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TAXATION AND POLITICAL MODELS

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Thesis submitted to Trinity College, University of Dublin in fulfilment of the requirements for the degree of Doctor of Philosophy (Ph.D.)

2013
Declaration:

I declare that this thesis has not been submitted as an exercise for the degree of Doctor of Philosophy (Ph.D.) at this or any other university. All research contained herein that is not entirely my own but is based on research that has been carried out jointly with others is duly acknowledged in the text wherever included.

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Summary:

This thesis is a collection of three separate essays. Each essay deals with taxation policy directly or the expectation of future taxation by an electorate during a time of war. In terms of taxation, this essay generally focuses on transaction taxes levied against some or all of the banking system. Various versions of these taxes have been proposed to generate large government revenues and help maintain financial stability. The first paper (Chapter 2) looks directly at transaction taxes. The second paper (Chapter 3) looks at structural characteristics which would be relevant to policy makers using transaction taxes as an example. The final paper (Chapter 4) examines how war costs, including future expectations regarding taxation, are empirically modelled in political election predictions. This paper utilises nonparametric estimation methods, theoretical proofs of behaviour, and econometric analysis.

Chapter 1 provides the context of the thesis. It provides an overview of the three research questions addressed in the later chapters of the thesis.

Chapter 2 examines the viability of financial transaction taxes (FTT) to raise large amounts of revenue for the government and if these taxes would have helped prevent the financial crisis. The history of transaction taxes are examined along with some plausibility analysis of transaction taxes in general. FTTs are found not to be a general panacea able to increase government revenue without significant costs. The revenue generated from transaction taxes are expected to drastically underperform the amounts predicted by its advocates and lead to incentives for tax evasion. This chapter includes narrative from Professor Patrick Honohan.
Chapter 3 looks at how including structural characteristics such as skewness and kurtosis of revenue may assist policy makers when choosing between different tax-policy regimes. Traditional economic analysis commonly concerns itself with minimisation of any dead-weight loss associated with any taxation regime. Commonly, this is done through analysis of the tax base and rate. Revenue shape characteristics (such as variance, skewness, and kurtosis) coupled with basic political realities also matter when selecting a tax policy regime. This chapter demonstrates how revenue characteristics can be translated into a policy relevant tool for policy makers.

Chapter 4 investigates the different ways of modelling how wars are treated in political forecasting models. Traditionally, the involvement of a country in a war was either ignored entirely or simply noted through the use of a binary dummy variable. Chapter 4 asserts that capturing war costs and looking at how long the war progresses over time capture relevant information for use in models. To illustrate this fact, dummy variable models are compared with time progression and war cost models. Dummy variable models are shown to be inferior to models which either capture a time trend or capture direct war costs.

Chapter 5 concludes and suggests areas for further investigation in the areas covered within this thesis.
Acknowledgements:

I desire to express deep appreciation to several individuals. Their guidance and encouragement were essential to the completion of this thesis. As always, any errors and omissions are mine alone and do not reflect upon these individuals in any way.

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Chapter 1: General Context

Taxes and government revenues occupy the thoughts of both elected government officials and their electorates in many countries today. One can hardly turn on a news programme in the United States without hearing some politician decry the evils of excessive taxation. European governments have had to make serious decisions regarding austerity measures in light of revenue shortfalls.

These conditions have led many to search for new (and hopefully better) means of taxation. One idea is to tax bank transactions (Edgar L. Feige, 2005). Several versions of this idea have appeared throughout the economic literature and in public debate. Keynes proposed a version of this tax on securities such as stocks (John Maynard Keynes, 1936). Tobin famously proposed a transaction tax upon currencies (James Tobin, 1978). Yet these proposals have different purposes and goals they try to achieve.

The primary purpose of Feige's proposed tax on bank account transactions is for enhancing government revenue. The primary idea is to leverage the underground, and by extension untaxed, economy by forcing transactions to be taxed when deposited, transferred, or withdrawn from the banking system. This proposal provides some obvious challenges with tax evasion and tax cascading throughout an economy.

As initially proposed, both Keynes' Security Transaction Tax and Tobin's Currency Transaction Tax intend to remediate a public negative. These ideas represent a form of a Pigouvian tax (1950). The intent of this tax is to incentivise economic actors whose actions are detrimental to the economy as a whole to internalise the cost and therefore damage their actions levy upon the economy. Following from this idea of remediating a public negative, one argues that the revenue generated from the transaction tax could be used for a public good thus creating a "double dividend."
With two separate and distinct goals in mind, the proponents of transaction taxes have found unusual allies politically in pushing through their agenda. Recently, both of these groups have advocated for transaction taxes. Schulmeister argues that a transaction tax could increase government revenues for the European Union at minimal economic cost (2008). At the same time, Krugman argues that a similar tax is necessary to remediate the negative effects caused by speculators (2009).

