University of Alberta

The Economic Impact of the Alberta Heritage Savings Trust Fund on the Consumption-Savings Decision of Albertans

by

Michael Douglas Hoffman ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Arts

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled The Economic Impact of the Alberta Heritage Savings Trust Fund on the Consumption-Savings Decision of Albertans submitted by Michael Douglas Hoffman in partial fulfillment of the requirements for the degree of Master of Arts.

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ABSTRACT

The creation of the Alberta Heritage Savings Trust Fund has raised some important economic issues. This thesis employs economic theories to develop a framework from which the economic impact of the Heritage Fund on individual consumption-savings behaviour can be assessed. This assessment was based on the Ricardian equivalence theorem. Under this theorem, the existence of the Heritage Fund should cause the future tax burden to decline and current consumption to increase.

The Heritage Fund represents a form of government savings that does not have any associated future liability. Therefore, it provides a unique opportunity to test Ricardian equivalence while also examining the impact of the Heritage Fund on the consumption-savings decision of Albertans. Empirical results indicate the Ricardian equivalence theorem is not supported since Albertans have not altered their consumption-savings behaviour in a manner that is consistent with the Heritage Fund representing a future reduced tax burden.

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INTRODUCTION

The Alberta Heritage Savings Trust Fund ("Heritage Fund") was created in 1976 in recognition that the then rapidly-increasing revenues received by the province from the sale of non-renewable resources would not continue indefinitely. Since its inception, the Heritage Fund has had three basic objectives: (*i*) to save for the future; (*ii*) to strengthen and diversify Alberta's economy; and (*iii*) to improve the quality of life in Alberta. By 31 March 1994, the Heritage Fund held equity investments of almost $12 billion and had expended another $3.4 billion in capital projects. Low resource revenues and large deficits of the past decade have resulted in a growing provincial debt. This situation led many Albertans to question the future of the Heritage Fund. In 1994, the government announced a full review of the Heritage Fund to take place in early 1995.

The creation of the Heritage Fund has raised some important economic issues. First, do Albertans view collective savings differently than their own private savings? Also, do Albertans view the Heritage Fund as providing lower taxes at some future date? If the answer to these questions is yes, the Heritage Fund will have an impact on individual consumption-savings decisions, and liquidating the Heritage Fund would impact this decision. Second, in making their consumption-savings decision, do Albertans look at the Heritage Fund as a whole or do they view the more liquid portions differently? If Albertans view components of the Heritage Fund differently, the composition will also impact the consumption-savings decision. Finally, the Heritage Fund was a transformation of wealth in the ground (in the form of oil and natural gas) to wealth in the form of financial assets. Do Albertans view wealth defined by financial assets differently from wealth in the ground?

This thesis focuses on the first objective of the Heritage Fund: to save for the future. Analysis of this objective is done by examining individual consumption-savings behaviour and how the existence of the Heritage Fund has affected this behaviour. Simply, has the Heritage Fund caused Albertans to alter their consumption-savings behaviour in a manner that is consistent with viewing the Heritage Fund as providing a reduced future tax burden? The results of the empirical analysis performed in this thesis indicate the short answer to this question is, no.

This thesis is organized into seven chapters. Chapter 1 is an introduction to the Heritage Fund. It explains why the Heritage Fund was created and how it is organized. Chapter 2 provides the background to the theory used to develop the model that will be examined. It includes an extensive literature review, outlines the key issues underlying the theory, and summarizes the existing empirical findings. Chapter 3 explains the role of interprovincial migration in the analysis.

Chapter 4 develops a model of consumption. This model is the basis for the empirical analysis in this thesis and is derived from theory presented in the preceding chapters. In Chapter 5 the data used in the empirical analysis are described in detail. In Chapter 6, the model is empirically tested and the results are reported. Finally, Chapter 7 summarizes the results and draws conclusions.

CHAPTER 1: THE ALBERTA HERITAGE SAVINGS TRUST FUND

In 1971, the new Conservative government began developing policies that placed higher priority on the resource sector. The government believed management of the province's natural resources was central to economic development and important to the financial management of the province. Canada allowed itself to become increasingly dependent on an offshore oil supply. The rapid increase in world energy prices which began in 1973 made access to Alberta oil and gas production imperative; cutbacks in production could not be considered. Despite concerted efforts by the federal government and central Canada to suppress price increases, domestic prices of oil and natural gas began to rise. Higher production and rising prices resulted in provincial royalty revenues increasing in magnitudes that far exceeded previous expectations.

Higher revenues enabled the Alberta government to raise the level and quality of services provided to Albertans while maintaining the most favourable corporate, personal and sales tax regime in Canada. Further reductions in taxes were seen as limited. The Alberta economy had consistently been near capacity since the early 1970's. "The danger of overstimulation, and of imposing inflationary pressures on the economy that such changes would almost certainly provoke, provide[d] a strong argument in favour of fiscal restraint." [1] Fiscal

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[1] Collins (1980), p. 159.

stimulation could also induce substantial migration flows to the province and would create economic inefficiencies in both Alberta and the sending provinces. Additionally, if private consumption, because of reduced taxes or increased provision of government services, was permitted to rise unchecked, Albertans could experience a more traumatic adjustment process if non-renewable resource revenues were unable to support the level of consumption and government services at some point in the future. A fiscal strategy that was cognizant of these potential problems needed to be advanced.

The fiscal strategy would also need to take into account what Warrack called the axiom of practical politics: the highest level of public service provided becomes the minimum expectation of that public.[2] If government expenditures were affordable in the short term, large budgetary surpluses over a series of years would result in substantially increased spending. When non-renewable resource revenue disappeared, if the axiom is correct,[3] "the only choice would be a dramatic and permanent pattern of tax increases and mounting public debts."[4]

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2 Warrack (1985), p. 17.

3 This axiom would appear to apply to the case of present-day Alberta. The public realizes the importance of eliminating the deficit and reducing the province's debt but is accustomed to the level and quality of services and sees many of the cuts as reducing services beyond the level they have grown to expect.

4 Warrack (1985), p. 17.

1.1 Creating the Heritage Fund

The government began considering a policy of saving a portion of the non-renewable natural resource revenue. This action would reduce inflationary pressures and investment of the fund would provide a source of income, and perhaps capital, that could be used in the future to supplement other government revenues. Therefore, when non-renewable resource revenue began to diminish, the upward adjustment of taxes, or the reduction in services, could be more gradual than otherwise necessary. Second, monies from the fund could be invested in certain sectors of the economy and specific projects to promote diversification away from the province's dependence on conventional oil and gas production. Finally, the non-renewable resources that form part of Alberta's capital stock could be converted to financial assets (and real assets in the form of investments in capital projects), thus preserving a portion of the resource wealth for use by future generations.

In 1974, the concept of an Alberta Heritage Fund was introduced and was an issue in the 1975 election. Following the election, the government felt it had a mandate to legislate the fund's creation. After considerable debate and public consultation, legislation was introduced and passed in the spring 1976 session. The Heritage Fund would receive income through a transfer of thirty percent of the province's annual non-renewable natural resource revenue. The income would be invested in three separate divisions: the Capital Projects Division, the Alberta

Investment Division, and the Canada Investment Division. In the early 1980's, changes to the Heritage Fund resulted in the creation of the Commercial Investment Division, Energy Investment Division and a residual component, the Cash and Marketable Securities Portfolio.

Throughout the lifetime of the Heritage Fund, Alberta has been considered an attractive place for private initiative and investment. To minimize interference in the private sector, the Heritage Fund has not been used to make equity investments in existing enterprises. However, equity investments have been made to advance specific goals such as the Heritage Fund's equity position in the Syncrude project, ensuring the go-ahead of that major oil sands initiative.[5] Also, while not wishing to interfere with the operation of Canadian financial markets, the Heritage Fund is administered, where possible, to develop Alberta's financial community. A description of each division is provided below. Current net assets of each component of the Heritage Fund are summarized in Table 1.

1.2 Composition of the Heritage Fund

The Alberta Investment Division is intended to strengthen and diversify the economy of Alberta, and is expected to yield a reasonable return or profit. Permitted investments include debt or equity and there is no statutory limit on the relative size of the division. Currently, the Alberta Investment Division includes debentures of provincial Crown corporations, corporate securities, project

[5] Collins (1980), p. 160.

investments and equity holdings, representing approximately thirty per cent of the Heritage Fund's equity. All investments must be approved by the Investment Committee which must be satisfied that a prospective investment will satisfy the criteria set out in the *Alberta Heritage Savings Trust Fund Act*.

TABLE 1
ALBERTA HERITAGE SAVINGS TRUST FUND BALANCE SHEET
March 31, 1994 (thousands of dollars)

	1994	% of Fund Equity
Alberta Investment Division	3,706,541	31.2%
Canada Investment Division	1,068,628	9.0%
Capital Projects Division Investments	131,647	1.1%
Commercial Investment Division	399,507	3.4%
Energy Investment Division	0	0%
Cash and marketable securities	6,028,870	50.7%
Accrued interest and accounts receivable	526,537	4.4%
Due from the General Revenue Fund	32,661	0.3%
Fund Equity	11,894,391	100.0%
Capital Projects Division Amounts Expended	3,366,222	

Source: Alberta Heritage Savings Trust Fund 1993-94 Annual Report

In creating the Heritage Fund, it was clear that it was necessary to invest part of the income in areas outside the province. Investments in this category compose the Canada Investment Division. In addition to reducing inflationary pressures in Alberta, investments outside the province would provide all Canadians with access to capital from the Heritage Fund. These investments would also permit a more diversified portfolio necessary for prudent management. The portfolio of the Canada Investment Division includes provincial government or government-backed debentures. The investments were made between 1977 and 1982.

The government realized the objective of providing for future generations could be met in several ways. Some investments could provide long-term benefits without directly earning income, while others could provide Albertans with a few special amenities that would not otherwise have been undertaken. This is the reason the Capital Projects Division was created. The division makes capital investments in many areas including environmental protection, health, education, and energy.

The Commercial Investment Division was established in 1982 to help diversify the Heritage Fund's investments, which are primarily fixed income securities. The division invests primarily in equity securities of Canadian companies. These investments are expected to earn better long-term returns than fixed income securities. The division is not permitted to invest in bank stocks, and does not invest in stocks of small companies.

The Energy Investment Division was intended to facilitate the development, processing, and transportation of energy resources within Canada. "The intention fell victim, like so many energy investments, to the former federal government's National Energy Program. The concept of Alberta Heritage Fund energy investments elsewhere in Canada may be politically difficult to resurrect."[6] As of 31 March 1994, the Energy Investment Division held no investments.

Finally, funds that are not immediately required for investment in other divisions are invested by the Provincial Treasurer under section 10 of the *Alberta Heritage Savings Trust Fund Act.* Cash and marketable securities provide the Heritage Fund with the ability to fund its various investments. They also provide the province with considerable flexibility in managing its borrowing. Investments include short- and medium-term money market securities, marketable bonds, deposits, and mortgage-backed securities. In 1993-94, the Cash and Marketable Securities portfolio represented slightly over fifty percent of the Heritage Fund's equity.

1.3 Heritage Fund Revenue Sources

The Heritage Fund has had two sources of revenue: a percentage of Crown non-renewable resource revenue and income from financial yields on investments of the Heritage Fund. From 1976 to 1982, the government transferred thirty percent of non-renewable resource revenue to the Heritage Fund. From 1983 until 1987, the percentage was reduced to fifteen percent, and since 1987, no non-renewable resource revenue has been transferred. In 1982, the government began transferring all the Heritage Fund's net annual income to the General

6 Warrack (1985), p. 27.

Revenue Fund to pay for various government services. As of 31 March 1994, these transfers had accumulated to over $15 billion.

The initial investment in the Heritage Fund was made on 30 August 1976 when the government transferred $1.5 billion from the General Revenue Fund to the Alberta Heritage Savings Trust Fund. Over the next seven years, the growth of the Heritage Fund was staggering. By 1982-83, the Heritage Fund had assets exceeding $11 billion and more than $1.5 billion had been spent on capital projects. The growth began to slow down when the government reduced the transfer percentage to the Heritage Fund to fifteen percent of non-renewable resource revenues. In addition, the transfer of the Heritage Fund net income to the General Revenue Fund provided funds for government services but stopped investment income of over $1 billion a year from being reinvested. Since 1988, the government has stopped all non-renewable resource revenues from being transferred to the Heritage Fund. Assets have declined by a total of 6.7% over the past seven years although capital project spending has increased slightly.

The decline in the growth of Heritage Fund equity can be attributed to a few different factors. First, after 1986-87, all transfers from non-renewable resource revenue were halted. Second, the growth rate declined after 1982-83, when Heritage Fund income was not reinvested, but was instead transferred to the General Revenue Fund. As a result, growth in the Heritage Fund could only come from the assets held by fund. While the average return on the Heritage Fund is approximately 10% per annum, some investments have not performed well and their value has been written down, causing Heritage Fund equity to decline. However, it is important to understand that Heritage Fund equity is calculated at book value and not market value. Therefore, when an investment is made in a particular division, such as the Commercial Investment Division, the value at the time the investment is made is used to calculate Heritage Fund equity. This method of accounting has resulted in the Heritage Fund equity being somewhat understated as some investments have a market value that exceeds the book value. As at 31 March 1994, Heritage Fund equity at market value was $12.482 billion whereas book value was only $11.894 billion. Nonetheless, Heritage Fund equity has declined since 1986-87 when it peaked at a book value of $12.745 billion. The historical trends of the Heritage Fund are summarized in Table 2.

TABLE 2
ALBERTA HERITAGE SAVINGS TRUST FUND HISTORICAL SUMMARY
(thousands of dollars)

	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82
Fund Equity	2,181,554	3,244,264	4,450,323	5,681,557	7,619,301	9,699,531
Growth Rate (%)	n.a.	48.71	37.18	27.67	34.11	27.30
Capital Projects Division	35,961	122,797	255,087	733,435	960,508	1,309,322
Net Income	87,689	186,547	293,694	342,807	723,847	1,006,703
Non-Renewable Resource Revenue Transfers	620,182	931,175	1,059,002	1,331,757	1,445,328	1,434,160
Transfers to General Revenue Fund	0	0	0	0	0	0

	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Fund Equity	11,396,709	11,777,046	12,273,859	12,716,212	12,744,531	12,561,853
Growth Rate (%)	17.50	4.22	3.34	3.60	0.22	-1.43
Capital Projects Division	1,604,920	2,162,393	1,934,638	2,402,481	2,629,287	2,758,363
Net Income	1,481,599	1,577,062	1,469,251	1,666,683	1,444,906	1,353,482
Non-Renewable Resource Revenue Transfers	1,356,415	737,198	720,402	684,637	216,391	0
Transfers to General Revenue Fund	865,720	1,575,285	1,469,217	1,666,683	1,444,906	1,353,482

	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
Fund Equity	12,411,760	12,286,574	12,132,345	12,039,098	11,951,488	11,894,391
Growth Rate (%)	-1.19	-1.01	-1.26	-0.77	-0.73	-0.48
Capital Projects Division	2,913,373	3,047,073	3,197,388	3,281,735	3,366,222	3,436,733
Net Income	1,252,219	1,244,438	1,336,857	1,386,184	784,532	1,103,470
Non-Renewable Resource Revenue Transfers	0	0	0	0	0	0
Transfers to General Revenue Fund	1,252,219	1,244,438	1,336,857	1,386,184	784,532	1,103,470

Source: Alberta Heritage Savings Trust Fund Annual Reports, 1976-1977 to 1993-1994

CHAPTER 2: RICARDIAN EQUIVALENCE THEORY

2.1 Theory

The standard theoretical model, typically associated with Keynes, maintains deficit-financed government expenditure causes a short-term stimulus to output and employment, a rise in the rate of interest and a crowding out of private investment. In an open economy, a small country's deficit may have negligible effects on the real rate of interest in international capital markets. Thus, there is a tendency toward increased borrowing from abroad rather than higher real interest rates. This result would indicate budgetary deficits lead to current-account deficits, and the lack of movement in the rate of interest causes less crowding out of private investment. The results of the standard model can be attributed to the inclusion of government debt as part of the stock of private wealth, implicitly assuming the private sector is myopic, not accounting for the impact on future taxes. The standard theory could be applied to the Heritage Fund, but the consequences of government saving would be opposite to those of deficit financing.

