all countries except Australia. One approach to address non-stationarity is to difference the data. However, Sims (1980) and Sims et al. (1990) caution against differencing, as differencing throws away information concerning the co-movements in the data. Thus we choose not to difference the Australia data before estimation.

III.III. Empirical Results

We determine the lag structure, namely, the value of K in (2), for each country based on AIC and FPE criteria. Our examination of the data reveals that the second-order lag structure is adequate for Australia, Sweden and the UK, that third-order is adequate for Canada, Finland and Switzerland, and that fourth-order is adequate for Belgium and the United States.

[43] The longest time coverage in our data set is from 1973 to 2009 for the US, whereas the comparable coverage in Edison and Slok (2002) is from 1990 to 2000. However, ours are quarterly data and theirs are monthly, therefore our effective sample period is not effectively longer.

Figure 3.2 and 3.3 depict consumption responses to housing price shocks for the eight different countries in our data set. The horizontal axis indicates the time that has passed, in quarters, after a 10% exogenous shock to housing prices initially. The vertical axis indicates the corresponding changes to consumption in percentages. Dashed and dotted lines indicate, respectively, 1.645 and one standard deviation confidence bands (or, 90% and 68% confidence intervals). For all countries except Finland, we observe that the initial consumption response to a housing price shock (i.e., on impact response) is positive and statistically significant at a 10% level. Sweden exhibits the largest on impact consumption response, at 6.42% to a 10% shock, and Finland exhibits the least, at 0.6% which is not statistically significant.

However, housing price has only a transitory effect on consumption, as is revealed by figure 3.2 and 3.3. Consumption multipliers of housing price shocks level off over time and decline eventually: for the majority of these countries, after 12 quarters, the consumption multiplier declines to a value that is less than the response on impact. Furthermore, there is a great deal of heterogeneity in the shape of the impulse-response function over time: for Canada, the UK, and Sweden it peaks very soon and then trends down swiftly, whereas for Belgium and Switzerland the trends are visible but almost flat.

Figure 3.4 and 3.5 depict consumption responses to stock market capitalization shocks for the same countries. The responses on impact for all countries, except Finland, are positive and statistically significant at a 10% level. Canada leads in the consumption response on impact at 2.27% to a 10% shock, and Finland again ranks as the last, at a statistically insignificant 0.15%. Yet, in contrast to the pattern of responses to housing price shocks, the consumption multipliers of five countries (except the US, Belgium, and

Switzerland) keep increasing over time. After 8 quarters, all countries have a larger consumption multiplier than the consumption response on impact. Edison and Slok (2002, figure 4) also obtain a persistent consumption response to stock valuation shocks for their selected countries. Their sample includes the US, Canada, the UK, which are also included in our sample; however, their estimated effects are much smaller in comparison to ours.

To compare the consumption multipliers to house price shocks with those to stock market capitalization shocks, we tabulate the two-year impact effects in Table 3.2. The consumption response is to a 10% initial shock to housing prices, or to stock market capitalization. Seven countries (Australia excluded) exhibit a larger initial response to housing price shocks than to stock market capitalization shocks, sometimes substantially (e.g., 6.42% versus 2.14% in the case of Sweden).[44] By the end of two years, however, four of these countries display a larger consumption multiplier in response to a stock market capitalization shock than to a housing price shock.

Could the differences in wealth effects of housing and stocks be attributable to the use of housing prices instead of home values? We investigate this by replacing household real estate values with the housing price index for the United States. Figure 3.6 demonstrates the dynamic wealth effects of consumption to housing price shocks by separately using these two data series for housing wealth. The basic pattern that the consumption multiplier levels off and eventually falls does not change, yet the

[44] Our results for Australia are consistent with the findings in Dvornak and Kohler (2007). Based on state-level data for Australia, they find that the MPC out of housing wealth (0.02-0.05) is lower than that out of stock wealth (0.08-0.12).

consumption multiplier estimated from housing price series drops off more precipitously. Figure 3.7 shows that the impact on estimates of consumption multipliers to stock value shocks is minimal when switching to housing value series.[45]

After analyzing the wealth effects separately for each country, we are now at a position where we can gauge the average effects by examining the mean group estimates. This estimator has been applied in Dvornak and Kohler (2007), Edison and Slok (2002), Slacalek (2009), to name a few. In essence, it is equivalent to pooling the data and imposing the identical-slopes restriction for all countries.[46] We show the results in Table 3.3. For all countries as a whole, the initial consumption response to a 10% housing price shock is 2.79%, in contrast to the (statistically insignificant) 1.31% to a 10% stock market value shock. Still, by the end of two years, the stock wealth effect overshadows the housing, consistent with the pattern for the majority of countries observed above, even though these mean group estimates are not statistically significant after 8 quarters. We divide the eight countries into two groups: Anglo-Saxon countries (Australia, Canada, the UK, and the United States) versus Continental Europe countries (Belgium, Finland, Sweden, and Switzerland). The rationale is that the former group has a more robust housing and stock market system than the latter. From Table 3.3 we observe that the wealth effects on consumption for the former group are generally greater than those for the latter group.

[45] Likewise, Edison and Slok (2002) find that, by the substitution of stock prices for stock market capitalization as a measure of wealth for the US, none of their VAR estimates of stock wealth effects changes.

[46] Pesaran and Smith (1995) show that mean group estimators can provide consistent estimates in dynamic models with heterogeneous coefficients across groups (countries). Strictly speaking, the number of countries in our sample is small, thus the criteria of large N for applying the mean group estimator is not satisfied. The results reported below should be treated with caution.