Chapter 2 examines directly the question of viability of transaction taxes in achieving the two goals of government revenue generation and the remediation of a public bad. This chapter highlights the simple reality that any tax high enough to meaningfully remediate any negative economic activity from speculators is unlikely to provide sufficient revenue to the government. The inverse is also true; any tax low enough to provide enough revenue will not act as a sufficient deterrent to speculators. As a result, transaction taxes are more a damp squib than anything else.

Given that policy makers are searching for new taxation regimes, economics commonly plays a central role in the debate. The common role for economics is to run a general equilibrium analysis to determine which taxation regime carries a lower dead-weight loss upon the economy as a whole. This economic analysis has been extended to include some political considerations as to which segments of society bear the costs of any taxation regime. However, precious little debate has been given to the mathematical shape of the revenue itself.

Policy makers are interested in many aspects of the mathematical shape of revenue proposals. Generally speaking, most policy makers are primarily interested in the mean of the proposed taxation regime. Some economic literature has allowed for debate about the variance of revenue in a political context. However, shape determinants from higher order mathematical moments (such as skewness and kurtosis) have generally been left out of the debate.

¹ Namely, spending hawks seeking increased revenue and more balanced budgets and anti-free market capitalists believing that financial markets are inherently broken
Chapter 3 directly asserts that including skewness and kurtosis is useful to policy makers when considering between two taxation regimes. The skewness will provide an indication as to the viability of the estimated mean. Skewness numbers farther from zero indicate a high likelihood that the estimated revenue mean is deceptive for any given fiscal year. Kurtosis provides a relative indication of how frequently extreme revenue surplus or shortfall years are expected to occur. Tax regimes with high levels of excess kurtosis will require intervention from policy makers much more frequently than tax regimes with lower levels. Furthermore, these two measures taken together provide an empirical measure of how dependent a government may find itself upon financial markets for revenue smoothing between one fiscal policy year and another.\(^2\)

Taxation clearly matters to both policy makers and to the electorate. While policy makers are interested in being able to keep deficits low and increase spending on popular spending programmes, electorates which pay the bill are interested in keeping their existing service levels (and possibly increasing government services) while minimising the tax burden. Because of the dual nature of the interest in the electorate, political forecasting models which ignore a growing budget expense seem to be doing so needlessly.

Chapter 4 investigates directly if election forecasting models which ignore war time conditions have higher or lower predictive power than those which include war time costs directly. Generally, there are three approaches to capturing war costs: dummy variables, time trends, and direct war costs.

Most models capture war time simply with the use of a dummy variable. This variable changes its value during wartime and reverts during peacetime. This variable is not commonly interacted

\(^2\) While in normal times the idea of smoothing may be ignored under the assumption of well-functioning financial markets, recent events from the failure of Lehman Brothers in the United States to the sovereign debt crisis in Europe raises the possibility that governments may find themselves in a position where this assumption no longer holds true. The common reaction is precautionary savings. However, this precautionary saving requires a fiscal discipline which many in government have not shown a willingness to do in the face of elections and an acknowledgement of the problem a priori. Most governments seem caught off-guard when the financial markets no longer accept bonds at terms governments find acceptable.
with other economic variables such as GDP or inflation. As a result, the dummy variable simply changes the base level for which one party can expect support over another party.

Models which include a time trend appear superior over models which only use a dummy variable. This is reasonable on two accounts. First, one would expect the public to see a war differently the longer it continues. Secondly, one may rightly expect the costs of a war effort to be much higher in years well after the initial effort by appealing to increasing marginal costs. The research in chapter 4 found that time trend models perform in a superior manner to the dummy variable models.

Increasing war cost models have the implicit assumption that the effect of war costs upon voters is linearly structured. This may or may not be true. An essential war going badly for 8 years may have a different effect than a war generally going well for 8 years. As a result, chapter 4 attempts to see if directly capturing war costs leads to any significant improvement over the use of dummy variables and the time trend. While there was an improvement, this improvement was quite marginal over the time trend method for the war and body politic examined in chapter 4.
Chapter 2: Financial Transactions Tax: Panacea, Threat, or Damp Squib?

2.1. Introduction

Against the background of growing political demands for regulation to curb financial sector excesses, or (to use an out-of-fashion phrase) overtrading, this paper takes a new look at some old and recurrent proposals to tax finance on a much larger scale, especially by taxing transaction flows.

A confluence of events over the past year or so promise to bring the taxation of financial intermediation centre stage.

- First, the severe failures of finance that became evident since 2007, and the perception that uncontrolled and lightly-taxed expansion of financial transactions and financial intermediation are to blame has led to a view that regulation and taxation that have the effect of constraining excesses in finance would be socially desirable.

- Second, growing fiscal deficits in many advanced economies is heightening the search for revenue-raising mechanisms with limited adverse effects on the economy. Because financial taxes are paid in the first instance by large institutions, they can seem relatively painless, at least from a political point of view. This is especially true when one considers the dollar size of potential tax bases—such as total banking assets, or the flow of financial transactions—and hence the apparent possibility of generating a large volume of revenue from a low rate of tax.