In recent years, traditional theory has been questioned and an alternative theory, "Ricardian equivalence," has received considerable attention. Ricardian equivalence suggests there is no difference between deficit-financed and tax-financed government expenditures. The intuition behind this theory is straightforward; government expenditure must be paid for now or later, with the total present value of revenues in the infinite horizon equal to the total present value of all expenditures. Therefore, any debt-financed expenditure must be offset, at some time, by increased taxes. Rational agents, recognizing this equivalence, will reduce consumption by the present value of the debt to cover the future tax liability; output does not increase as standard theory would indicate. Rational agents are indifferent between paying $1 in taxes today and paying $1 plus interest in taxes tomorrow. Since the timing of taxes does not affect an agent's lifetime budget constraint, it cannot alter the consumption decision.[7] In the context of the Heritage Fund, if Ricardian equivalence is supported, agents should view government savings as providing a future reduced tax burden and consumption in the current and subsequent periods should increase.

As Seater (1993) notes, Ricardian equivalence is a straightforward generalization of the permanent income/life-cycle hypothesis. Given the general acceptance of the permanent income/life-cycle hypothesis as a tool for analyzing household choice, the theoretical case for Ricardian equivalence seems trivial. However, the Ricardian equivalence theorem requires many explicit and implicit assumptions about an agent's behaviour.

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7 While associated with Ricardo, O'Driscoll notes that Ricardo, himself, did not support the theory. Ricardo posed the question but later stated that "This argument of charging posterity with the interest on our debt, or of relieving them of a portion of such interest is often used by well informed people, but I confess I see no weight in it." (Ricardo from Sraffa (1951), p. 187). See O'Driscoll (1977).

2.1.1 Infinite Horizons

Ricardian equivalence theory requires agents to have an infinite horizon. However, this assumption appears problematic since agents clearly experience a finite horizon. The horizon length is central to life-cycle models. In these models, agents capitalize only the taxes they expect to face before dying. Consider an economy where agents live for exactly two periods in a succession of overlapping generations, and derive utility only from their own consumption. The government raises money for expenditures through taxation and deficit financing. The issuance of government debt, which lowers the taxes of the current working generation, will be redeemed with taxes levied on future generations. The present value to the current working generation of the future tax burden will be less than the tax reduction. Therefore, financing schemes that alter the timing of taxes will have wealth effects and will stimulate macroeconomic activity. The same result can be found when generations live for longer than two periods. As long as some of the tax liability is borne by a future generation, the current working generation does not bear the full tax liability of the deficit. This results in the ability of the agent to benefit from the deficit-financed expenditure without ever realizing the full tax liability. The rational agent, therefore, will only alter consumption by the present value of the portion of the tax liability that will be realized. The agent's net wealth rises, consumption increases, and private saving does not rise by enough to fully offset the decline in government saving.

While the reality of a finite horizon is problematic for Ricardian equivalence, advocates overcome this problem by creating an intergenerational link. Robert Barro (1974) showed Ricardian equivalence holds in a model in which individual agents have the finite horizons if agents regard their children as extensions of themselves. This altruistic utility function can be defined as $U_t = U_t\left(C_{1t}, C_{2t}, U^*_{t+1}\right)$. The utility of an agent of generation t becomes a function of the consumption when young and old (C_{1t}, C_{2t} respectively) and the utility of agents in generation *t+1*, U^*_{t+1}.

> A network of intergenerational transfers makes the typical person a part of an extended family that goes on indefinitely. In this setting, households capitalize the entire array of expected future taxes, and thereby plan effectively with an infinite horizon.[8]

Thus, the Ricardian equivalence theorem which relied upon an infinite horizon is not invalidated by finite lifetimes.

Barro (1989) noted an important point associated with intergenerational transfers. These transfers do not have to be large, but rather, it is necessary for the transfers based on altruism to be operative at the margin for most people. "Specifically, most people must be away from the corner solution of zero transfers, where they would, if permitted, opt for negative payments to their children. (The results go through, however, if children typically support their aged parents)."[9] It is not necessary for transfers to show up as bequests at death. Other transfers such

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8 Barro (1989), p. 40.
9 Barro (1989), p. 41.

as support of a child's education can work in a similar manner. Ricardian equivalence can hold even if there is little transferred as a formal bequest.

One objection to the intergenerational link involves families without children. These agents would have no concern for taxes levied on future generations as they have no direct connection to them. Therefore, when government expenditure is financed by a deficit, the childless agent will alter the consumption path and Ricardian equivalence will be violated. Tobin (1980) and Barro (1989) maintain that there is likely some offsetting response from agents with families. Because a disproportionate share of the future taxes will be borne by their children, the agents will appropriately adjust their bequests. Studies by Darby (1979) and Kotlikoff and Summers (1981) have concluded that most people give or receive intergenerational transfers, thus supporting the Ricardian equivalence position. Modigliani (1988) questions these results, but Kotlikoff (1988) showed that Modigliani focused on a narrow definition of intergenerational transfers which explains the contradictory result.

Critics of Ricardian equivalence who are willing to accept the importance of intergenerational transfers argue that the motivation for the transfers is important. Bernheim, Shleifer, and Summers (1985) examine strategic behaviour and bequests. In their study, instead of being driven by altruism, bequests are considered a strategic device. The parents may use bequests to induce their children to behave properly, while children may threaten to reduce their own welfare and also that of their parents. In this strategic model, if the government redistributes income between generations by operating with deficits or increasing social security benefits, the old have no reason to raise transfers to fully offset the government's actions. The older generation is made better off at the expense of the younger generation, and aggregate consumer demand rises. The analysis then follows the standard approach.

As Barro (1989) explains, this approach treats the interaction between parents and children as equivalent to the purchases of services on markets. Consequently, it would be expected that parents pay wages, rather than bequests or other forms of transfers, to children. This, along with the fact parents appear to have some concern for the welfare of their children, indicate there is a case for altruistic bequests.

2.1.2 Perfect Capital Markets

Ricardian analysis assumes the existence of perfect capital markets. A common argument against the theorem maintains many households are liquidity constrained, and would consequently be willing to have their current taxes reduced and their future taxes raised by a current debt-for-taxes swap. Hubbard and Judd (1986) emphasize the importance of liquidity constraints for short-run issues. If twenty percent of the population is liquidity constrained, they show how a $1 deficit-for-taxes swap could increase consumption by $0.20, whereas the pure wealth effect would be approximately $0.05. To illustrate this argument, consider two types of infinitely-lived agents. Group A has the same discount rate, r, as the government, and is therefore willing to hold government debt; this group is not liquidity constrained and would include large businesses and some individuals. Group B has a higher discount rate, $r' > r$. This group would include smaller business and households that have inferior collateral. Loans to group B imply large costs of evaluation and enforcement, and the members of the group, therefore, face higher borrowing costs, even after accounting for default risks. This implies group B has a higher rate of time preference for consumption and a high marginal return on investment.

If the government introduced a policy to cut current taxes in favour of a budget deficit, group B would effectively be able to borrow at a lower rate of interest. The liquidity constraint has caused a deficit-financed tax reduction to increase consumption and investment by group B. This is a result of the present value of the future taxes falling short of the tax cut. Those in group A experience no net wealth effects and willingly hold their extra share of the public debt. "In the aggregate, a budget deficit now raises aggregate demand, or equivalently, the aggregate of desired private saving increases by less than one-to-one with the government's deficit."[10] Therefore, liquidity constraints result in non-Ricardian outcomes.

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10 Barro (1989), p. 42.

This analysis indicates the government could, in the presence of an imperfect loan market, provide a useful form of financial intermediation. Members of group A who are not liquidity constrained hold more than their share of the public debt. Those in group B, with poor access to credit, hold less than their share, in effect, resulting in a loan from group A to group B. Therefore, while an imperfect capital market prevented borrowing by one group, the government budget deficit has, in effect, allowed the liquidity constrained group to access credit. "This process works because the government implicitly guarantees the repayment of loans through its tax collections and debt payments."[11]

Seater (1993) notes the implication of a liquidity constraint depends upon the reason the constraint occurs. Essentially, Ricardian equivalence is invalidated by liquidity constraints if government deficit financing introduces an element private markets are unable to create. If, as in the above example, the liquidity constraint resulted from differing risk characteristics, and therefore the government faced lower borrowing rates, deficit financing would relax the constraint and Ricardian equivalence fails. Alternatively, differing and unobservable individual risk characteristics create an adverse selection problem for the lender. "Ricardian equivalence again fails because the government, through the universal and compulsory nature of its actions, can overcome the adverse selection problem and

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[11] Barro (1989), p. 44.

have real effects with its debt policy."[12] However, if a liquidity constraint is present due to credit rationing resulting from the uncertainty of future incomes (which, as Seater (1993) notes, would make it optimal to tie the loan rate to the size of the loan because of the possibility of default), Ricardian equivalence continues to hold because the government deficit leads to a substitution of government loans for private loans; Ricardian equivalence is not affected by the state of uncertainty in this case.

While liquidity constraints could invalidate the Ricardian equivalence theory, the constraints must appear in specific forms that cause government action to have real effects. The presence of transactions costs or adverse selection will cause non-Ricardian equivalence results, whereas a constraint due to uncertainty about future income will not invalidate the theory. Unfortunately, the true reason for a liquidity constraint is difficult to ascertain. For example, a recent university graduate can expect higher income in the future, but is typically unable to borrow against that income; the graduate has a liquidity constraint. Before this feature can invalidate the theory, the reason for the constraint must be known. If it is a result

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12 Seater (1993), p. 151. Seater also notes this argument tacitly assumes the government is more efficient than the private sector at collecting payment from high-risk individuals. Presumably, the tax collector simply shows up at the door and collects what is due. This presumption is false. The government cannot simply commandeer money from those unwilling to pay; it must go to court, just as the private sector must. The laws differ with respect to private and government collection of debts, but it is not obvious that the government's total costs are lower than those of the private sector. Barro (1989), p. 44, makes a similar argument.

of differential borrowing rates or adverse selection, the above analysis shows how government debt can assist in perfecting the market. On the other hand, if the liquidity constraint is a result of uncertainty about the graduate's future income, government intervention will still display Ricardian results.

2.1.3 Nondistortionary Taxes and Redistribution

The timing of taxes may have a significant impact on Ricardian equivalence theory regardless of the validity of the infinite horizon and perfect capital market assumptions. Departures from Ricardian equivalence arise if taxes are not lump sum.. Consider a reduction in the current tax rate on labour income that is expected to last until the debt caused by the decreased tax rate matures. Upon maturity, the tax rate will rise. In the first period, households are motivated to work more than usual. and less than usual in the second period. Since the increase in the tax rate is on income and not expenditures, national saving rises in the first period and falls in the second. In a closed economy, after-tax real rates of interest are typically low in the first period, along with a budget deficit, and higher in the second period with a budget surplus. In an open economy, a current-account surplus accompanies the budget deficit in the first period with the opposite holding in the future period. [13] The results are non-Ricardian, but also counter to the standard view; the rearrangement of the timing of marginal taxation induces

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[13] Barro (1989), p. 46.

intertemporal substitution and alters behaviour, causing Ricardian equivalence to fail.

> Unlike in the Ricardian case where debt and deficits do not matter, it is possible in a world of distorting taxes to determine the optimal path of the budget deficit, which corresponds to the optimal time pattern of taxes. In effect, the theory of debt management becomes a branch of public finance; specifically, an application of the theory of optimal taxation.[14]

Seater (1993) comments, however, that intertemporal substitution effects and related behavioural changes do not cause the failure of Ricardian equivalence. The substitution effects and behavioural changes arise from changes in the path of marginal tax rates, not from changes in the path of the debt. Although debt and marginal tax rates may change simultaneously, there is no necessity that they do so. He notes that multiple-regression analysis examines the debt coefficient and not the coefficient of marginal tax rates. If the debt coefficient is zero, the theory holds, otherwise it does not. Other coefficients are not relevant.[15]

Ricardian equivalence theory requires no redistribution effects. If the deferral of taxes through deficit financing alters the pattern of incidence, the theory may fail. Bernheim (1987) notes that redistribution can only significantly alter current aggregate consumption if there are no intergenerational linkages and the different generations have different propensities to consume. ". . . There is a common presumption, ignoring intergenerational issues and liquidity constraints,

[14] Barro (1989), p. 46.
[15] Seater (1993), p. 155.

the distributional consequences of postponing taxes are of second-order importance."[16]

2.2 Direct Evidence of Ricardian Equivalence

Since the seminal article by Barro (1974), there have been a multitude of empirical consumption and saving function studies of Ricardian equivalence with results spanning the entire spectrum of possibilities. Empirical studies can be classified into three categories: life-cycle models, permanent income models and Euler equation tests.[17]

2.2.1 Life-cycle Models

Bernheim (1987) notes there are typically two different specifications of life-cycle models in the empirical literature; the difference lies in estimation using gross or net income. The models are identical since imposing common factor restrictions cause one to result in the other. The standard model estimates

$$C_t = \beta_0 + \beta_1 Y_t + \beta_2 (T_t - G_t - r_t D_t) + \beta_3 G_t + \beta_4 D_t + \beta_5 W_t + X_t \underline{\beta} + \varepsilon_t \quad (1)$$

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16 Bernheim (1987), p. 271.

17 As Seater notes, Tanner (1970, 1989), Kochin (1974), Barro (1978), Darby (1979), Leimer and Lesnoy (1982), Kormendi (1983), Koskela and Virén (1983), Aschauer (1985), Seater and Mariano (1985), Kormendi and Meguire (1986, 1990) and Evans (1988) present evidence favourable to Ricardian equivalence; Feldstein (1974, 1978, 1982), Yawitz and Meyer (1976), Reid (1985), Modigliani and Sterling (1986, 1990), Bernheim (1987) and Feldstein and Elmendorf (1990) present evidence unfavourable to it; Seater (1982) and Blinder and Deaton (1985) present evidence that is mixed.

where C is consumption, Y is national income, T is tax revenues, G is government expenditure, D is debt, W is private wealth, r is the interest rate, X is a vector of other exogenous variables and ε is a stochastic error term. Pure Ricardian equivalence would hold if $\beta_2 = 0$, and the pure Keynesian view is validated if $\beta_2 = -\beta_1$. The coefficient β_2 measures the effect on current consumption of a $1 tax-for-deficit swap. Tests of this model have produced both favourable and unfavourable results for Ricardian equivalence.

Many of the studies employ ordinary least squares estimation and fail to account for potential endogeneity and simultaneity; shocks to consumption may be correlated with income shocks which raise tax revenues and lower the deficit. Consequently, ignoring the potential endogeneity biases results in favour of Ricardian equivalence, even if the world is Keynesian. Some studies do employ instrumental variables but the validity of the chosen instruments is suspect.

2.2.2 Euler Equation Tests

Some economists prefer tests based on Euler equations (first-order conditions arising from the consumer's utility maximization problem) derived from the permanent-income, life-cycle hypothesis. A simple Euler equation is

$$u'(C_t) = E_t \beta R^t u'(C_{t+1}) \quad (2)$$

where $u'(C_t)$ is the marginal utility of consumption in period t; E_t is the expectation held in period t of consumption in period $t+1$; β is the rate of time preference; R^t is the rate of interest in period *t*; and $u'(C_{t+1})$ is the marginal utility of consumption in the next time period. The Euler equation indicates the optimal consumption will be chosen such that the marginal rate of substitution between current and future consumption, $u'(C_t)/u'(C_{t+1})$, is equal to the relative price of the two where the relative price is the rate of time preference multiplied by the rate of interest. Alternatively, since equation (2) only holds at the optimum, $u'(C_t)$ and $u'(C_{t+1})$ can be regarded as optimal choices. If the consumer deviates from this plan by giving up one unit of consumption at time *t*, the marginal cost of doing so is $u'(C_t)$. On the other hand, this unit of consumption can be invested at the interest rate, R^t, yielding a marginal benefit in the next period of $R^t u'(C_{t+1})$. Discounting this to the current time period so consumption is in the same units, the marginal benefit becomes $\beta R^t u'(C_{t+1})$. The Euler equation condition simply implies, along the optimal path, the marginal cost and marginal benefit of reallocating an additional unit of consumption are intertemporally equated. Current-period consumption will also depend on the current-period values of other variables such as income, but only to the extent that these variables contain new information that was not available in the previous period. Seater (1993) notes that the few studies that utilize this approach generally support Ricardian equivalence.