All the estimates listed so far are expressed in terms of elasticities. It is straightforward to multiply the elasticity by the consumption-wealth ratio to obtain MPCs that can be compared with the existing estimates of MPCs in the literature. Since the housing and stock wealth values are both available only for the US, we select the US to carry out this exercise. Note that the consumption-wealth ratio itself varies over time. We choose two different three-year time periods for the calculation of the MPCs: one is from 2003q1 to 2005q1, representative of the booming period for both housing and stock markets; the other is from 2006q1 to 2008q1, representative of the bust period.

Table 3.4 presents the MPCs calculated for these two time periods. For the boom years, the computed MPC out of housing wealth is 0.093 in the initial period, which means for the US a dollar increase in housing prices leads to an immediate 9.3 cents rise in consumption. This finding compares with a 0.060 MPC out of stock wealth initially. By the end of two years, the MPC out of housing wealth is 0.24, whereas the MPC out of stock wealth is 0.136. For the bust period, initially, the housing and stock wealth MPCs are both lower than those in the boom years (0.08 and 0.051 now). Yet because of the decline in both housing and stock wealth values and the fact that consumption cannot decline indefinitely, by the end of two years, the MPCs become substantially greater those in the boom period. The initial MPCs for housing and/or stock wealth are within the range of those reported in the literature for the US (Benjamin et al. 2004; Cardarelli et al. 2008; Slacalek, 2009).[47] Nevertheless, the crucial additional insight from our study is that the two-year MPCs turn out to be much greater due to the dynamic

[47] Our estimated initial MPCs of housing and stock wealth are close to the "eventual" MPCs obtained in Carroll et al. (2011), whose approach exploits the sluggishness in consumption response to shocks.

effects of one variable on the others. In particular, this finding of continuing stock wealth effects boosting consumption for a few quarters is consistent with that in Dynan and Maki (2001), who use Consumer Expenditure Survey micro data in their analysis. Our estimated magnitude also agrees with what they obtain.

Empirically teasing out the causes behind the differences in housing and stock wealth effects is a difficult task. Here we just navigate on one key difference between housing and stock assets: housing assets can be used for collateralized borrowing, while it is less common for households to post stock shares to borrow. We explore the relationship between estimated housing wealth effects and country values of Mortgage Market Index (MMI) constructed by Cardarelli et al. (2008). Mortgage Market Index is constructed from a variety of indicators, including mortgage equity withdrawal, refinancing easiness, typical loan-to-value ratio, mortgage-backed security issues, et cetera, and measures the maturity and development of mortgage market of a country. A higher value of MMI indicates easier household access to mortgage credit. Table 3.2 lists the values of MMI for our sample of countries except Switzerland, for which the data is not available. Figure 3.9 plots the on impact, 1-year, and 2-year consumption elasticities to a 10% housing price shock against the Mortgage Market Index constructed by Cardarelli et al. (2008). The trendlines of these scatter plots visualize the fact that those countries with higher MMIs are associated with greater housing wealth effects.

III.IV. Conclusion

This paper employs the structural VAR model to analyze the relationship between consumption, income, and stock and housing wealth. We apply this model to time series data of eight developed countries. Our main finding is that for a majority of countries in our data housing wealth exerts a larger and statistically significant response of consumption on impact than stock wealth does, yet the long-run effects of a housing wealth shock are not as persistent as those of a stock capitalization shock. For the US, our estimates imply an immediate MPC of 8-9 cents out of a dollar increase in housing wealth, in contrast to a MPC of 5-6 cents for stock wealth. Our identification strategy is based on the particular Cholesky recursive ordering but our results are robust to other orderings as well.

Because of data availability, we can only use housing prices as a proxy for house values. For the US, however, we do have data for both housing prices and household owned real estate values, and we find that our results are not sensitive to which measure in use. We find a larger housing wealth effect is associated with easier access to mortgage credit for these countries.

Our finding that the stock wealth effect is more persistent than the housing wealth effect probably stands in contrary to conventional wisdom. It is unclear how we can generalize this finding, however, since there are only eight countries in our sample. Nevertheless, the results are firm and robust for the US and they suggest important public policy implications. Existing studies that have obtained a higher, immediate MPC of housing markets would hint paying close attention to possible policy effects to housing markets rather than to equity markets. However, based on our study, a buoyant stock market, even though its immediate impact on the economy through consumption boosting is weaker, would make its economic contributions persistently over time.

Table 3.1. Results of Johansen trace tests for eight countries

	Johansen trace test		
Country	Trace Statistic	1% Critical	Maximum Rank
Australia	73.21	54.46	0
	30.6	35.65	1*
Belgium	63.61	54.46	0
	36.27	35.65	1
	17.27	20.04	2*
Canada	52.18	54.46	0*
Finland	71.38	54.46	0
	26.43	35.65	1*
Sweden	50.72	54.46	0*
Switzerland	47.64	54.46	0*
UK	51.8	54.46	0*
US (housing price	47.77	54.46	0*
US (housing value	37	54.46	0*

Notes: "*" by the maximum rank indicates that this is the value of rank selected by Johansen's multiple-trace test procedure.

Table 3.2. The dynamic percentage change of consumption to a 10% shock to housing prices and to stock market capitalization

		Consumption response to a 10%					
		house price shcok			stock market value shock		
Country	Mortgage market index[(a)]	Initial	1-year	2-year	Initial	1-year	2-year
Australia	0.69	1.38%**	2.47%**	1.42%	1.45%**	3.43%**	3.66%**
Canada	0.57	2.93%**	4.00%**	1.19%	2.27%**	3.86%**	2.84%*
UK	0.58	5.37%**	5.81%**	3.45%**	1.46%**	1.70%*	2.17%*
US (housing price)	0.98	2.35%**	5.09%**	5.37%**	0.94%**	2.1%**	3.04%**
US (housing value)		2.18%**	5.22%**	6.58%**	1.26%**	2.55%**	3.21%*
Belgium	0.34	1.54%**	3.36%**	3.40%**	0.50%*	1.11%*	3.90%**
Finland	0.49	0.60%	-0.83%	-2.79%*	0.15%	1.85%*	3.20%*
Sweden	0.66	6.42%**	9.00%**	7.33%*	2.14%**	3.98%**	3.77%*
Switzerland	—	1.75%**	2.17%**	1.89%*	1.58%**	2.31%**	2.43%**