2.2.3 Permanent Income Specifications

Consumption models based on the permanent income hypothesis follow a similar specification to the life-cycle models in that consumption is a function of income, government expenditure, the tax burden, transfers to individuals, and government debt. The critical difference involves the decomposition of income and government expenditure into permanent and transitory components. This specification accounts for the agent's different responses to changes in the two components. A change in permanent income or permanent government expenditure will result in a permanent change in consumption. Alternatively, changes in the transitory component of variables should have no effect on consumption unless uncertainty causes agents to be unable to ascertain if the shock is actually transitory. Failing to decompose income and government expenditure into its components causes the income variable to incorrectly reflect the true underlying process that created it.

Seater (1993) notes permanent income models can be characterized, in its most basic form, by the following specification:

$$C_t = \alpha_0 + \alpha_1 Y_t^* + \alpha_2 \left(Y_t - Y_t^*\right) + \alpha_3 G_t^* + \alpha_4 \left(G_t - G_t^*\right) + \alpha_4 D_t + \varepsilon_t \qquad (3)$$

where Y^* is permanent income, Y is current income, G^* is permanent government expenditure, G is current government expenditure, and D is the market value of the government debt.[18] All variables are in real per capita terms. Decomposition of variables into permanent and transitory components can be achieved with various techniques. Testing for Ricardian equivalence in the permanent income hypothesis model should result in $\alpha_3, \alpha_4 < 0$ while $\alpha_2 = \alpha_4 = 0$ and $\alpha_1 < 1$. The coefficient on permanent income, α_1, should be less than one since it would be expected the marginal propensity to consume would not be greater than one. In addition, the coefficient is expected to be positive. The permanent-income hypothesis also indicates transitory income should have no impact along with the level of government debt. Consequently, these two coefficients are equal to zero. The coefficients on government expenditures are expected to be negative since the model maintains government expenditure is a substitute for private consumption; if the coefficients are negative and equal to unity, government expenditure would be a perfect substitute for private expenditure.

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[18] Seater (1993) includes additional variables in equation (3): a measure of marginal tax rates, short- and long-term interest rates, government tax revenue, transfers to individuals and social security wealth. The equation is from Seater and Mariano (1985). The inclusion of a marginal tax rate is attributed to imperfect measurement of the permanent component of income; interest rates are included because the authors wish to extend the basic theory. The inclusion of tax revenue in the equation was done since the authors were modeling consumption in the presence of a liquidity constraint that caused incomplete tax discounting. Transfer payments to individuals can easily be included as part of income. Social security wealth could be included along with a wealth variable in the equation if permanent income did not capture this component. For further discussion, see Seater and Mariano (1985), pp. 197-202.

2.2.4 Problems With Empirical Studies

There are some general problems encountered in testing the Ricardian equivalence theory. Bernheim (1987) lists eight common problems found in virtually every study that utilizes macroeconomic time-series data. These problems are outlined below.

First, accurate measurement of debts and deficits is difficult. Inflation adjustments, adjustments from par to market values, properly accounting for government assets and investments as well as for contingent liabilities and valuing liabilities such as social assistance programs create problems in accurately defining the size of the debt and deficit. In addition, econometric estimates appear sensitive to the corrections that one makes.[19]

Second, some studies have questioned if economists have devised appropriate models for aggregate variables such as consumption and interest rates.[20] "To the extent one misspecifies the relationship of interest, estimates of fiscal effects may be highly unreliable, being contaminated by biases of unknown direction and magnitude. Evidence that appears to reject some hypothesis about deficits may in fact simply reject the underlying model."[21]

Third, it is important to distinguish between expected and unexpected movements in explanatory variables. The permanent income hypothesis indicates

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19 See for example Eisner and Pieper (1984, 1986), Eisner (1986), Boskin (1982, 1986), and Kotlikoff (1986).

20 See for example Hayashi (1985).

21 Bernheim (1987), p. 274.

only unexpected changes in explanatory variables have an impact. If the government announces a policy, agents can perfectly anticipate movements in the deficit and there may be no empirical relationship between deficits and current economic activity. This result would not hold, and there would be a real effect, if the government followed some different, unanticipated policy.

Fourth, the level and innovation in explanatory variables convey considerable information about future events. There may be a correlation between current deficits, or innovations in the deficit, with future income or government expenditure. If agents realize this correlation, they may adjust current spending in response to the deficit policy, but not necessarily because of the deficit itself.

Fifth, endogeneity is a significant problem in empirical studies of Ricardian equivalence. It is not unreasonable for deficits, government expenditure, consumption, income and interest rates to be determined simultaneously. Some studies have attempted to overcome this problem by employing instrumental variable estimation techniques. However, the exogeneity and choice of the instruments used are often questionable.

Sixth, there is an identification problem between the different fiscal policy variables. For example, government expenditure and deficits typically move closely together. In addition, economists are generally interested in government spending, transfers, taxes, deficits and the debt. Each variable has an independent effect on economic activity, yet the first four, plus interest on the debt, sum to zero. Bernheim (1987) notes this is typically dealt with by assuming the tax coefficient equals the negative of the income coefficient since taxes decrease disposable income. However, this assumption is valid only if taxes are nondistortionary. To properly identify the models, the effective marginal tax rate is needed. Identification will, unfortunately, be difficult since marginal tax rates and revenue likely move closely. Also, obtaining a reliable series for marginal tax rates is difficult.

Seventh, Poterba and Summers (1986) argue deficits typically have been paid off quickly. Therefore, existing time-series evidence only bears on deficit policies when agents anticipate a rapid payback. Recent fiscal experience does not appear to lead to rapid elimination of the deficit and debt. The anticipated extended payback of the current deficit and debt makes it questionable if inferences from time-series data are legitimate.

Finally, it may not be feasible to distinguish between hypotheses given the size of macroeconomic noise. For example, the effects of a particular policy may be small in the short run, and there may be larger implications in the long run. If the short-run effect is small, it may be difficult to pick it up in the data, despite the existence of significantly large long-run effects. In fact, empirical testing may not be capable of distinguish between two competing hypotheses.

CHAPTER 3: FISCALLY INDUCED MIGRATION AND RICARDIAN EQUIVALENCE

Charles Tiebout (1956) hypothesized ". . . the consumer-voter may be viewed as picking that community which best satisfies his preference pattern for public goods . . . the consumer voter moves to that community whose local government best satisfies his set of preferences."[22] Consequently, differences in the mix of public goods provided by regional governments would, *ceteris paribus*, influence the pattern of human migration. This idea has been termed "voting with one's feet." Individuals move in order to express their preferences for publicly-provided goods and services. This behaviour stems from the hypothesis that individuals can do little to change government policy and expenditures but ". . . individuals can to some degree consume the public goods they desire by locating in the area most compatible with their preferences."[23]

The return from migration between region i and j consists of a stream of expected income differentials prevailing between two provinces. To realize these gains, the migrant must invest in moving to the region of higher income. Assuming, for now, earnings of the two provinces are constant over time and prevail for an indefinite period, the net present value of migration for the representative infinitely-lived migrant is characterized by

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22 Tiebout (1956), p. 418.

23 Cebula (1979), p. 705.

$$PV = \left[\left(W_j - W_i\right)/r_i\right] - C_{ij} \qquad (4)$$

where W_i and W_j represent wages in provinces *i* and *j*, r_i is the discount rate of future wage receipts and C_{ij} is the cost of moving from province *i* to province *j*. The opportunity cost of moving should be considered and not simply the accounting cost. Consequently, migration is viewed as a mechanism for which a better allocation of resources is achieved since it should reduce interprovincial income differentials except for any differential related to the cost of moving.

If real gross income differentials are small, the migration decision will be based on comparisons of the real tax burden and real expenditures on public goods in each province. In general, migrants will prefer lower tax burdens since this causes real personal disposable income to increase. Increased personal disposable income permits the migrant to purchase more private-sector commodities which increases utility. Migrants will also prefer higher real levels of public expenditures if the expenditures are of a variety that allow direct consumption or provide a vicarious benefit in a meaningful way. Migration resulting from differences in tax levels and levels of public expenditures has been termed fiscally induced migration.

Recent literature has brought forward the belief that fiscally induced migration may lead to a misallocation of resources resulting in a widening wage differential. As Mills, Percy, and Wilson (1983) explain, neo-classical theory purports migration is efficient since workers respond to wages and thus move where their marginal product is maximized. If one province exhibits a large fiscal residual, workers may migrate there, despite the possibility their marginal product, and thus their wage, will be lower. This migration is because their real income, inclusive of the fiscal residual, will be higher. Proponents of equalization payments in Canada advance this argument since a transfer of some of the large fiscal residual from one province to the province exhibiting emigration will result in a Pareto improvement.

Access to non-renewable resource revenues not available to other provinces provides Alberta with the opportunity to offer more attractive expenditure and tax packages. The fact Alberta currently maintains the lowest corporate and personal tax rates in Canada, and comparable government expenditure levels, is indicative of this.

The effect of migration on the Ricardian equivalence proposition was first suggested by Ricardo himself. He suggested that bond financing would be advantageous if the owners of bonds (the private sector) emigrated before taxes were raised to repay the bonds.[24] This scenario is reasonable within a federation such as Canada.

Migration also leads to an increase in the value of fixed factors, such as land. As an example, the oil boom of the 1970's caused significant migration to Alberta. The sizable royalty revenues permitted the government to increase the level of public services while maintaining low tax rates. The increased inflow of

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[24] Ricardo from Sraffa (1951), p. 244.

migrants resulted in an increased demand on the fixed factor (land). Since land is in fixed supply, the increased demand simply caused the price to rise. Owners of the land could capitalize the oil boom through rents.

The creation of the Heritage Fund could be viewed as a method of reducing future taxes, thus permitting the maintenance of government expenditures when non-renewable natural resource revenues did not meet previous standards. If migration occurred as a result of the development of the Heritage Fund, the owners of land could capitalize the full future benefit of the Heritage Fund by selling land when the rents were maximized. Once this capitalization was achieved, the individual could leave the province having realized the future benefits of the Heritage Fund long before the natural resource revenue disappeared and the Heritage Fund was required to supplement annual revenues.

Van Dalen (1992) notes the ability to migrate amounts to a violation of the assumption of lump-sum taxation. Lump-sum taxes should not induce a private-sector reaction. To eliminate the distortion, a tax, independent of residence, must be levied.[25] While federal taxes are of this type, provincial and local taxes are not. Consequently, if Ricardian equivalence holds in a world with no migratory effects, the instant people are permitted free movement, as found in a federation, Ricardian equivalence cannot possibly hold. This result is due to the fact residents of one province can avoid future taxes by moving to another.

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[25] Van Dalen (1992), p. 226.

CHAPTER 4: A MODEL OF CONSUMPTION

4.1 Deriving a Life-cycle Model of Consumption

The model closely follows Aschauer (1985) and is derived from first principles. Consider a representative agent with time-separable preferences over private consumption, C, and goods and services provided by the government sector, G. Government expenditure is exogenous; it is not a choice variable. The agent's utility function can be defined as

$$V_t = E_t \sum_{j=0}^{\infty} \left(\frac{1}{1+\delta} \right)^j u(C^*_{t+j}) \tag{5}$$

where δ is a constant rate of time preference and $u(C^*_{t+j})$ is a time-invariant, concave, momentary utility function. E_t is the expectational operator for expectations based on information available in period *t*. Let C^*_t denote the level of effective consumption in period *t*. Additionally, let effective consumption be a linear combination of private consumption and government goods and services as follows

$$C^*_{t+j} = C_t + \theta G_t \tag{6}$$

As a result of this specification, the marginal rate of substitution is constant, implying that government goods and services and private consumption are perfect substitutes where one unit of G yields the same utility as θ units of C. This specification of the utility function does not include leisure, implying labour supply is elastic. This is a common assumption in the literature. Mankiw *et al.* (1982) find a model with leisure in the utility function is not consistent with the data since many people are constrained in the amount of leisure they take.

The budget constraint of the representative agent follows a standard specification

$$\frac{W_{t+1}}{(1+r)} - W_t + C_t = N_t - T_t \tag{7}$$

where N_t is labour income in period *t*, T_t is taxes paid, net of transfers, in period *t* and r is the rate of interest. W_t represents the public wealth of the household at the beginning of period *t*, measured as the holdings of *t+1* period bonds (which includes government debt). All variables are in real terms. The interest rate is assumed to be constant as in Begg (1982), Bilson (1980), Flavin (1981), Hall (1978), Hansen and Sargent (1982), Hayashi (1982), and Sargent (1978). Hall (1978) notes that this assumption is unlikely to bias the results of the analysis. In addition, Flavin (1981) maintains that allowing the interest rate to vary has not contributed to the empirical understanding of consumption. Bean (1986) agrees, and Muellbauer (1983) provides empirical evidence to support this claim. Finally, the assumption the rate of interest is constant greatly simplifies the model. If the interest rate is permitted to vary, some other simplifying assumption must be made, such as certainty equivalence. For examples, see Muellbauer (1983), and Wickens and Mulana (1984).

Forward substitution of equation (7) yields the following budget constraint after utilizing the condition that $\lim_{k \to \infty}\left(\frac{1}{1+r}\right)^k W_{t+k} = 0$. This condition indicates the representative agent depletes the level of wealth over the infinite time period such that there is no wealth remaining after the last period (i.e. the representative agent cannot hold wealth forever; it must eventually be exhausted).

$$E_t\left\{\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j C_{t+j} - W_t - \sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j\left[N_{t+j} - T_{t+j}\right]\right\} = 0 \qquad (8)$$

Equation (8) indicates the present discounted value of lifetime private consumption expenditure equals the present discounted value of lifetime wealth (defined as initial holdings plus future net labour earnings).

The budget constraint of the government is of the form

$$\frac{B_{t+1}}{(1+r)} - B_t + T_t = G_t \qquad (9)$$

where B_t is government debt of one-period maturity. Forward substitution of equation (9) yields the following when the no-Ponzi condition,[24] $\lim_{k \to \infty}\left(\frac{1}{1+r}\right)^k B_{t+k} = 0$, is imposed:

$$E_t\left\{\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j T_{t+j} - B_t - \sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j G_{t+j}\right\} = 0 \qquad (10)$$

24 The no-Ponzi condition means the government cannot issue debt indefinitely; at some time, it must be repaid. Thus, in the limit, debt is zero.

Equation (10) indicates the present discounted value of tax revenue must equal the initial stock of debt plus the present discounted value of government expenditure on goods and services. As a result of this specification of the government budget constraint, the representative agent is assumed to be forward looking with respect to the government's fiscal affairs. This assumption incorporates the Ricardian equivalence theorem. The agent realizes debt issues in the current period must eventually be offset by future tax liabilities, implying the agent accounts for the future benefits of the provision of goods and services by the government. This link between the government budget constraint and the agent's response permits the integration of the two budget constraints. Combining equations (8) and (10) and utilizing equation (7), the representative agent's life-time budget constraint becomes

$$E_t \sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j C^*_{t+j} = \left(W_t - B_t\right) + E_t \sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j \left[N_{t+j} + (\theta-1)G_{t+j}\right] \qquad (11)$$

This expression indicates the present discounted value of effective consumption is constrained by the level of net economy-wide wealth, $\left(W_t - B_t\right)$, plus the present discounted value of labour earnings, plus $(\theta-1)$ times the present discounted value of government expenditure on goods and services.

Consider the consumer's maximization problem whereby utility is maximized subject to the life-time budget constraint. At time period t, the agent will maximize utility by choosing a time path for consumption. Maximization of equation (5), subject to the budget constraint, equation (11), results in the following Euler equation:

$$E_t u'\left(C^*_{t+j}\right) = \left(\frac{1+\delta}{1+r}\right)^j u'\left(C^*_t\right) \tag{12}$$

The Euler equation indicates the agent will choose an optimal time path for effective consumption such that there is no pareto improvement through substitution of consumption in one period for consumption in another. The cost of reducing consumption in the current period and purchasing a bond is the reduction in utility caused by the action. Current utility would be reduced by $u'\left(C^*_t\right)/(1+r)$. In the next time period, the benefit would be the subjectively discounted increase in utility of $u'\left(C^*_{t+1}\right)/(1+\delta)$. Aschauer notes equation (12) is a general specification that should hold even if utility is dependent upon leisure in a manner separable from effective consumption.[25]

To obtain a closed-form solution for equation (12), assume the utility function is quadratic and of the form

$$u'\left(C^*_t\right) = -\left(\overline{C}^* - C^*_t\right)^2 /2 \tag{13}$$

where $\overline{C}^*$ is the bliss level of effective consumption. Consequently, the Euler equation can be defined as

$$C^*_{t+1} = \alpha + \beta C^*_t \tag{14}$$

[25] Aschauer (1985), p. 119.

where $\alpha \equiv [(r-\delta)/(1+r)]\overline{C}^*$ and $\beta \equiv (1+\delta)/(1+r)$. Utilizing equation (14) to eliminate C^*_{t+j} for $(j = 1, 2, ...)$ and equation (11) allows effective consumption to be written as

$$C^*_t = \left\{\frac{(\delta-r)}{r(1+r)^2}\right\}\overline{C}^* + \left\{\frac{r^2+2r-\delta}{(1+r)^2}\right\}\cdot \left\{\sum_{j=0}^{\infty}\left(\frac{1}{1+r}\right)^j\left[N_{t+j}+(\theta-1)G_{t+j}\right]+(W_t-B_t)\right\}. \tag{15}$$

Removing the period t levels of income and government expenditure from the present discounted value term in equation (15) results in the following specification for consumption

$$C_t = \beta_0 + \beta_1 N_t + \beta_2 W_t + \beta_3 G_t + \beta_4 B_t + \beta_5 E_t \sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j N_{t+j} + \beta_6 E_t \sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j G_{t+j} \tag{16}$$

where

$$\beta_0 = \frac{(\delta-r)}{r(1+r)^2}\overline{C}^*$$

$$\beta_1 = \beta_2 = -\beta_4 = \beta_5 \approx \frac{r}{1+r}$$

$$\beta_3 = \beta_6 \approx -(1-\theta)\left(\frac{r}{1+r}\right)$$

where approximations are for $\delta \approx r$.

To find a simple expression for $E_t \sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j N_{t+j}$, let N_t follow a random walk such that $N_t = \gamma_1 N_{t-1} + \varepsilon_t$ (i.e. N_t is a random walk, the coefficient on N_{t-1}

must be unity and ε_t is white noise). If N_t follows a random walk, then $E_t N_{t+j} = N_t \quad \forall j \geq 1$. Utilizing this result and the fact $\left|\frac{1}{1+r}\right| < 1$, it is known that $\sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j$ reduces to $\left(\frac{1+r}{r}\right)$. Given that γ_1 must equal one, it is known that

$$E_t \sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j N_{t+j} = \left(\frac{1+r}{r}\right) N_t \tag{17}$$

For a similar approach to expected income see Chapter 12 of Sargent (1979). He assumes that income follows a random walk with a drift; $N_t = N_{t-1} + \varphi + \varepsilon_t$ where φ is a constant and ε_t is a serially uncorrelated random error. Sargent also uses $N_t = \rho N_{t-1} + \varepsilon_t$ and derives a non-linear model. Blinder (1981) and Bilson (1980) also use this approach, and note different subsets of N_t may be described by different stochastic processes; Flavin (1981) follows Sargent. Bilson (1980) and Hayashi (1982) discuss more complex forecasting models consistent with rational expectations.

Assume also that $E_t \sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j G_{t+j}$ follows a random walk so that $G_t = \gamma_2 G_{t-1} + \varepsilon_t$. Employing the same methods used for labour income in deriving equation (17),

$$E_t \sum_{j=1}^{\infty}\left(\frac{1}{1+r}\right)^j G_{t+j} = \left(\frac{1+r}{r}\right) G_t \tag{18}$$

Integrating the results from equations (17) and (18) into equation (16) results in the following estimable equation

$$C_t = \phi_0 + \phi_1 N_t + \phi_2 W_t + \phi_3 G_t + \phi_4 B_t + \varepsilon_t \qquad (19)$$

where

$$\phi_0 = \beta_0 = \left(\frac{\delta - r}{r(1+r)^2}\right)\overline{C}^* \approx 0$$

$$\phi_1 = (1+\beta_1) \approx \left(1 + \frac{r}{1+r}\right)$$

$$\phi_2 = \beta_2 \approx \left(\frac{r}{1+r}\right)$$

$$\phi_3 = -(1-\theta) + \beta_3 \approx -(1-\theta)\left(1 + \frac{r}{1+r}\right)$$

$$\phi_4 = \beta_4 \approx \left(\frac{r}{1+r}\right)$$

where approximations are for $\delta \approx r$.

4.2 Incorporating a Permanent Income Specification

As explained in chapter 2.2.4, a consumption model based on the permanent income hypothesis follows a similar specification to the life-cycle model as specified by equation (19). The critical difference involves the decomposition of key variables into permanent and transitory components. This decomposition permits the representative agent to respond differently to the two components. Changes in permanent components will result in a permanent change in consumption, whereas a change in the transitory components will have no effect on consumption unless agents do not recognize the change is transitory.

Consequently, failing to perform this decomposition causes variables to incorrectly reflect the true underlying processes that created them, and would lead to biased paramter estimates if this is the true model.

Incorporating these permanent and transitory changes into equation (19) results in the following respecified model:

$$C_t = \lambda_0 + \lambda_1 N_t^* + \lambda_{11}(N_t - N_t^*) + \lambda_2 W_t + \lambda_3 G_t^* + \lambda_{31}(G_t - G_t^*) + \lambda_4 B_t + \varepsilon_t \tag{20}$$

where N_t^* and G_t^* represent the permanent components of income and government expenditure and $(N_t - N_t^*)$ and $(G_t - G_t^*)$ represent the transitory components (actual value less permanent value). Chapter 6 outlines the method utilized for decomposition of these variables.

4.3 Adapting the Model to Study the Heritage Fund

To examine the Heritage Fund, equation (20) must be slightly expanded. First, the permanent and transitory government expenditure variable must be changed to reflect a federal system. Government expenditure is provided through three levels of government: federal, provincial and local. To isolate the effects of the Heritage Fund on consumption, it is necessary to include all three levels of government. If, for example, local government expenditure was not included in the model, changes in consumption that appear to be caused by the Heritage Fund may in fact be a result of a change in local government expenditure. To illustrate this point, consider a decrease in local government revenue caused by lower tax revenue. As a result of the reduced revenue, the local government decides to eliminate garbage collection services. If consumers desire this service, it will be supplied by a private company. The consumer's consumption would increase since part of personal disposable income must be used to pay the private company. If the estimated model only included provincial government expenditure, consumption would have increased while there was no change in the provincial government's fiscal position. However, the fact is, consumption increased because government expenditure at the local level was lower. Conclusions based on the estimated model with only provincial expenditure would not be correct. Thus, it is imperitive to have a complete model, including all levels, for the government sector.

In addition to including all levels of government, it is necessary to include, as part of personal disposable income, transfers to individuals. This is a significant component of government expenditure, but it is money that is spent by the consumer. In fact, all transfers, including those between governments, should be netted out of government accounts to ensure that double counting of expenditure does not occur.

Including separate variables for the three levels of government expenditure provides the opportunity to test if consumers react differently to changes in permanent and transitory government expenditure provided by different levels of government. If all three levels are considered the same, they can be combined into a general government variable and equation (20) would be unchanged. Allowing for differences could result in some interesting policy implications. For example, if consumers weigh local government expenditure as more valuable than provincial and federal expenditure, a strong case could be made to transfer more money away from the federal and provincial government and give it to local governments for program expenditure.

Second, the debt variable, B_t, needs to be decomposed into a federal, provincial and local component. As with government expenditure, it is necessary to account for all government debt within the system. If the federal government provided more services by running a deficit, the impact on consumption is different than if all three levels of government are included or if only provincial government debt is included. In addition, separating the debt by the three levels of government permits testing of the hypothesis: do agents view a dollar of federal debt the same as a dollar of provincial debt? The results of this test are highly relevant. Agents can only escape federal debt by leaving the country whereas provincial and local debt can be avoided by moving to another municipality or province. Though it is possible to escape the debt in one province (or municipality), moving to another province results in assuming a share of the debt of the new province, which may, or may not, be comparable.

Third, it is necessary to incorporate the Heritage Fund into the model. This can be done by further separating the provincial component of B_t into outstanding debt and savings represented by the Heritage Fund. Again, the hypothesis that agents consider these two components to be identical can be tested. If one is viewed differently than the other, there is a reasonable economic argument for either maintaining the Heritage Fund or applying it to reduce the debt.

As a result of these modifications, the model can be characterized by the following equation:

$$\begin{aligned} C_t = {} & \lambda_0 + \lambda_1 N_t^* + \lambda_{11}(N_t - N_t^*) + \lambda_2 W_t + \lambda_{f,3} G_{f,t}^* + \lambda_{f,31}(G_{f,t} - G_{f,t}^*) + \\ & \lambda_{p,3} G_{p,t}^* + \lambda_{p,31}(G_{p,t} - G_{p,t}^*) + \lambda_{l,3} G_{l,t}^* + \lambda_{l,31}(G_{l,t} - G_{l,t}^*) + \\ & \lambda_{41} B_{f,t} + \lambda_{42} B_{p,t} + \lambda_{43} B_{l,t} + \lambda_{44} AHSTF_t + \varepsilon_t \end{aligned} \tag{21}$$

In equation (21), federal, provincial and local government variables are indicated with a subscript f, p and l respectively. The Heritage Fund is indicated by the term AHSTF.

4.4 Testing the Ricardian Equivalence Theorem

A pure test of the Ricardian equivalence theorem would be to test if the debt coefficient is not significantly different from zero. The intuition underlying this test is straightforward. Government expenditures must be paid for either now or later. If the government does not have adequate tax revenues to pay for the expenditures in the current period, taxes must be increased or debt must be issued. Keynesian theory indicates agents consider government debt to be part of the stock of private wealth, implicitly assuming the private sector is myopic by not accounting for the impact on future taxes. As a result, when the government issues debt in a Keynesian world, output increases and the debt coefficient in equation (21) would be significantly positive. Ricardian equivalence maintains there is no difference between raising taxes and issuing debt to finance government expenditure. Rational agents, recognize the future tax liability, would reduce their consumption in the current period by the present value of the debt to cover the future tax liability. Issuing debt to finance government expenditure does not increase output; there is no change since the increased government expenditure is offset by an equal decrease in consumption. Therefore, government debt is not, in the Ricardian equivlance world, considered net debt; the amount of debt is insignificant in the agents consumption decision. As a result, testing for Ricardian equivalence entails testing if the coefficient on the debt variable is zero. If this is the case, the Ricardian equivalence theorem is supported. Utilizing equation (21), the appropriate test is to determine if λ_{41}, λ_{42} and λ_{43} were all equal to zero. The methodology used to perform this test is outlined in Chapter 6.

It is also possible to determine if government expenditure is a substitute for consumption by the agent. If the coefficients on the government expenditure variables are negative, this would indicate an increase in these variables causes a decrease in personal consumption. If the coefficients were unitary and negative, a one dollar increase in government expenditure would result in a one dollar decrease on consumption, thus indicating the two goods are perfect substitutes. If the coefficients are less than unity and negative, there would be some substitution effect, although not perfect.

CHAPTER 5: THE DATA

5.1 Consumption, Income, and Government Expenditure

Annual data for consumption, personal disposable income, government expenditure, and transfers for 1947 to 1992, were taken from the *Alberta Economic Accounts* (Alberta Bureau of Statistics) and the *Provincial Economic Accounts* (Statistics Canada). Government expenditure included separate data for federal expenditure in Alberta, provincial expenditure and Alberta local government expenditure. Canada Pension Plan data were incorporated into the federal component, and hospitals were included with the provincial numbers.

Transfers between governments and to individuals were netted out of the expenditure components of the various groups to eliminate double counting. Simply, transfers were included in the accounts of the government that spent the money on goods and services or debt servicing costs. For example, if the federal government transferred $1 billion to Alberta and the province used this money to fund various programs, the $1 billion was included in the Alberta expenditure account and subtracted from the federal government's account. If this netting-out was not done, the expenditure would be counted in both accounts, thus overstating the true amount. Since transfers to individuals, including the Canada Pension Plan are already included in personal disposable income, no adjustment is necessary.

5.2 The Alberta Heritage Savings Trust Fund

The data for the Alberta Heritage Savings Trust Fund were collected from the Heritage Fund's third quarter (December 31) reports. All data are from the Heritage Fund balance sheet. Fund equity includes investments in all divisions and the Cash and Marketable Securities Portfolio but excludes the Capital Projects Division.

5.3 Provincial and Federal Debt

Provincial debt numbers from 1982 through 1992 are provided by Alberta Treasury. The debt numbers utilized for this study are the combination of the General Revenue Fund debt and the Capital Fund debt.[28] The data provided by Alberta Treasury are the actual outstanding debt as tracked by the Government's financial reporting database. Debt data are available on a weekly basis from 1985 to present.[29] For the period 1982 to 1985, debt data are from monthly cash flow

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28 The Capital Fund was created in 1986. Since capital projects yield a long-term benefit compared to expenditures on goods and services, the debt associated with a particular project is kept in the Capital Fund. The debt is amortized over a period, such as thirty years, and each year, a portion of the debt is transferred to the General Revenue Fund debt. Regardless of this accounting procedure, the provincial debt will be the sum of these two Funds.

29 Calendar year-end debt outstanding was taken as the outstanding debt as of the last day of the year but the weekly numbers did not always match the end of the year. In these cases, the year-end values were found by determining the growth between the nearest dates before and after the end of the year and adjusting the number by the appropriate number of days. There was no substantial financing during the periods for which this procedure was performed and therefore, while this adjustment may not be exact, it should be extremely close to the actual debt outstanding.

statements which indicate the liabilities of the General Revenue Fund. This is a comparable number to latter years since the Capital Fund was not created until 1986.

Prior to 1982, no calendar year-end debt data are available. Consequently, fiscal-year numbers were obtained from the Government of Alberta Provincial Accounts. To convert this data to annual calendar data, the growth rate was assumed to be constant throughout the year. The debt for the previous year was then extrapolated to arrive at a calendar year-end number. This procedure was obviously not as accurate as those employed for more current years. However, from 1947-48 to 1981-82, the provincial debt was between $20 million and $292 million. In 1982-83 and 1983-84 the debt was $870 million and $1 billion and subsequently fell to pre-1982-83 levels until it began to rapidly increase around 1986. Consequently, any approximation to the calendar year-end data should provide a reasonably accurate estimate of the actual value; in the years of significant movements in the debt, actual debt numbers at December 31 have been obtained.

It should be noted Alberta also holds debt related to programs such as the Farm Credit Program. While there is debt outstanding in these programs, the funds are not important to this study. In these programs, the government provides loans to groups, such as farmers and small business. Money for the program has been borrowed but will be repaid when the loan is repaid by the borrower. The rate of the loan and the Government's debt financing are designed such that there is no cost to the government, provided no defaults occur on the loans. Therefore, this debt is not similar to the General Revenue Fund and Capital Fund debt which is debt associated with money spent and not recoverable by the Government. No effort has been made to quantify the province's contingent liabilities such as pensions.

Federal debt data are published by Statistics Canada. To ensure the federal debt values utilized for this study were similar to the provincial debt numbers, the federal debt only includes the sum of all previous deficits as reported in the *Public Accounts of Canada*. In determining the portion of federal debt held by Alberta, the debt was distributed across Canada on a per capita basis.[30] Local government data were insufficient to cover the entire period.

5.4 Wealth

Since there are no data available for wealth in Alberta, it was necessary to find an appropriate proxy. The importance of natural resources, specifically oil and natural gas, to the Alberta economy is well known. Thus, it seemed only natural to develop a proxy for wealth based on these resources. As Smith (1992)

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[30] Other methods include a distribution based on the provincial share of GDP or a distribution based on historical benefit. The GDP method would yield a comparable distribution to the per capita distribution based on recent shares. The historical benefit distribution would yield a dramatically smaller federal debt in Alberta. For more on these methods of distribution federal debt among the provinces, see Boothe *et al.*

noted, "one concern is that temporary increases in consumption may have been purchased at the cost of permanent loss in the wealth and productive capacity of the province."[31] Further, these marketable natural resources should be considered assets. "The sale of assets to increase consumption may be an indication that a province is living beyond its means, and it reduces its ability to create income in the future."[32] Smith (1992) developed a set of accounts for oil and natural gas from 1963 to 1988; this study extends the analysis to include 1948-1962 and 1989-1992. These accounts place a monetary value on the oil and natural gas resources. While the monetary accounts are not a perfect substitute for household wealth, they are an excellent proxy.