Notes: Consumption percentage change in response to a 10% exogenous shock to housing prices and to stock market capitalization for each country. All calculations are based upon the impulse-response functions implied by our SVAR estimates. Initial elasticity is the elasticity in the initial period. ** and * indicate statistical significance levels of 0.1 and 0.32, respectively. (a) Mortgage market index is an index of the maturity and development of mortgage market of a country (higher value indicating easier household access to mortgage credit), constructed from indicators of mortgage equity withdrawal, refinancing easiness, typical loan-to-value ratio, mortgage-backed security issues, et cetera. See Cardarelli et al. (2008) for further detail.

Table 3.3. The mean group estimators of consumption to a 10% shock to housing prices and to stock market capitalization

	Consumption response to a 10%					
	house price shock			stock market value shock		
Region	Initial	1-year	2-year	Initial	1-year	2-year
Anglo-Saxon countrie	3.01%***	4.34%*	2.86%	1.53%*	2.77%*	2.93%
Continental Europe	2.58%*	3.43%*	2.46%	1.09%	2.31%	3.33%
All	2.79%*	3.88%	2.66%	1.31%	2.54%	3.13%

Notes: Consumption percentage change in response to a 10% exogenous shock to housing prices and to stock market capitalization for each region. Reported here are the unweighted mean group estimators for each region. The standard error of each mean group estimator is calculated assuming the estimates for each country are independent. All calculations are based upon the impulse-response functions implied by our VAR estimates. Initial elasticity is the elasticity in the initial period. ***, ** and * indicate statistical significance levels of 0.05, 0.1 and 0.32, respectively. Anglo-Saxon Countries include Australia, Canada, UK, and US; Continental Europe countries include Belgium, Finland, Sweden, and Switzerland.

Table 3.4. The Marginal Propensity to Consume for the United States

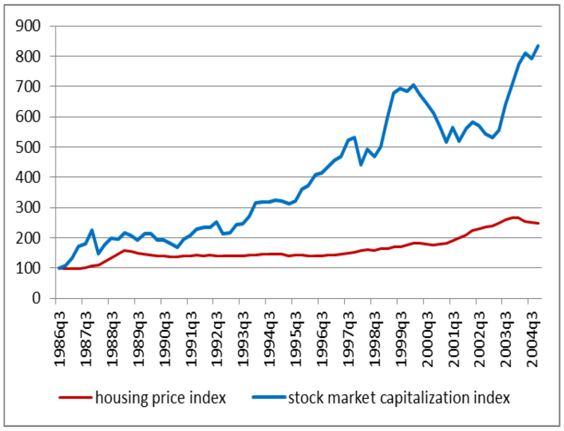
	U.S. Marginal Propensity to Consume (MPC) of					
	housing wealth			stock wealth		
starting period	Initial	1-year	2-year	Initial	1-year	2-year
2003q1	0.093	0.209	0.240	0.060	0.112	0.136
2007q1	0.080	0.224	0.345	0.051	0.107	0.214

Notes: MPC is calculated as the elasticity of consumption to wealth multiplied by consumption-wealth ratio of the corresponding period. The elasticities are obtained from the impulse-response functions implied by our SVAR estimates. We choose U.S. because it has both household house value and stock market capitalization value in data.

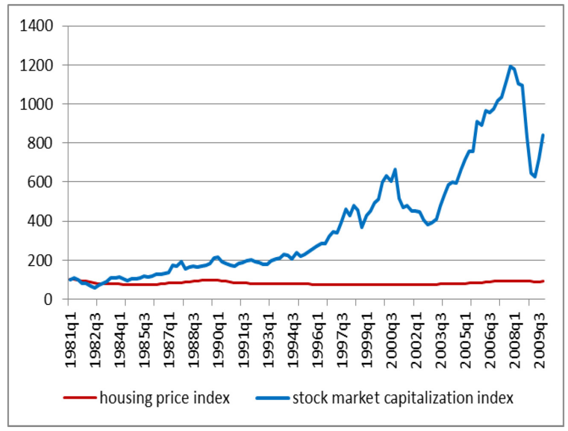
Table 3.5. Summary period of coverage and number of observations for countries

Country	Period of coverage	Number of observation
Australia	1986q3—2004q4	74
Belgium	1981q1—2004q4	96
Canada	1981q1—2009q4	116
Finland	1988q2—2004q4	67
Sweden	1986q1—2004q4	76
Switzerland	1981q1—2003q4	92
United Kingdom	1984q2—2004q4	83
United States	1973q1—2009q4	148

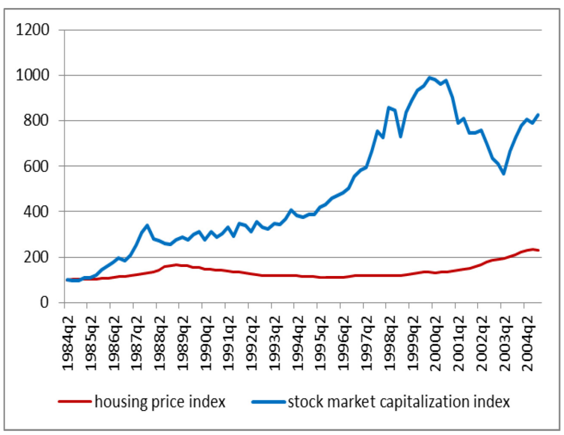
Figure 3.1. Housing price and stock market index: Australia, Canada, United Kingdom, United States