5.4.1 Methodology for Developing Monetary Resource Accounts

To develop monetary resource accounts, it is important to understand the assumptions and methodology that have been employed. As Smith (1992) explained, the physical stock of oil and natural gas is established at the beginning of each period. This figure represents the opening and closing stock. Any net change between periods is due to new discoveries, depletion through extraction, or adjustments due to new information. To assign a monetary value to these stocks, the average price of a resource unit and the cost of the unit was required. The net rent per unit was estimated as the difference between the price and the cost of

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31 Smith (1992), p. 388.
32 Smith (1992), p. 388.

production. Costs include the cost of exploration, development, extraction, marketing and a normal return to the required physical and financial capital. The opening stock in monetary terms was the physical stock at the end of the previous period times the per unit rent of the previous period. In Table 3 the 1992 opening monetary stock for crude oil is \$3,239.7 million, which is equal to the physical stock at the end of 1991 (490.0 million m^3) multiplied by the rents for 1991 (\$6.61 per m^3). The net change is the net change in the physical stock during the current period multiplied by the per unit rent of the current period (-37.8 million m^3 x \$33.98 per m^3 = \$1,285.2 million for 1992). Revaluation is the value of the opening stock multiplied by the change in rent from the previous period (490.0 million m^3 x (\$33.98 - \$6.61) per m^3 = \$13,441.6 million for 1992). Finally, the closing stock is the physical stock at the end of the period multiplied by the average per unit rent of the period, or simply the sum of the previously calculated values (3,239.7 million - 1,285.2 million + 13,411.6 million = 15,366.1 million = 452.1 million m^3 x \$33.98 per m^3 for 1992).

The physical stock data were obtained from the Canadian Association of Petroleum Producers *Statistical Handbook;* the price per unit and expenditure were also found in this source. Production cost was calculated as the total of expenditures by the industry less those on royalties and on land acquisition and rental costs. Costs were distributed between oil and natural gas and other petroleum products based on the share of the total value of production. The cost of equity was calculated as 7% plus the rate of inflation for each year; equity investment was found in *Corporation Financial Statistics* (Statistics Canada, 1965-1987), *Financial Statistics for Enterprise* (Statistics Canada, 1988-1992), and *Taxation Statistics* (Department of National Revenue, 1949-1964).

Established reserves for 1948 to 1961 were calculated as initial established reserves less production. Unfortunately, there was a break in the data between 1961 and 1962 which caused the pre-1962 reserves not to lead to the actual 1962 established reserves. This difference was equivalent to an average overstatement in reserves of 4%.[33] Prices for both natural gas and oil for Alberta were available to 1951. For 1947 to 1950, Canadian prices were used. These prices are not significantly different from Alberta prices in subsequent years. Expenditures by the industry in Alberta were available from 1947 and equity calculations followed Smith (1992).

The calculated production cost, following the methods of Smith (1992), resulted in negative rents for oil production and natural gas production for most years between 1948 and 1961. Even if equity costs were not included in the calculation of production costs, rents in Alberta did not become positive until

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33 The reserves for this study have been adjusted by 4% each year such that the 1961 closing reserves are consistent with the opening reserves in 1962. While this method averages the overstatement of reserves and does not capture individual observations which may be above or below average, the estimates should not significantly bias the results. Most years did not have positive rents and the monetary value was replaced by a zero value. The actual reserve number will only affect a few observations.

1954. For more details relating to these accounts, see Smith (1992). A summary of the newly calculated monetary accounts for crude oil and natural gas can be found in Table 3 and Table 4 respectively. The sum of the oil and natural gas monetary accounts closing stock was used to proxy wealth in Alberta at the end of the year.

As can be seen in Tables 3 and 4, the monetary value of the closing stock of oil and natural gas was subject to large fluctuations. This feature also holds true for the period 1962-1988 in Smith (1992). At first glance, this result may seem unusual since there does not appear to be a large variation in the physical closing stocks. The reasons for the large fluctuations in the monetary accounts is associated with the unit values for oil and natural gas.[34] Using the oil accounts as an example, the price of oil increased by 19.5% from 1988 to 1989 and by 22.8% from 1989 to 1990. In the same two years, production costs increased by only 16.1% and 5.5% respectively. This resulted in rents increasing by 48% ($5.40 per m^3) and 137% ($22.64 per m^3) for the same period. As a result, the 1990 monetary accounts achieved a peak closing stock of $20,779.3 million. In 1991, the price of oil fell by 17.9% while production costs increased by 4.3%. As a result, rents fell to $6.61 per m^3, a decline of 83%. These low rents caused the monetary accounts closing stock to fall to $3,239.7 million since the closing stock is calculated by multiplying the physical account closing stock by the rent (490.0

[34] There were decreases in the physical closing stock of oil and natural gas but these decreases did not have nearly the impact the unit values did.

million m^3 x \$6.61 per m^3 = \$3,239.7 million). In 1992, the price of oil increased only slightly, but production costs were reduced by almost 22% causing rents to increase to \$33.98 per m^3. This 1992 rent is only 13% below the 1990 value. The increased rents caused the monetary closing stock of oil to rebound to \$15,336.1 million. Similar analysis holds for the natural resource accounts.

Much of Alberta's wealth is considered to be related to its natural resources. As the rents from oil and natural gas increase, the value of that wealth clearly rises. Perhaps more significant, as the rents and physical stock decline not only does the monetary value decline but there exists the possibility the reserves will no longer be commercially viable. If oil and natural gas ceased to be economically viable to extract and produce, the wealth of Alberta would clearly be seen as having substantially declined. Despite being subject to significant fluctuations, the oil and natural gas monetary accounts provide a reasonable proxy for the wealth of the province.

5.5 Other Data

All data described above are in nominal terms. To convert the data to real terms, the Consumer Price Index for Canada was used. It was not possible to deflate the data using a price index for Alberta since provincial price index data were only available after 1960. Population figures for Alberta and Canada were used to convert data to per capita terms. All data for Canada were taken from the *National Accounts* (Statistics Canada).

TABLE 3
MONETARY RESOURCE ACCOUNTS: CRUDE OIL, 1948-1954

	1948	1949	1950	1951	1952	1953	1954
Physical Account (millions of m^3)							
Opening Stock	42.7	105.0	237.5	286.2	353.9	406.1	524.0
Net Change	62.3	132.6	48.6	67.8	52.2	117.8	237.8
Closing Stock	105.0	237.5	286.2	353.9	406.1	524.0	761.8
Unit Values (C$ per m^3)							
Price	18.91	17.75	18.15	15.87	14.92	15.82	16.37
Production Cost	37.09	30.42	29.43	26.55	23.38	18.73	16.49
Rent	-18.18	-12.67	-11.28	-10.68	-8.46	-2.91	-0.12
Monetary Accounts (millions of C$)							
Opening Stock	0.0	-1,907.9	-3,009.0	-3,226.7	-3,780.2	-3,435.9	-1,523.3
Net Change	-1,131.8	-1,679.4	-548.3	-723.7	-441.8	-342.5	-27.8
Revaluation	-776.1	578.3	330.6	170.2	786.2	2,255.1	1,462.1
Closing Stock	-1,907.9	-3,009.0	-3,226.7	-3,780.2	-3,435.9	-1,523.3	-89.0

TABLE 3 (continued)
MONETARY RESOURCE ACCOUNTS: CRUDE OIL, 1955-1961

	1955	1956	1957	1958	1959	1960	1961
Physical Account (millions of m^3)							
Opening Stock	761.8	785.8	766.1	740.2	874.3	895.6	988.7
Net Change	24.0	-19.7	-25.9	134.0	21.3	93.1	-55.6
Closing Stock	785.8	766.1	740.2	874.3	895.6	988.7	933.1
Unit Values (C$ per m^3)							
Price	15.29	15.55	16.41	15.88	15.12	15.09	14.89
Production Cost	16.08	16.30	15.54	20.34	16.76	16.83	15.03
Rent	-0.76	-0.75	0.87	-4.46	-1.64	-1.74	-0.14
Monetary Accounts (millions of C$)							
Opening Stock	-89.0	-596.0	-578.1	647.6	-3,902.9	-1,470.1	-1,722.7
Net Change	-18.2	14.9	-22.6	-598.3	-35.0	-162.3	7.7
Revaluation	-488.7	3.0	1,248.4	-3,952.3	2,467.8	-90.3	1,585.1
Closing Stock	-596.0	-578.1	647.6	-3,902.9	-1,470.1	-1,722.7	-129.8

TABLE 3 (continued)
MONETARY RESOURCE ACCOUNTS: CRUDE OIL, 1988-1992

	1988	1989	1990	1991	1992
Physical Account (millions of m^3)					
Opening Stock	631.3	611.5	582.5	530.2	490.0
Net Change	-19.8	-29.0	-52.3	-40.2	-37.8
Closing Stock	611.5	582.5	530.2	490.0	452.1
Unit Values (C$ per m^3)					
Price	105.38	125.93	154.61	126.95	128.07
Production Cost	94.23	109.38	115.42	120.34	94.09
Rent	11.15	16.55	39.19	6.61	33.98
Monetary Accounts (millions of C$)					
Opening Stock	33,951.3	6,818.2	9,639.6	20,779.3	3,239.7
Net Change	-220.8	-479.4	-2,050.7	-266.1	-1,285.2
Revaluation	26,912.3	330.8	13,190.3	-17,273.5	13,411.6
Closing Stock	6,818.2	9,639.6	20,779.3	3,239.7	15,336.1

Source: Physical Account data and prices are from the Statistical Handbook (Canadian Association of Petroleum Producers: 1993). Production cost is taken as total expenditure by the industry less those on royalties and on the land acquisition and rental costs. The cost of equity was assumed to be 7% plus the rate of inflation, with equity investment taken from Financial Statistics for Enterprise (Statistics Canada, 1988 to 1992) and Taxation Statistics (Department of National Revenue: 1949 to 1964). Costs were distributed between oil, natural gas, and other petroleum products based on the share of the total value of production of each over a period of years per Smith (1992) for 1962 through 1992. For the years 1947 to 1961, the distribution was based on the total value of production for each individual year. Monetary accounts for 1962 to 1988 can be found in Smith (1992) with the 1988 numbers included in this table.

TABLE 4
MONETARY RESOURCE ACCOUNTS: NATURAL GAS, 1948-1954

	1948	1949	1950	1951	1952	1953	1954
Physical Account (millions of m^3)							
Opening Stock	355.0	328.4	299.3	288.7	278.2	286.4	424.8
Net Change	-26.6	-29.2	-10.6	-10.5	8.2	138.4	47.7
Closing Stock	328.4	299.3	288.7	278.2	286.4	424.8	472.5
Unit Values (C$ per m^3)							
Price	2.32	2.24	2.08	2.17	3.32	3.29	3.28
Production Cost	2.81	2.37	2.26	2.56	3.58	2.56	2.22
Rent	-0.49	-0.13	-0.18	-0.39	-0.26	0.76	1.06
Monetary Accounts (millions of C$)							
Opening Stock	0.0	-161.3	-39.8	-52.6	-109.3	-75.0	312.1
Net Change	13.1	3.9	1.9	4.1	-2.1	101.7	50.5
Revaluation	-174.4	117.7	-14.8	-60.9	36.5	285.3	138.4
Closing Stock	-161.3	-39.8	-52.6	-109.3	-75.0	312.1	501.0

TABLE 4 (continued)
MONETARY RESOURCE ACCOUNTS: NATURAL GAS, 1955-1961

	1955	1956	1957	1958	1959	1960	1961
Physical Account (millions of m^3)							
Opening Stock	472.5	587.0	607.5	589.6	647.1	644.7	748.0
Net Change	114.5	20.5	-17.9	57.6	-2.4	103.3	-22.5
Closing Stock	587.0	607.5	589.6	647.1	644.7	748.0	725.5
Unit Values (C$ per m^3)							
Price	3.32	3.42	3.63	3.83	3.39	3.46	4.29
Production Cost	2.33	2.17	2.08	3.34	2.83	2.98	3.36
Rent	0.99	1.25	1.55	0.49	0.56	0.48	0.93
Monetary Accounts (millions of C$)							
Opening Stock	501.0	578.5	758.5	913.6	313.9	363.7	355.7
Net Change	112.9	25.6	-27.7	27.9	-1.4	49.1	-20.9
Revaluation	-35.4	154.5	182.8	-627.6	51.2	-57.1	340.9
Closing Stock	578.5	758.5	913.6	313.9	363.7	355.7	675.7

TABLE 4 (continued)
MONETARY RESOURCE ACCOUNTS: NATURAL GAS, 1988-1992

	1988	1989	1990	1991	1992
Physical Account (millions of m^3)					
Opening Stock	1,727.7	1,688.1	1,705.6	1,689.9	1,678.6
Net Change	-39.6	17.5	-15.7	-11.3	-56.7
Closing Stock	1,688.1	1,705.6	1,689.9	1,678.6	1,621.9
Unit Values (C$ per m^3)					
Price	54.02	54.77	55.18	48.65	48.68
Production Cost	45.96	40.08	40.56	39.38	28.31
Rent	8.06	14.69	14.62	9.27	20.37
Monetary Accounts (millions of C$)					
Opening Stock	20,490.5	13,606.1	25,063.0	24,698.2	15,554.9
Net Change	-319.2	256.6	-229.1	-105.0	-1154.5
Revaluation	-6,565.3	11,200.4	-135.7	-9,038.3	18,635.4
Closing Stock	13,606.1	25,063.0	24,698.2	15,554.9	33,035.8

Source: Physical Account data and prices are from the Statistical Handbook (Canadian Association of Petroleum Producers: 1993). Production cost is taken as total expenditure by the industry less those on royalties and on the land acquisition and rental costs. The cost of equity was assumed to be 7% plus the rate of inflation, with equity investment taken from Financial Statistics for Enterprise (Statistics Canada, 1988 to 1992) and Taxation Statistics (Department of National Revenue: 1949 to 1964). Costs were distributed between oil, natural gas, and other petroleum products based on the share of the total value of production of each over a period of years per Smith (1992) for 1962 through 1992. For the years 1947 to 1961, the distribution was based on the total value of production for each individual year. Monetary accounts for 1962 to 1988 can be found in Smith (1992) with the 1988 numbers included in this table.

CHAPTER 6: EMPIRICAL RESULTS

6.1 Beveridge-Nelson Decomposition

It is common in macroeconomic studies to decompose variables into permanent and transitory components. Traditional decomposition techniques assume the economy grows along a smooth trend path; the part of output due to permanent shocks is smooth. The simplest method of decomposition is an exponential growth path that best fits the historical data. "But there appear to be long-run changes in productivity growth that are badly captured by such a trend."[35] As Blanchard and Fischer (1992) point out, there is no reason to believe productivity shocks lead to smooth output growth.[36] Under the traditional decomposition methods, transitory shocks account for most fluctuations in the variable.

The method of decomposition utilized in this study follows Beveridge and Nelson (1981). Beveridge and Nelson assume the steady-state growth path of the time series shifts upward or downward over time. Consequently, the trend is stochastic rather than deterministic; fluctuations around the growth path represent the transitory effects. Cuddington and Urzúa (1989) show how this method is preferable since the standard time-trend fitting procedure (time-stationary) tends to overestimate the transitory component and consequently underestimates the

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35 Blanchard and Fischer (1992), p. 8.

36 Blanchard and Fischer (1992), pp. 9-10.

growth effects. Using the Beveridge-Nelson technique causes the permanent component of a variable to account for the movement in output. As a result, it is not unreasonable for the permanent component to have greater variation than the actual value of the variable.

6.1.1 Methodology for Beveridge-Nelson Decomposition

Prior to performing the Beveridge-Nelson methods, the time series must be checked for stationarity. If a time series is non-stationary, first differencing is performed and the Beveridge-Nelson technique can be used. If the data do not require first differencing, the technique is not applicable. Augmented Dickey-Fuller unit root tests on the data indicated all variables contained a unit root.[37]

The Beveridge-Nelson decomposition technique employs ARIMA(p,1,q) models and their estimation and forecasting techniques. First, it is necessary to identify the autoregressive and moving average processes in a time series. An ARIMA model was run on each variable, and the autocorrelation and partial autocorrelation functions were graphed. Inspection of these functions did not always provide an obvious underlying process in some of the variables as it was

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37 For a time series, Y_t, the augmented Dickey-Fuller regressions equations with no trend and with a trend are, respectively:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t .$$

Testing for a unit root is a test of whether the coefficient $\alpha_1 = 0$.

difficult to distinguish between a moving average and an autoregressive process. This is not an unusual occurrence with the identification stage.