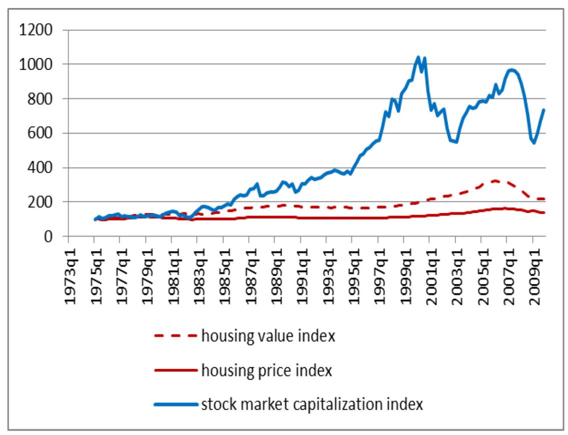
Australia



Canada



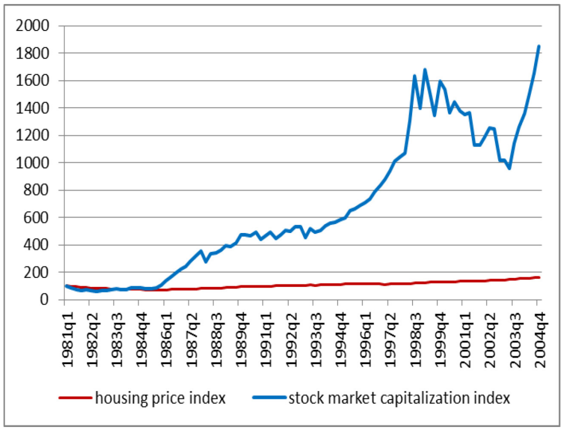
UK



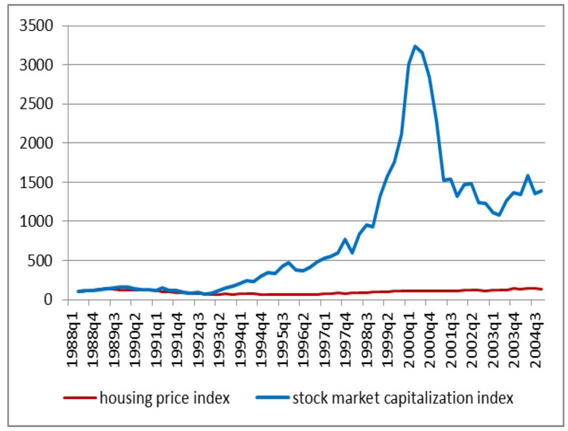
US

Notes: index = 100 for both housing price and stock market capitalization at the beginning of data time series for each country. For the United States, the series of market value of household owned real estate is also included.

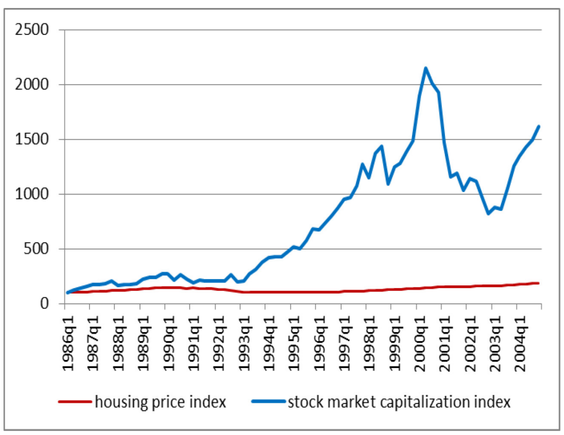
Figure 3.2. Housing price and stock market index: Belgium, Finland, Sweden and Switzerland