Since ARIMA models are not based on any underlying economic theory, it is acceptable to use the data in natural or logarithmic form; the choice is based on the method that yields better results. For some variables (personal disposable income and combined provincial and local government expenditure), transforming the data into logarithmic form appeared to simplify the ARIMA process to be estimated and provided better results. Further, economic theory does not predict whether a variable will exhibit a moving average or an autocorrelation process and does not provide an indication as to the order. Consequently, it is not unreasonable to identify one variable as an autoregressive process and another as a moving average.

When identification did not result in a clear choice, a few alternative specifications were estimated. In some cases logarithmic data was used and sometimes a constant was included in the model; in both cases this was done with personal disposable income and combined provincial and local government expenditure. The preferred model was chosen by minimizing the Schwartz Criteria and also ensuring the forecasted values were not unreasonable.[38] Hoff (1983)

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[38] The Schwartz Criteria is a model selection statistic defined as $\tilde{\sigma}^2\left(n^{\frac{k}{n}}\right)$ where $\tilde{\sigma}^2 = \frac{e'e}{n}$, and k is the number of estimated parameters in the model, including the constant. Utilizing the Schwartz Criteria to select the model was suggested by Stephen Beveridge.

provides a simple method for determining if a constant should be included in the specification. If the mean of the differenced series is significantly large, a constant should be included. The mean is considered to be significantly large if it is greater in magnitude than twice the standard deviation of the differenced series divided by the square root of the number of data values in the differenced series.[39]

Once identified, each model was re-estimated using the appropriate process and estimates of the model parameters were obtained. In all models, the estimated parameters were significant. To ensure the errors resulting from the model were random, the Ljung-Box-Pierce Q-statistic was examined. The null hypothesis of random errors could not be rejected at the 5% level of significance for most lags on the variables; at the 1% level, the null was never rejected. Estimation results for the variables are summarized below.

<u>Income: ARIMA(0,1,1)</u>

$$\Delta \ln N_t = \underset{(0.01272)}{0.092806} - \underset{(0.1397)}{0.33929} e_{t-1} + e_t \quad (22)$$

$$\ln N_t = 0.092806 + \ln N_{t-1} - 0.33929 e_{t-1} + e_t \quad (23)$$

$R^2 = 0.0936$ $\qquad \hat{\sigma}^2 = 0.0040744$

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[39] The significance level was approximately $\alpha = 0.05$. See Hoff (1983), p. 134.

Federal Government Expenditure in Alberta: ARIMA(2,1,0)

$$\Delta GF_t = \underset{(0.1517)}{0.62135}\Delta GF_{t-1} - \underset{(0.1553)}{0.30787}\Delta GF_{t-2} + e_t \tag{24}$$

$$GF_t = 1.62135GF_{t-1} - 0.92922GF_{t-2} + 0.330787GF_{t-3} + e_t \tag{25}$$

$R^2 = 0.1993$ $\hat{\sigma}^2 = 82338$

Provincial Government Expenditure in Alberta: ARIMA(1,1,0)

$$\Delta GP_t = \underset{(0.1175)}{0.66012}\Delta GP_{t-1} + e_t \tag{26}$$

$$GP_t = 1.666012GP_{t-1} + e_t \tag{27}$$

$R^2 = 0.1903$ $\hat{\sigma}^2 = 123770$

Local Government Expenditure in Alberta: ARIMA(1,1,0)

$$\Delta GL_t = \underset{(0.1008)}{0.76996}\Delta GL_{t-1} + e_t \tag{28}$$

$$GL_t = 1.76996GL_{t-1} + e_t \tag{29}$$

$R^2 = 0.2966$ $\hat{\sigma}^2 = 14445$

Provincial and Local Government Expenditure in Alberta: ARIMA(0,1,1)

$$\Delta \ln GPL_t = \underset{(0.01295)}{0.12467} - \underset{(0.1347)}{0.40397}e_{t-1} + e_t \tag{30}$$

$$\ln GPL_t = \ln GPL_{t-1} + 0.12467 - 0.40397e_{t-1} + e_t \tag{31}$$

$R^2 = 0.1552$ $\hat{\sigma}^2 = 0.0038484$

After a model was found for each variable, the forecasting techniques in SHAZAM were used to determine the stochastic trend in the Beveridge-Nelson technique. SHAZAM provides an option that automatically computes the result.[40] The stochastic trend was used as the permanent component of the variable; the transitory component was found by subtracting the permanent component from the observed value. Charts 1 through 5 illustrate the Beveridge-Nelson decomposition results for the stochastic trend. As can be seen, the transitory component is relatively small and the permanent component does appear to have more variability than the actual value. As outlined above, this is not inconsistent with the expected results.

6.2 Estimation of the Permanent-Income Life-Cycle Model of Consumption

The data were transformed to real per capita dollars to eliminate any inflationary effects. Examining the model on a per capita basis helps eliminate the effects of a changing population. The overall income of Alberta is much higher in 1992 than in 1962, but a higher population has caused per capita income to increase by a smaller amount. Simply, transforming the data into real per capita dollars results in inflation and population effects being held constant in the analysis and simplifies estimation.

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[40] For a more detailed treatment of the method of determining the stochastic trend, see Beveridge and Nelson (1981), Cuddington and Urzúa (1989), and Stock and Watson (1988).