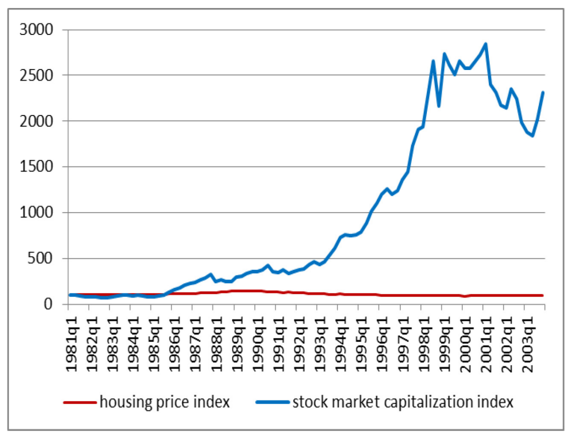
Belgium



Finland



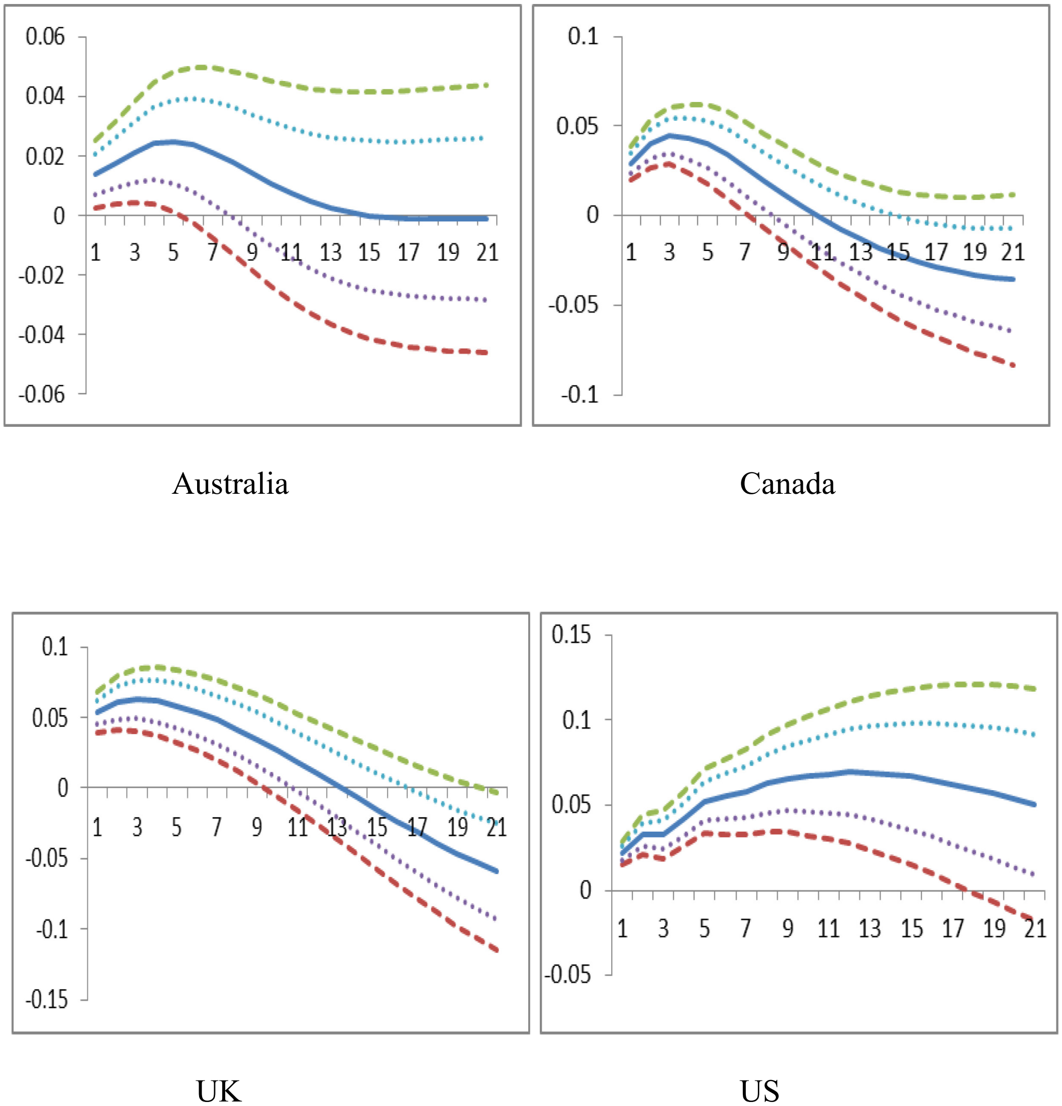
Sweden



Switzerland

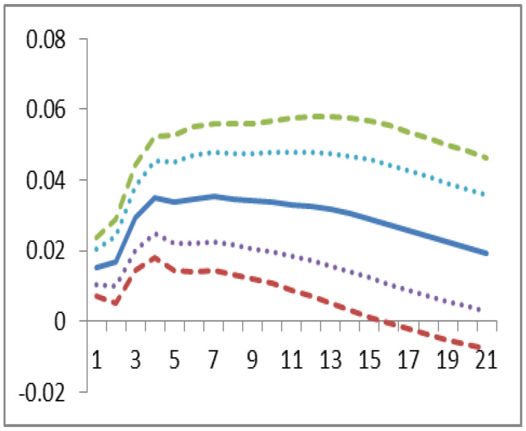
Notes: index = 100 for both housing price and stock market capitalization at the beginning of data time series for each country. For the United States, the series of market value of household owned real estate is also included.

Figure 3.3. Impulse response functions of consumption given a 10% increase to housing prices: Australia, Canada, United Kingdom and United States

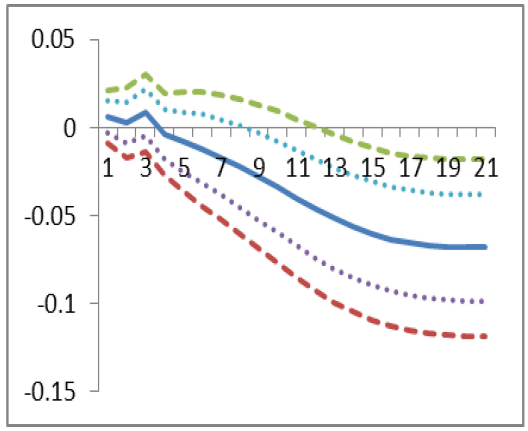


Notes: dashed lines indicate 90% confidence interval; dotted lines indicate 68% confidence interval.

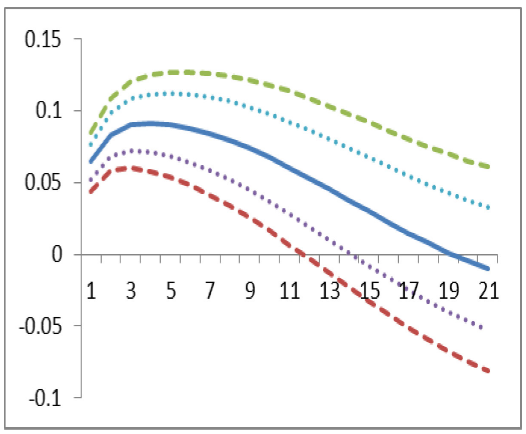
Figure 3.4. Impulse response functions of consumption given a 10% increase to housing prices: Belgium, Finland, Sweden, Switzerland