CHART 1
DECOMPOSITION OF INCOME

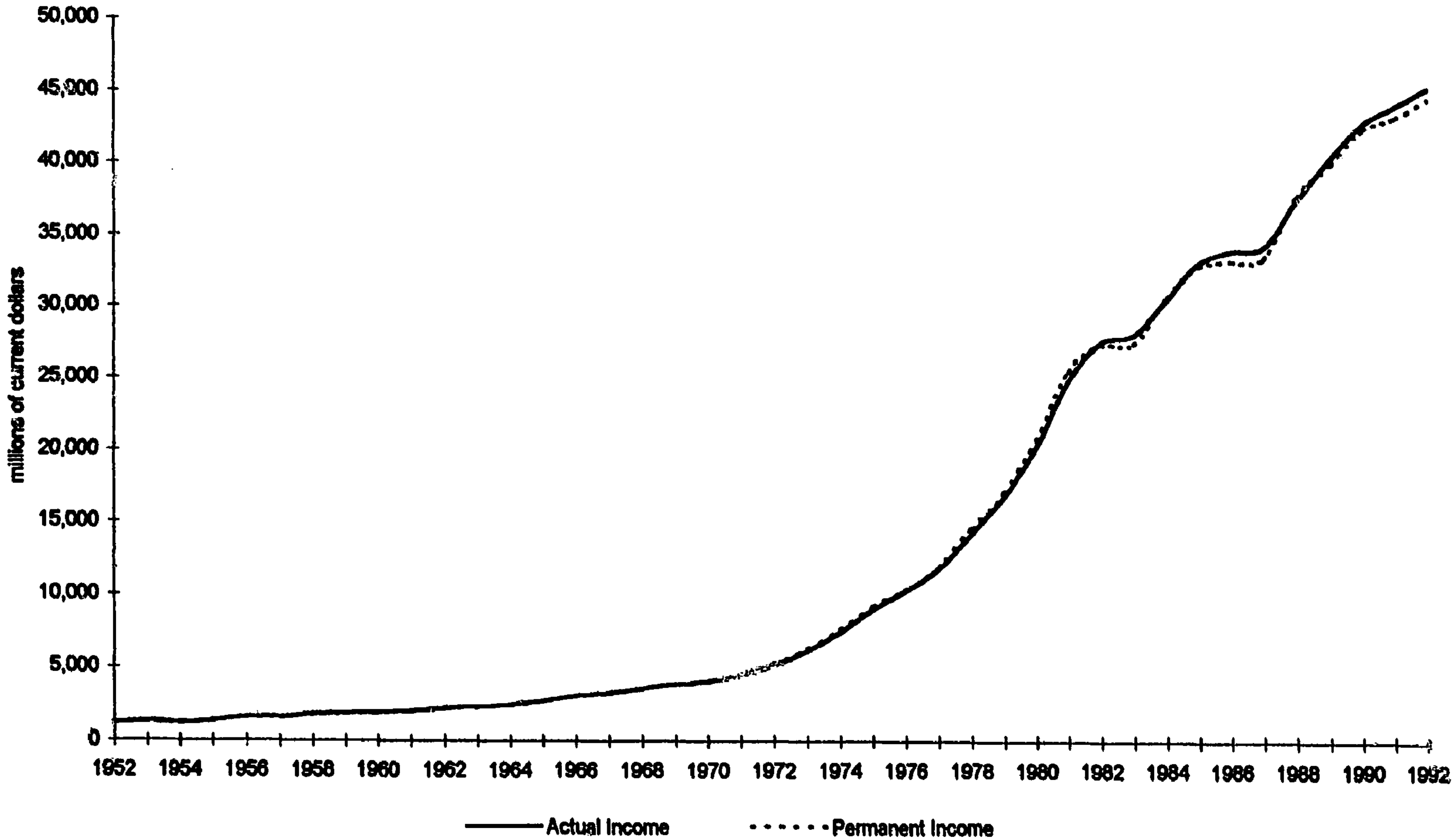


CHART 2
DECOMPOSITION OF FEDERAL GOVERNMENT EXPENDITURE

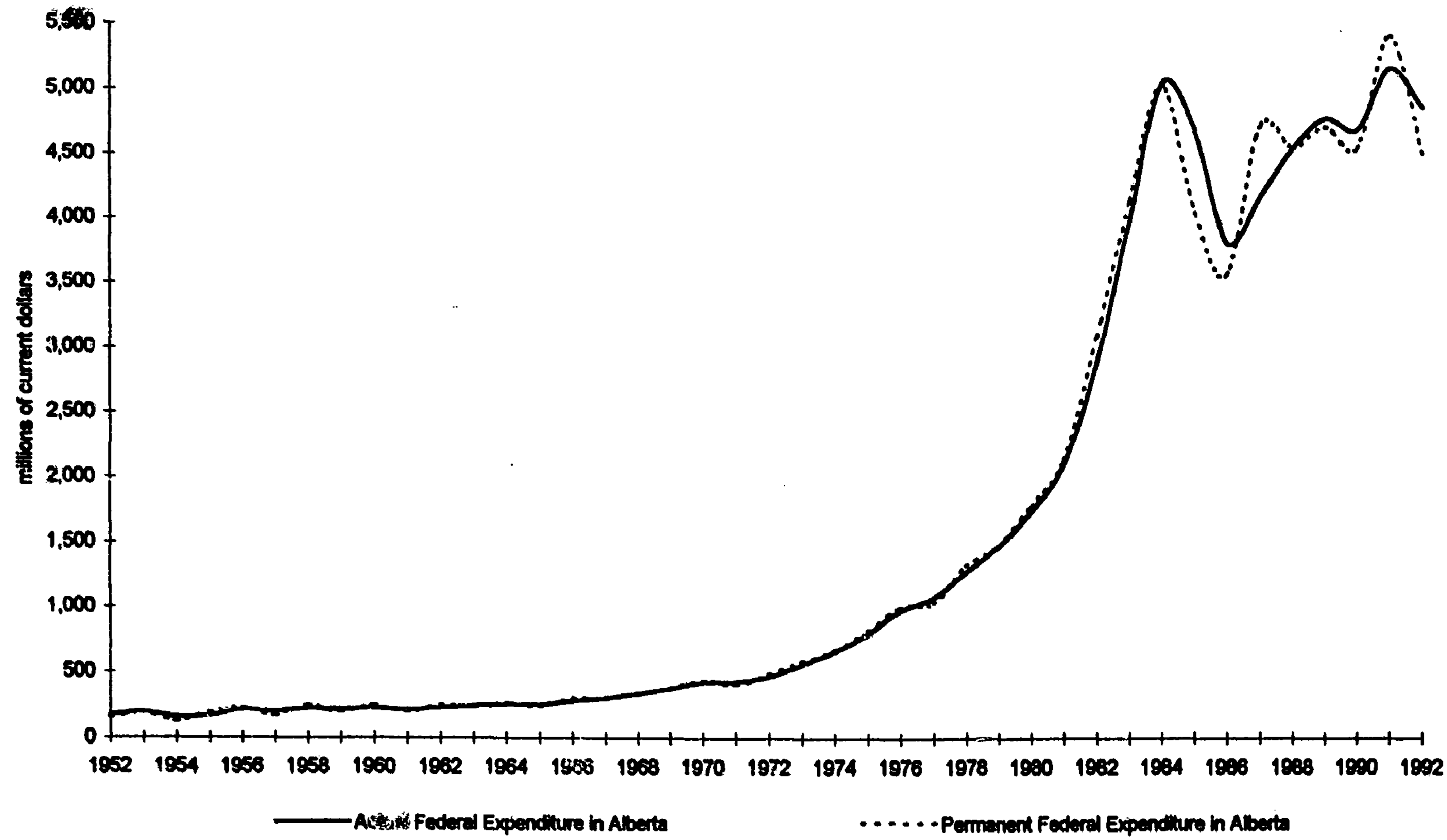


CHART 3
DECOMPOSITION OF PROVINCIAL GOVERNMENT EXPENDITURE

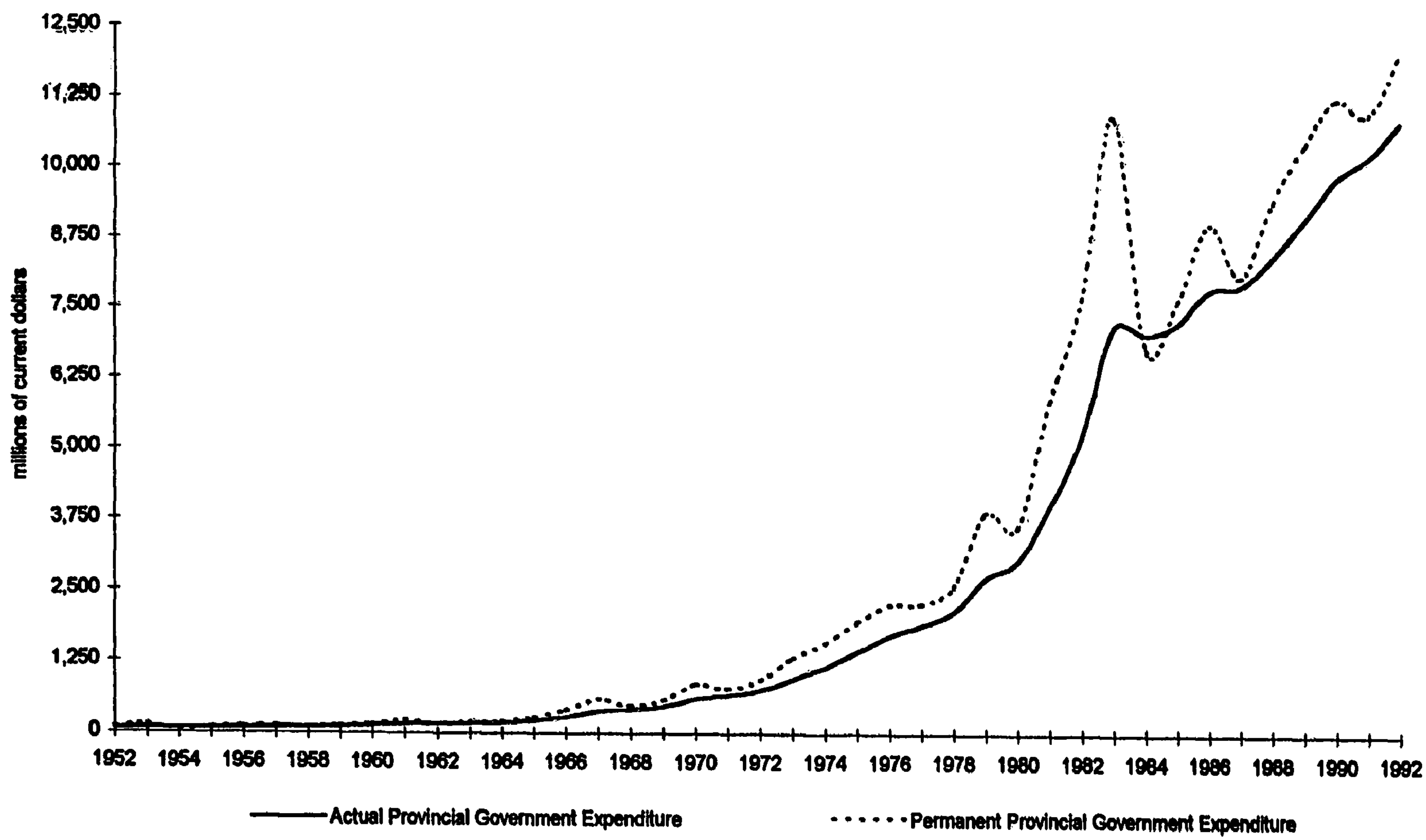


CHART 4
DECOMPOSITION OF LOCAL GOVERNMENT EXPENDITURE

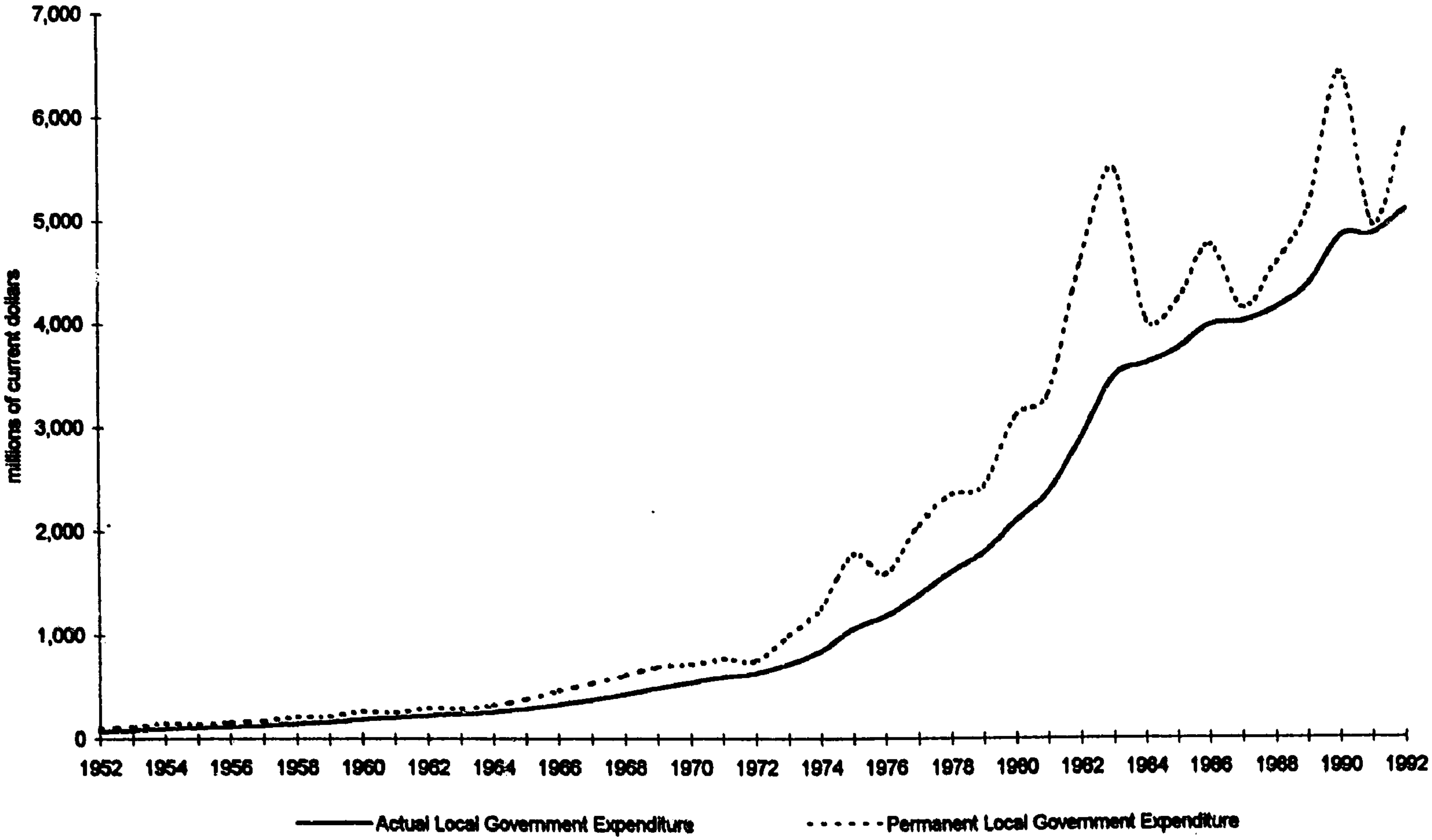
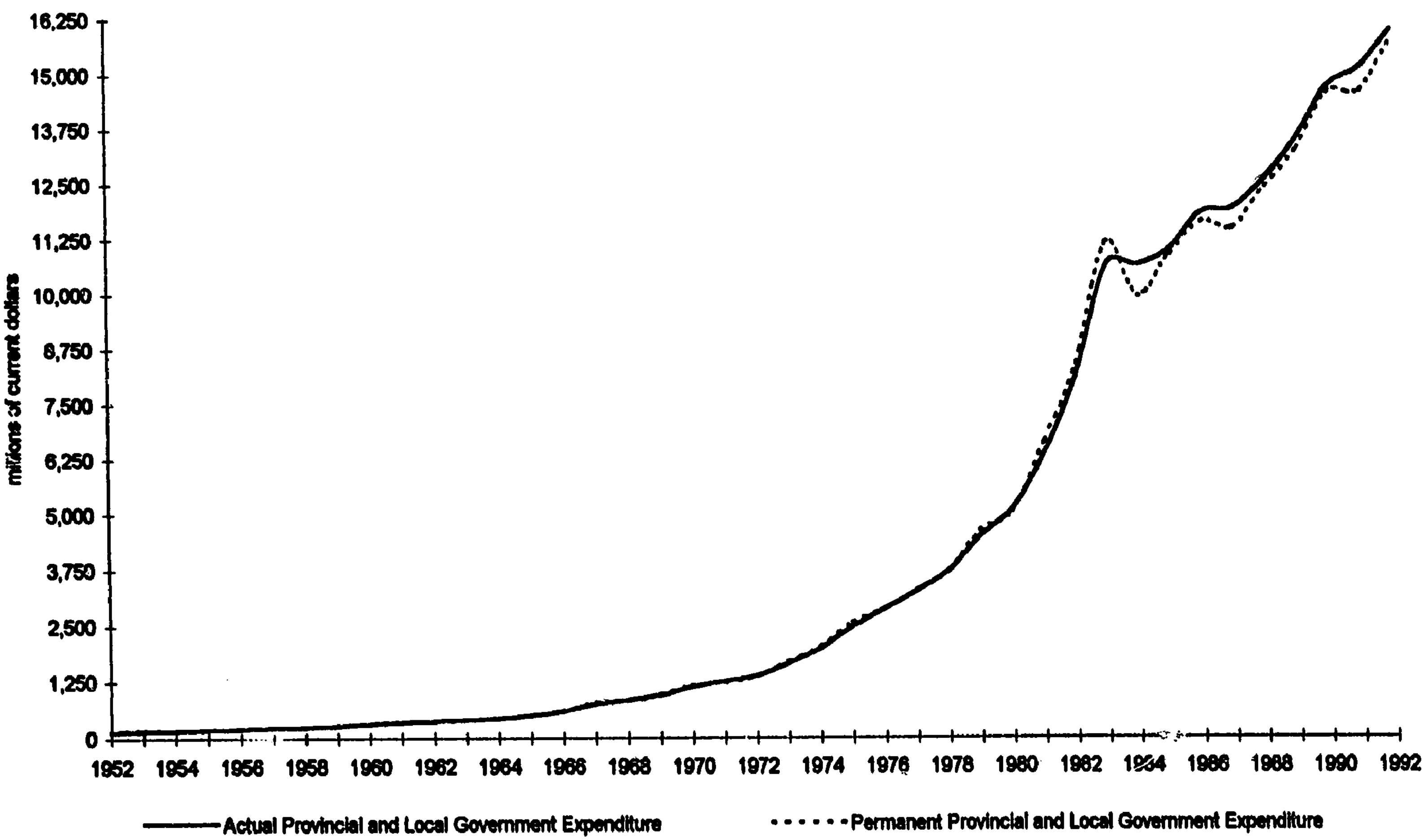


CHART 5
DECOMPOSITION OF PROVINCIAL AND LOCAL GOVERNMENT EXPENDITURE



Prior to estimating equation (21), the real per capita data were tested for stationarity using the augmented Dickey-Fuller unit root test. At the 10% level of significance, evidence of a unit root was found in all variables except the transitory components of income, federal government expenditure and provincial and local government expenditure. The permanent component of income did not exhibit evidence of a unit root in the constant, no trend model. Since these results indicate most data are non-stationary, it was important to establish that there is a cointegrating relationship between the variables. If variables are cointegrated, it indicates there is a long-run relationship between them. Individual variables may not be stationary around a trend. However, if two or more variables have a long-run relationship (e.g., each follow the same, non-stationary process) they are considered to be cointegrated. The residuals of the model were examined and there was no evidence of a unit root. This procedure indicated there was some cointegrating relationship between the variables in the model and traditional estimation techniques were not invalidated.

Equation (21) was estimated using ordinary least squares. Diagnostic testing revealed evidence of autocorrelation at may lags. This result indicated a lagged-dependent variable model may be appropriate. The one-period lagged consumption coefficient was significant at the 5% level of significance and reduced the evidence of autocorrelation. The hypothesis of no autocorrelation was rejected at a 5% level of significance for the third and fifth lags; at the 1% level of significance the hypothesis was still rejected, indicating autocorrelation was still present in the model.[41] As a result, the model was estimated using the autocorrelation-consistent matrix which utilizes the Newey-West correction method.[42] This eliminated the evidence of autocorrelation at the 1% level for the fifth lag; the third lag had a similar result. All other lags could not reject the hypothesis of no autocorrelation at the 5% level of significance.[43] In addition, the Durbin h-statistic value of -0.59906 was not significant at the 5% level.

The Breusch-Pagan-Godfrey test could not reject the hypothesis of homoskedasticity in the model since the test statistic value of 17.464 was below the 5% (11 degrees of freedom) critical value of 19.675.

RESET tests could not reject the hypothesis of no specification error since the test values of 0.54415, 0.33446, and 0.73843 are well below the 5% critical values of 4.17, 3.39 and 2.99 respectively. In addition, the Jarque-Bera LM test of 2.8013 could not reject the hypothesis that the error term is normally distributed as the critical value at the 5% level of significance is 5.991.

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[41] Using a two-tail Lagrange Multiplier (LM) test for autocorrelation the 5% and 1% critical values are 1.960 and 2.576 respectively. The third and fifth lags had LM statistics of 2.175 and 2.6254 respectively. The third lag is below the 1% critical value, causing the null hypothesis of no autocorrelation to not be rejected; at the fifth lag, the null hypothesis is rejected. All other lags could not reject the null hypothesis as the LM statistics was below the 5% critical value of 1.960.

[42] Newey and West (1987). Greene (1990, p. 493) provides an easier explanation of the method.

[43] The third and fifth lags had LM test statistics of 2.2002 and 2.2546 respectively which were below the 1% critical value of 2.576.

As a result of these tests, the null hypotheses of no autocorrelation, no heteroskedasticity, no specification error and random errors cannot be rejected. The estimated model is summarized in Table 5.

6.2.1 Tests on Coefficients

The model was first estimated using two variables for Heritage Fund equity The first variable consisted of the Cash and Marketable Securities Portfolio and the second was all other investments. The Cash and Marketable Securities Portfolio consists of investments in highly liquid assets such as stocks, bonds and treasury bills. The remainder of the assets of the Heritage Fund are relatively less liquid. It was hypothesized these two components might not have the same effects on consumption. A test of the hypothesis that the two coefficients were equal to each other resulted in a t-test statistic of 0.4858 which is insignificant at the 10% level. It was not possible to reject the null hypothesis that the Cash and Marketable Securities Portfolio and all other investments have the same effect. Consequently, the model was estimated using Heritage Fund equity as the only variable for the Heritage Fund.

As outlined in Chapter 4.3, since all three levels of government are included in the model, it was possible to test if taxes and expenditure by different governments are viewed differently by Albertans. The first test was to determine

TABLE 5
RESULTS OF THE ESTIMATION OF EQUATION (21)

Variable Name	Ricardian Equivalence Predicted Sign	Estimated Coefficient	Standard Error	t-ratio 29 d.f.
C_{t-1}	>0	0.30323	0.1393	2.176[5]
N_t^*	>0	0.56468	0.1293	4.367[1]
$(N_t - N_t^*)$	$=0$	0.52268	0.3724	1.404
W_t	>0	0.0012477	0.003138	0.3977
$G_{f,t}^*$	<0	-0.66763	0.2307	-2.893[1]
$(G_{f,t} - G_{f,t}^*)$	<0	-0.63721	0.2381	-2.676[1]
$G_{pl,t}^*$	<0	0.29721	0.1568	1.895[5]
$(G_{pl,t} - G_{pl,t}^*)$	<0	0.76151	0.5377	1.416[10]
$B_{f,t}$	$=0$	-0.032415	0.1077	-0.3009
$B_{p,t}$	$=0$	0.11362	0.1399	0.8121
$AHSTF_t$	>0	-0.16813	0.05313	-3.165[1]
Constant	$=0$	1027.9	704.9	1.458[10]
	$R^2 = 0.9969$	$\hat{\sigma} = 165.10$	SSE=790510	n=41

When the Ricardian equivalence predicted sign is zero, the null hypothesis is that the coefficient is equal to zero versus the alternative hypothesis that the coefficient is not equal to zero. The t-ratio critical value is based on a two-tail test. When the predicted sign is either positive or negative, the null hypothesis is that the coefficient is equal to zero versus the alternative that the coefficient is significantly positive (or negative as the case may be). When testing if a coefficient is greater than (or less than) zero and the estimated coefficient has the incorrect sign, the alternative hypothesis is set according to the estimated sign. For example, the variable $AHSTF_t$ has the opposite sign to the predicted sign. In this case the null is defined to be that the coefficient is equal to zero versus the alternative that the coefficient is less than zero. Since it is significant at the 1% level for this test, the null cannot be accepted. The conclusion is that the coefficient is significantly negative and the sign is not the same as the predicted sign. For one-tail tests, critical values are: $t_{0.10,29}$=1.311; $t_{0.05,29}$=1.699; $t_{0.01,29}$=2.462. For a two-tail test, the critical values are: $t_{0.10,29}$=1.699; $t_{0.05,29}$=2.045; $t_{0.01,29}$=2.756. Significance is indicated with a superscript 10, 5, or 1 for significance at 10%, 5% and 1% respectively; the lowest significance is indicated.

if there was a significant difference between provincial and local government expenditure and revenue coefficients. It was hypothesized there was no difference in these two estimated coefficients. The basis for the hypothesis was the fact there is a less apparent difference between provincial and local governments compared to the difference between the federal government and provincial governments; local government is essentially a product of the provincial government. Hypothesis testing indicated there was no difference between provincial and local permanent and transitory expenditure coefficients since the t-test statistics for the permanent expenditure t-test of -1.700 was, in absolute value, below the 5% critical value of 2.052; the transitory t-test statistic of -2.043 was, in absolute value, below the same critical value.[44] As a result, the model was re-estimated combining the two levels of government into one.

Next, the estimated debt coefficients were examined. First, it was hypothesized there should be a difference between the federal and provincial debt coefficients. As explained in Chapter 4, migration has implications for the Ricardian equivalence theorem. Since Albertans are free to move among provinces, they could escape the future tax liability resulting from debt financing. Federal tax liabilities are more difficult to escape since moving among provinces does not remove the liability. Consequently, it would not be unreasonable to expect the estimated coefficients on federal and provincial debt to be different.

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[44] The null hypothesis was that provincial government permanent expenditure less local government permanent expenditure was equal to zero; the alternative was that there was a difference (simply not equal to zero). The test on the transitory variables was the same. Critical values were for two-tailed tests.

However, hypothesis testing did not support this argument as the results indicated there was no significant difference at the 10% level.[45]

The second test on the debt coefficients was to see if the coefficient on provincial debt had a significantly different impact on consumption compared to the Heritage Fund. Once again, testing indicated there was no difference at the 10% level.

6.2.2 Testing for Structural Breaks

6.2.2.1 The 1973 Oil Shock

The oil shock of the early 1970's had a profound effect on Alberta. As a result, it is necessary to check for structural stability during this period. If the underlying parameters of the model changed at this point in time, an attempt to model the structural break should be made. The Chow test was used to test for structural breaks in the model.[46] For 1972, 1973 and 1974 no structural break could be found at the 5% and 1% levels of significance.[47]

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[45] The alternative hypothesis was that the federal debt coefficient less the provincial debt coefficient was non-zero. The t-test statistic of -0.6037 was, in absolute value, below the 5% critical value of 2.045 (two-tail test).