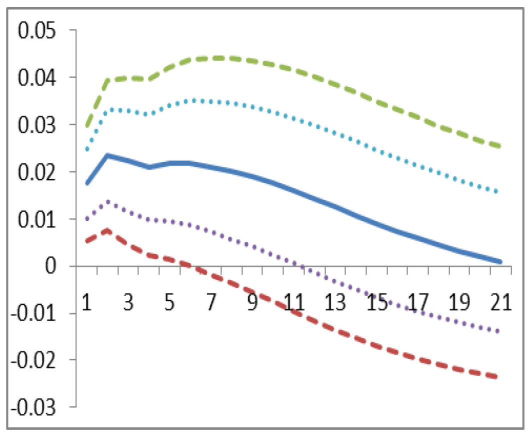
Belgium



Finland



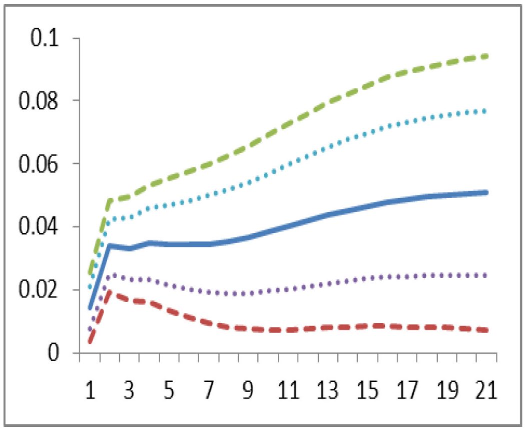
Sweden



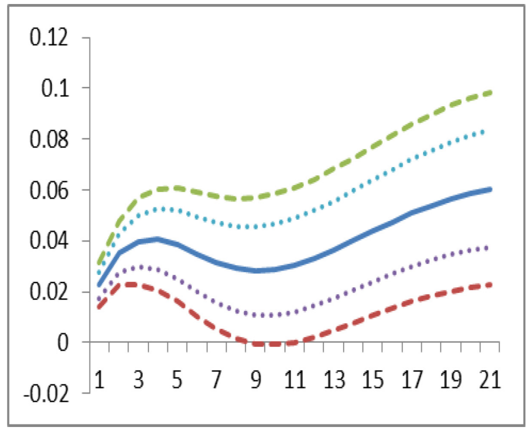
Switzerland

Notes: dashed lines indicate 90% confidence interval; dotted lines indicate 68% confidence interval.

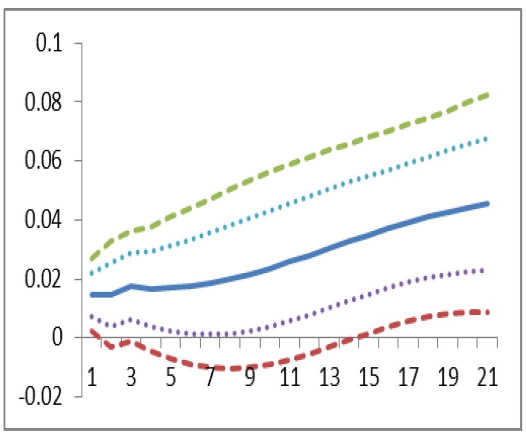
Figure 3.5. Impulse response functions of consumption given a 10% increase to stock market capitalization: Australia, Canada, United Kingdom, United States



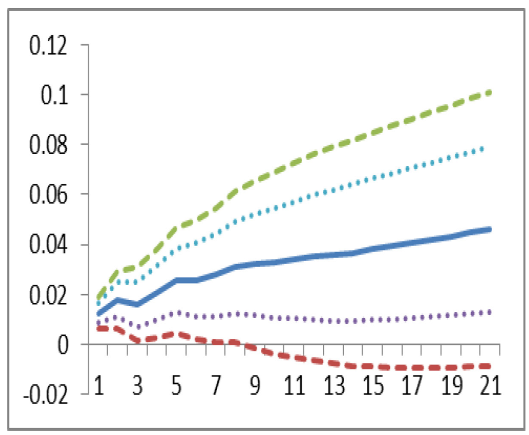
Australia



Canada



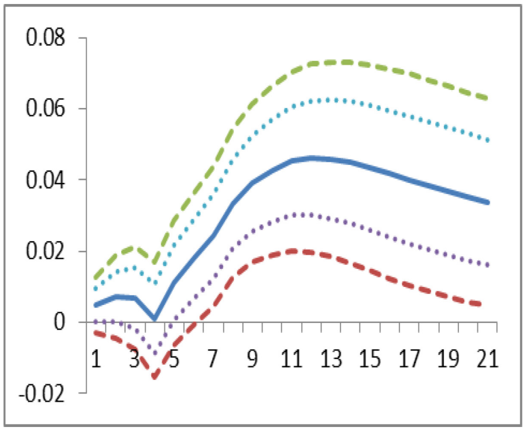
UK

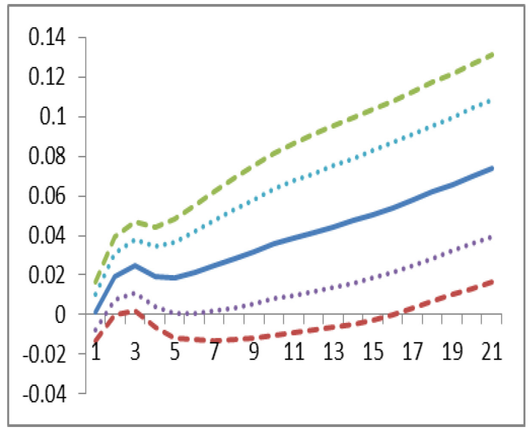


US

Notes: dashed lines indicate 90% confidence interval; dotted lines indicate 68% confidence interval.

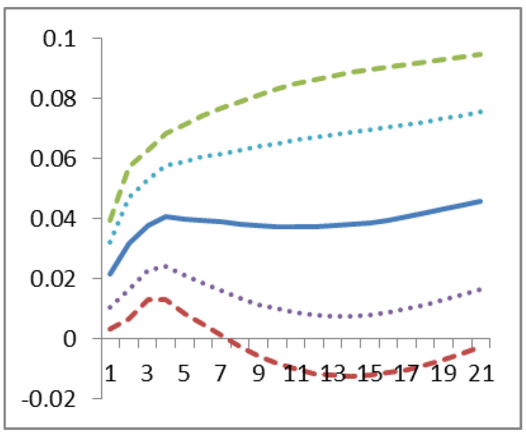
Figure 3.6. Impulse response functions of consumption given a 10% increase to stock market capitalization: Belgium, Finland, Sweden, Switzerland

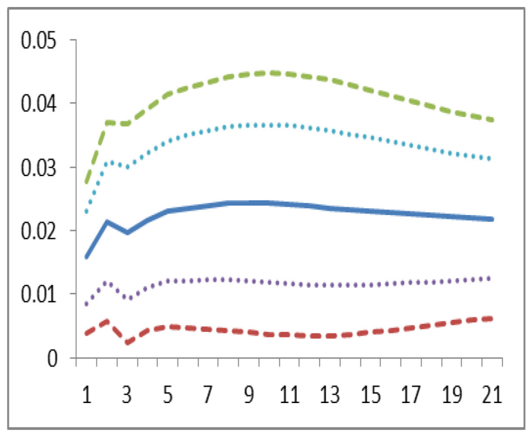




Belgium

Finland



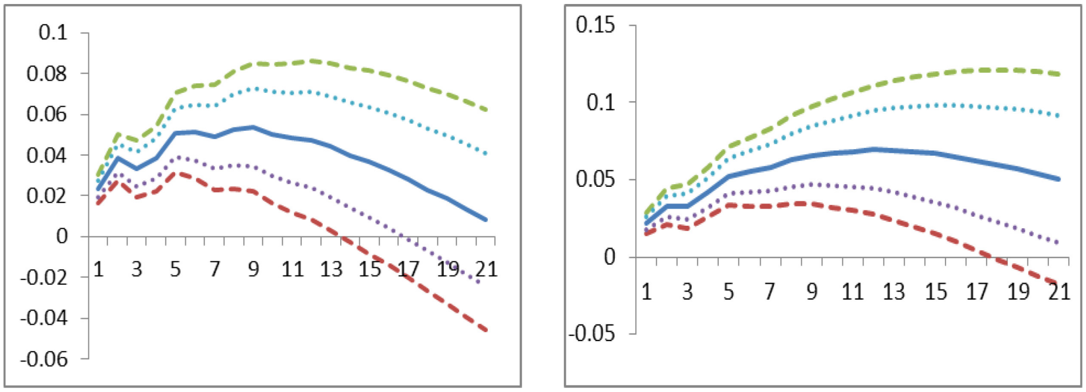


Sweden

Switzerland

Notes: dashed lines indicate 90% confidence interval; dotted lines indicate 68% confidence interval.

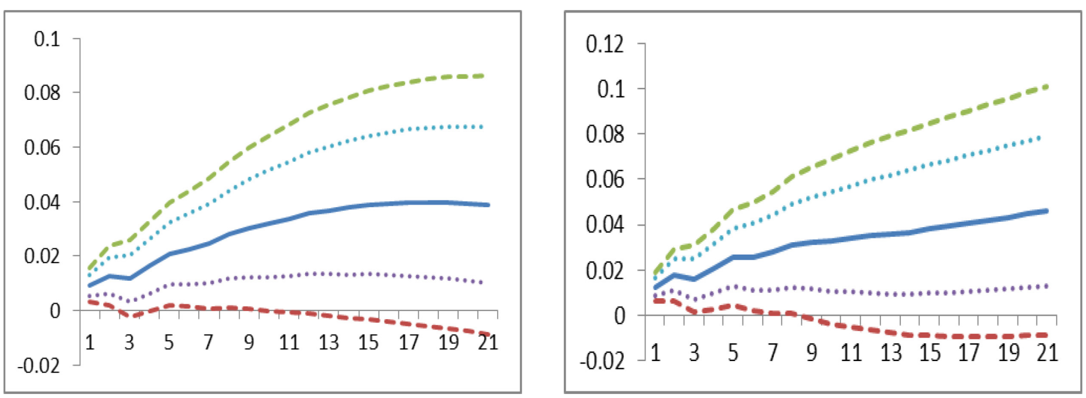
Figure 3.7. Impulse response functions of consumption given a 10% increase to housing value or housing price: United States



US (estimated with housing price index) US (estimated with housing value)

Notes: dashed lines indicate 90% confidence interval; dotted lines indicate 68% confidence interval.