[46] The limited number of observations combined with the number of parameters to be estimated in the model necessitated the use of the small-sample Chow test.

[47] Chow tests for 1972, 1973, and 1974 yielded test statistics of 0.5659, 0.6185, and 0.4285 respectively. The critical value (12 and 17 degrees of freedom) is 2.38 (5%) and 3.46 (1%). Therefore the null hypothesis of no structural break cannot be rejected.

6.2.2.2 The Heritage Fund

Chow tests can be utilized to determine if there were any structural breaks in the model at various points in the Heritage Fund's existence. In addition to testing if a structural break occurred in 1976 when the Heritage Fund was created, it is possible to test if there were structural breaks when the proportion of non-renewable natural resource revenue was decreased to 15% and subsequently to zero. It is also possible to examine if a break occurred when the Heritage Fund income was transferred to the General Revenue Fund.

Chow tests indicated a structural break did occur in 1976 when the Heritage Fund was created; tests for other years did not provide the same result. While it is possible the structural break in 1976 was not caused by the creation of the Heritage Fund, there is no other significant event that could be considered to have caused this result.[48]

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[48] The Chow test for 1976 was 6.1342. The critical value (24 and 29 degrees of freedom) is 1.89 (5%) and 2.47 (1%). For 1983 the Chow test statistic was 0.6535 with critical values (35 and 29 degrees of freedom) are approximately 1.79 (5%) and 2.30 (1%). In 1986 only some of the Heritage Fund income was transferred to the General Revenue Fund; in 1987 all income was transferred. The Chow test was run for both years. The test statistics were 0.6535 and 0.5923 for 1986 and 1987 respectively. Critical values for both tests were approximately 1.79 (5%) and 2.30 (1%). Approximations for critical values are a result of using the critical values for the closes number of degrees of freedom since the statistical table for the F-distribution does not provide statistics for every degree of freedom. For example, the critical values for 1976 are based on 24 and 30 (rather than 24 and 29) degrees of freedom.

6.2.3 Wealth Versus Heritage Fund Equity

The Heritage Fund represented a transformation of wealth in the ground (in the form of oil and natural gas reserves) to wealth in the form of financial assets. A rational agent should not consider there to be any difference between the two. Testing the hypothesis that Albertans do not view these two forms of wealth any differently was done. The t-test statistic of 3.106 resulted in rejecting the null hypothesis as the 1% critical value is 2.756. Consequently, it appears Albertans do view wealth in the form of Heritage Fund equity differently than they do wealth in the form of oil and natural gas reserves.[49]

6.3 Testing the Ricardian Equivalence Theorem

6.3.1 The Debt Coefficients

The most basic test for Ricardian equivalence is to determine if the coefficient on the debt variable is significantly non-zero. As outlined in Chapter 4.4, the intuition underlying this test is straightforward. Government expenditures must be paid for either now or later. If the government does not have adequate tax revenues to pay for the expenditures in the current period, taxes must be increased or debt must be issued. The Ricardian equivalence theorem maintains there is no difference between raising taxes and issuing debt to finance government expenditure. Rational agents, recognize the future tax liability, would reduce their

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[49] This test was performed for the entire sample. Ideally, it would be best to use the estimated coefficients for the entire sample but only test the hypothesis for the subsample in which the Heritage Fund existed.

consumption in the current period by the present value of the debt to cover the future tax liability. Therefore, the amount of debt is insignificant in the agents consumption decision. As a result, testing for Ricardian equivalence entails testing if the coefficient on the debt variable is zero. If this is the case, the Ricardian equivalence theorem is supported. In the model, both federal and provincial debt coefficients are not significant at the 1% level, indicating Ricardian equivalence is satisfied. However, the Heritage Fund should be significant and positive since government savings should be viewed, in a Ricardian world, as reducing the future tax liability. While the coefficient on the Heritage Fund in the model is significant at a 1% level of significance, the sign is negative. A positive coefficient would indicate increased savings via the Heritage Fund causes consumers to increase their current period consumption since they realize the implied future benefit from reduced taxes. Since the coefficient is negative, placing non-renewable natural resource revenue in the Heritage Fund actually reduced per capita consumption. Despite the fact the Heritage Fund coefficient is significant, the incorrect sign is problematic for supporting Ricardian equivalence.

6.3.2 Tests on Other Coefficients

As explained in Chapter 2.2.3, Ricardian equivalence in a permanent-income hypothesis model implies certain signs and values for other coefficients. First, the coefficient on permanent income should be positive and less than unity. This value corresponds to the permanent income component of the marginal propensity to consume. The model indicates this value is 0.30323 and is significant. Next, the coefficient on transitory income should be zero. The estimated model supports this expectation. Wealth effects should also be positive and less than unity. This is not supported as the wealth coefficient of 0.0012477 is insignificant.

Government expenditure coefficients are expected to be negative and less than unity. Both federal permanent and transitory expenditure are significant at the 1% level, and are negative. This result supports the theory since it is assumed in the model that government expenditures are substitutes for personal consumption. The provincial and local government permanent component is significant at the 5% level while transitory coefficient is significant only at the 10% level. Unlike the federal coefficients, both provincial and local government expenditure coefficients are positive.

The empirical results indicate it is not possible to support Ricardian equivalence. Some coefficients have the correct sign and significance. Arguments could probably be made in favour of Ricardian equivalence despite the insignificance of the wealth coefficient and the incorrect sign on provincial and local government expenditures. However, the incorrect sign on the Heritage Fund makes it difficult to support the Ricardian equivalence theorem.

6.4 Interpreting Empirical Results

While the estimated model does not appear to favour Ricardian equivalence resulting from the incorrect sign and questionable significance of the Heritage Fund, it is important to still look at the coefficients to determine if they appear to make economic sense. If the coefficients on the variables are not reasonable, the model may be the problem, and the result may simply be a consequence of the model.

Including the one period lagged consumption variable allows there to be a distinction made between the short-term and the long-term results. The short-term coefficients are those indicated in Table 5. The long-term coefficients can be calculated by holding consumption constant in all time periods (i.e., $C_t = C_{t-1} = C$). The resulting long-term coefficients are equal to short-term coefficient divided by $1-\lambda$ where λ represents the coefficient on lagged consumption. Table 6 summarizes the long-term coefficients and compares them to the short-term results.

6.4.1 Short-term Results

The constant in the model, 1,027.9, represents the subsistence level of consumption. When all other variables are equal to zero, consumption would be \$1,027.90.[50] This expenditure represents expenditure on necessities such as basic

50 These coefficients indicate per capita expenditures on consumption. All coefficients are in constant (1986) dollars.

food, clothing and shelter requirements. Since the estimated equation included a lagged-dependent variable, consumption in the previous year affects the current level. The coefficient on lagged consumption was 0.30323. This indicates approximately 30% of consumption today is based solely on the level of consumption in the previous period.

The income terms have differing effects. Theory indicates a change in permanent income will result in a permanent change in consumption. Alternatively, changes in the transitory component of income should have no effect on consumption as they are expected to average out to zero over one's lifetime. A change in the transitory component of income can only have an effect on consumption if uncertainty causes agents to be unable to ascertain if the shock is actually transitory or permanent.

The estimated coefficients on permanent and transitory income are 0.56468 and 0.52268 respectively. The permanent component indicates 56.468% of permanent income and 52.268% of transitory income in the current period are used for consumption. However, hypothesis testing indicated the transitory coefficient is not significantly different than zero, whereas the permanent coefficient is significantly positive. Thus, the results for income are consistent with theory.

The wealth coefficient, which is a proxy for the wealth of the province, is 0.0012477. This indicates consumption increases by 0.12477 cents for every dollar increase in Alberta's wealth as proxied by the monetary value of the province's oil and natural gas resources. The value is small, partly because it is not uncommon for the monetary accounts for natural resources to indicate a value of wealth in billions of dollars. However, the coefficient is insignificant and therefore does not appear to have any effect on consumption.

The government expenditure components were hypothesized to have a negative impact on consumption because the model assumed they were perfect substitutes. However, the results do not fully support this. Both permanent and transitory components of government expenditure were expected to be negative and between zero and one in absolute value. All estimates were in the correct range, but only federal government expenditures were negative. This result indicates federal government expenditures are substitutes for private consumption whereas provincial and local government expenditures are not. In addition, since the coefficients are not equal to one, expenditures by all governments are not perfect substitutes for private consumption. The magnitude of the coefficients indicate the amount by which consumption increases when government expenditure increases. This effect compounds the economy-wide effect of the government expenditure. For example, in addition to any direct impacts it may cause, a $1 increase in real permanent per capita provincial and local government expenditure would indirectly increase real consumption by almost $0.30. On the other hand, an increase in real permanent federal government expenditures will cause an indirect decrease in real consumption by $0.67.

The Heritage Fund coefficient is the remaining one found to have any significance. The value of -0.16813 indicates a $1 real per capita increase in the Heritage Fund causes a decrease in real consumption of almost $0.17. This is clearly not the desired effect of maintaining the Heritage Fund. Consequently, the model leads to the conclusion the Heritage Fund has been detrimental to consumption in Alberta.

Since the income and provincial and local government expenditure variables have a positive impact, the Heritage Fund would have provided a more favourable result if the savings were spent by either the government or directly by Albertans as these alternative uses would have provided increased consumption.

6.4.2 Long-term Results

Table 6 provides a comparison of the short- and long-term effects of the variables on consumption. The estimated long-term coefficients are derived by dividing the short-term coefficient by $1-\lambda$ where λ is the coefficient on one-period lagged consumption; there is no impact on the standard errors or the significance. Since $1-\lambda$ is close to 0.70, all coefficients have been scaled by approximately 1.43.

The long-term coefficient on permanent income, the marginal propensity to consume, is 0.8104 and is not inconsistent with expectations. The coefficients on federal government permanent and transitory expenditures changed to -0.9582 and -0.9145 respectively. This result indicates that in the long-term, federal

TABLE 6
COMPARISON OF SHORT-TERM AND LONG-TERM COEFFICIENTS

Variable Name	Short-term Coefficient	Long-term Coefficient
N_t^*	0.56468	0.8104
$(N_t - N_t^*)$	0.52268	0.7501
W_t	0.0012477	0.00179
$G_{f,t}^*$	-0.66763	-0.9582
$(G_{f,t} - G_{f,t}^*)$	-0.63721	-0.9145
$G_{pl,t}^*$	0.29721	0.4266
$(G_{pl,t} - G_{pl,t}^*)$	0.76151	1.0929
$B_{f,t}$	-0.032415	-0.0465
$B_{p,t}$	0.11362	0.1631
$AHSTF_t$	-0.16813	-0.2413
Constant	1027.9	1475.2

The long term coefficient is calculated by dividing the short-term coefficient by $1-\lambda$ where λ represents the coefficient on the one-period lagged consumption coefficient (1 - 0.30323 = 0.69677).

government expenditures are nearly perfect substitutes for private consumption. The transitory provincial and local government expenditure coefficient increased to 1.0929; it should have been less than unity. However, it is only significantly positive at the 10% level.[51] The permanent component has a long-term coefficient of 0.4266 and has the same interpretation as the short-term coefficient.

[51] Testing the null hypothesis of it being equal to zero versus the alternative of not equal to zero cannot reject the null hypothesis.

While there was a change in the federal and provincial debt coefficients, they remain insignificant. The Heritage Fund coefficient in the long-term remains negative and is equal to -0.2413. Thus, in the long-term, the Heritage Fund still has a negative impact on the individual's consumption stream.

CHAPTER 7: CONCLUSION

This study employed economic theories to develop a framework from which the economic impact of the Heritage Fund on individual consumption-savings behaviour could be assessed. This assessment was based on the Ricardian equivalence theorem. The underlying principle of the theorem is that Albertans should view the Heritage Fund as providing a revenue source from which future government expenditures can be supported when the province's non-renewable natural resource revenues disappear. The existence of the Heritage Fund should cause the future tax burden to decline and current consumption to increase. The Heritage Fund represents a form of government savings that does not have any future liability associated with it, and therefore, provides a unique opportunity to test Ricardian equivalence.

Empirical results indicate the Ricardian equivalence theorem is not supported since the Heritage Fund coefficient in the model is significantly negative. One possible explanation for this result is that by saving some of the non-renewable resource revenues, in the form of the Heritage Fund, the government induced migration to Alberta, since the existence of the Heritage Fund carries the implication of a future reduced tax burden. As the Heritage Fund is common property, those migrating to Alberta receive the same proportional share of the Heritage Fund as existing residents. Consequently, there is rent dissipation as the benefit is provided to a larger group. This could reduce the impact of the Heritage

Fund on individual consumption, although it is not clear this would necessarily cause the impact to be negative.

Another possible explanation could be as follows. When non-renewable natural resource revenues are unable to support existing government expenditures, the Heritage Fund equity is intended to supplement the lost revenues to ease the adjustment process. As the government began to save a portion of these revenues to fund future government expenditures, perhaps Albertans also increased private savings. One reason this might occur could be attributed to the fact the government was only saving a portion of the non-renewable resource revenues in the Heritage Fund. If Albertans agreed it was important to save some of this revenue for the future, but did not perceive the level of savings in the Heritage Fund to be adequate to maintain future expenditures, they may have increased private savings to cover future taxes still needed to supplement future revenue shortfalls. The existence of the Heritage Fund permitted a lower increase in private savings than may otherwise have been necessary. An increase in private savings would cause consumption to decline.

What is the implication of these findings? Empirical tests indicate Ricardian equivalence is not supported in this study. From the perspective of the Heritage Fund, the failure of Ricardian equivalence leads one to reject the hypothesis Albertans view the Heritage Fund as providing lower taxes at some future date. One goal of the Heritage Fund was to provide a revenue source from which future generations could benefit when the non-renewable natural resource revenues were insufficient to maintain the existing level of government expenditure and services. If the Heritage Fund was achieving this goal, Albertans should consider the Heritage Fund as providing a future reduced tax burden. Unfortunately, the empirical analysis does not support this conclusion.

This thesis has concentrated on the Heritage Fund and the impact it has had on individual consumption-savings behaviour. No attempt has been made to assess any other possible economic benefit, if any, that has been derived from the Heritage Fund (e.g., diversification of the Alberta economy). Regardless, economic analysis has shown the Heritage Fund has not caused Albertans to alter their consumption stream in a manner that is consistent with the Heritage Fund representing savings for the future, and providing a reduced future tax liability.

This study cannot conclude the government should not have saved a portion of non-renewable natural resource revenues for future generations; it can only conclude the manner in which it was done has not caused Albertans to alter their consumption-savings behaviour in a way that is consistent with expecting future reduced taxes. Perhaps a different investment strategy or a different type of fund would have been more appropriate. However, given the fact the empirical results indicate there was no difference between high liquidity investments of the Cash and Marketable Securities Portfolio, and less liquid investments, such as the Alberta Investment Division, it is not clear an alternate investment strategy would make a difference to individual consumption-savings behaviour.

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APPENDIX 1: DATA SOURCES AND DEFINITIONS

C ≡ Consumption, current dollars
Sources: *Alberta Economic Accounts; Provincial Economic Accounts;* 1947-1992.

N ≡ Personal Disposable Income, current dollars
Sources: *Alberta Economic Accounts; Provincial Economic Accounts;* 1947-1992.

W ≡ Wealth; proxied by Monetary Accounts for Oil and Natural Gas. For details of methodology and sources, see Chapter 5.4; 1947-1992

G ≡ Government Expenditure on Goods and Services and Debt Servicing Costs, current dollars
Sources: *Alberta Economic Accounts; Provincial Economic Accounts;* 1947-1992.

B ≡ Government Debt, current dollars
Sources: Federal Debt is from Statistics Canada *National Accounts;* Provincial Debt is from Alberta Treasury and the Government of Alberta *Public Accounts;* 1947-1992.

AHSTF ≡ Alberta Heritage Savings Trust Fund equity.
Source: *Alberta Heritage Savings Trust Fund Third Quarter Reports* (December); 1976-1992.

The Consumer Price Index (1986=100) used to convert current dollars in to constant dollars was from the *National Accounts* (Statistics Canada). Population figures were from the *National Accounts* (Statistics Canada), *Alberta Economic Accounts* (Alberta Bureau of Statistics), and *Provincial Economic Accounts* (Statistics Canada); 1947-1992.