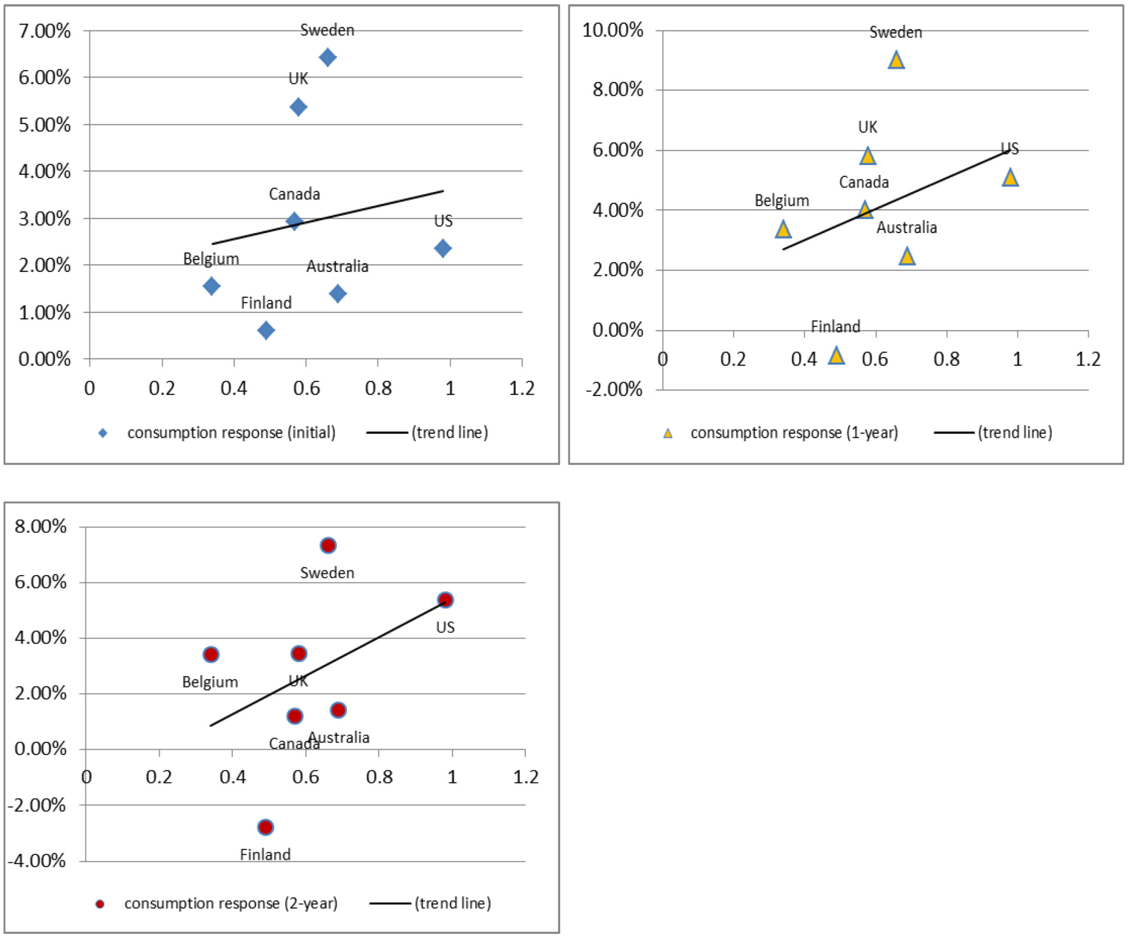
Figure 3.8. Impulse response functions of consumption given a 10% increase to stock market capitalization: United States



US (estimated with housing price index) US (estimated with housing value)

Notes: dashed lines indicate 90% confidence interval; dotted lines indicate 68% confidence interval.

Figure 3.9. Scatter Plots of consumption responses to a 10% housing price stock



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APPENDIX

Derivatives

The derivates in (24)-(28) are as follows:

$$q_1^* = \frac{(\varepsilon - t_l)}{\theta_g^2} > 0, \quad q_2^* = -\frac{1}{\theta_g} < 0 \tag{30}$$

$$k_1^* = \frac{r\theta_r(\varepsilon - t_l)}{\theta_c\theta_g^2 f''(\bar{k})} < 0, \quad k_2^* = \frac{\theta_g k_1^*}{\theta_c} < 0, \; k_3^* = \frac{r(\varepsilon - t_l)}{-\theta_c\theta_g f''(\bar{k})} > 0, \quad k_4^* = \frac{r\theta_r}{-\theta_c\theta_g f''(\bar{k})} > 0, \tag{31}$$

$$b_1^* = -\frac{f'(\bar{k})k_1^*}{r} > 0, \quad b_2^* = -\frac{f'(\bar{k})k_2^*}{r} > 0, \; b_3^* = -\left[\bar{c} + \frac{f'(\bar{k})k_3^*}{r}\right] < 0, \quad b_4^* = \frac{f'(\bar{k})k_4^*}{r}, \tag{32}$$

$$c^{*'} = r\bar{c} \tag{33}$$

$$\phi^{*'} = -\left(\frac{1}{r\theta_r^2}\right) \tag{34}$$

On the other hand, plugging adjustment cost equation into equation (20) and manipulating the obtained one will yield:

$$i_t = k_t\left(\frac{\theta_g(q - \bar{q})}{\chi\theta_c}\right) \tag{35}$$

Finally,

$$q_0 = E_t\sum_{t=0}^{\infty}\left(\frac{1}{1 + \frac{r\theta_r}{\theta_g}}\right)^t \frac{\theta_c}{\theta_g}\left[f^{'}(k_{t+1}) - r(1-\varepsilon) + \left[(\frac{i_{t+1}}{k_{t+1}})^2 T^{'}(\frac{i_{t+1}}{k_{t+1}})\right]\right] \tag{36}$$

if capital gains tax rate decreases, $\left(\frac{1}{1+\frac{r\theta_r}{\theta_g}}\right)^t$ will increase which means an increase in q_o. On the other hand, q_o will decline becaues of the decrease in $\frac{\theta_c}{\theta_g}$. Thus, we can conclude that the latter impact dominates the former.

Once the adjustment cost equation is plugged into equation (20), after some manipulation, we will end up with the following:

$$\frac{i_t}{k_t}=\frac{\theta_g q_t-\varepsilon+t_l}{\chi\theta_c} \tag{37}$$

As investment tax credit declines, t_l, investment level will decrease. Yet, on the other hand, the increase in q will stimulate investment. From figure (I.21), one can infer that the impacts of the decrease in t_l dominates the effects of the decrease in q on investment level in the short-run. However, it should be noted that the shock is temporary and dies out over time. Thus, after a certain point, the change in q outweighs by giving rise to an increase in investment as seen in figure.

Calibrating Parameters

To calibrate the model, we choose the parameters in conformance to the best practice in the literature, so that we have following initial values:

$r=0.04$, $\alpha=0.33$, $\rho=0.9$, $\mu=0.9$, $w=0.8$, $\chi=2.9$.

On the other hand, the country specific tax rate data is obtained from OECD Tax Data Base.

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Unal, Umut (March 2011). *Capital Income Taxation and Welfare under DSGE Framework*. Paper presented at the Southwestern Society of Economists Annual Conference, Houston, TX.

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