- Third, growing concerns about tax havens have increased the international political will to work effectively to control and limit flows between advanced economies and tax havens designed for tax evasion, money laundering and other illegal purposes. This will, if made
effective, could have the side-benefit of making it easier to limit the international leakage of the base of any taxes applied to financial intermediaries.

Attracting adherents both on the political right and the left, the idea of placing significant reliance on the taxation of finance, in particular through the taxation of financial transactions, has a long history. Already, there has been a ramping-up of interest in this area.\(^3\)

Anticipating this growing interest, the present paper reviews the main issues that arise in considering new proposals for a broad increase in financial sector taxation, especially those centring around the taxation of financial transactions. Transactions taxes have always attracted reformers especially because of their apparently large base (seeming to offer sizable revenue with low deadweight costs) and an apparent simplicity and transparency in their design.

Proposals of this type vary considerably as to the range of transactions that would be made subject to the tax. A relatively sharp distinction is customarily made between a securities transactions tax (STT), a currency transactions tax (CTT), and a bank debit tax.

In his *General Theory*, Keynes (1936) proposed an STT to reduce destabilizing speculation in equities; Tobin’s similar CTT (1978) had the goal of reducing destabilizing currency speculation. Bank debit taxes have been employed in several countries, especially in Latin America.

The explosive growth in financial derivative transactions over the past quarter century introduces a range of further possibilities. One proposal, which we will look at in greater depth, is for a comprehensive tax on all financial transactions to replace all taxes.

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\(^3\) That interest is already growing in this area is exemplified by policy advocacy work such as Baker, Dean. "The Benefits of a Financial Transactions Tax." (2008) and the commentary on this in the New York Times, the Guardian and in blogs; Pisek’s (2008) presentation to the European Parliament., as well as websites such as http://www.apptax.com/ (Edgar Feige’s scheme) and http://www.nationaldebittax.com/ (Leonard Crisp’s scheme). Financial transactions taxes are also on the agenda of the UN’s Leading Group on Innovative Financing for Development, as discussed below.
We will argue that attempts to raise a significant percentage of GDP in revenue from a broad-based financial transactions tax are likely to fail both by raising much less revenue than expected and by generating far-reaching changes in economic behaviour. Although the side-effects would include a sizable restructuring of financial sector activity, this would not occur in ways corrective of the particular forms of financial overtrading that were most conspicuous in contributing to the crisis.

We begin by looking at the three distinct goals currently driving interest in this type of tax reform: anti-avoidance, efficiency and revenue, before proceeding to consideration of the ideal tax—one which both improves economic efficiency by correcting market failures and negative externalities and also generates a sizable flow of revenue.

2.2. Anti-Avoidance, Efficiency and Revenue Goals

2.2.1 Curbs on tax havens will increase the scope for taxation of finance

When funds can easily flow across frontiers, financial assets and their yields cannot easily be taxed. This can usefully restrain onerous and poorly-designed taxation of finance. But it can also result in distortions as, for example, when unremunerated reserve requirements are retained for local currency deposits, but not for foreign currency deposits—a differential which can have the unintended adverse side-effect of promoting deposit dollarization, likely engendering problems of stability. Time and again, one hears that taxes on the financial sector cannot be applied because funds will migrate (cf. Helmut Reisen, 2002).

But now, coordinated worldwide action to restrict the movement of financial flows to tax havens has emerged on the policy agenda. Heightened international official concern about the role of tax havens in eroding the tax base of both advanced and developing economies is
evident not least from the communiqués of recent G-20 summits. This is not a new concern (Christian Aid, 2008), and there is little indication that tax havens have had a significant effect in contributing to the financial crisis (Geoffrey Loomer and Giorgia Maffini, 2009). But the increased awareness of it is indisputable. Here we take this heightened agenda as a given and consider only its broad implications for the financial sector. Regardless of the motivation of such restrictions, if effective, they open to policymakers the possibility of using a wide range of taxes hitherto seen as ineffective and of increasing taxes on others. Good or bad, this would change the landscape of financial taxation.

For, if there is an effective crackdown on tax havens, this could have the effect of closing the bolt-holes that allow tax bases to migrate away from high tax jurisdictions. It is important to recognize that low tax rates are not in themselves a sufficient criterion for designation as a tax haven; exchange of information and transparency issues are also relevant. Nevertheless, the removal of these bolt-holes would have the effect of reducing the elasticity of any tax base that was liable to migrate to a tax haven if subjected to a high rate of tax. This applies to many forms of tax base, but especially to the highly mobile tax bases of the financial sector. With the lower elasticity, the potential revenue would increase, and the distortions on product supply and employment from taxing these bases would decline.

In short, an effective crackdown on tax avoidance would make it easier to introduce new or higher taxes without fear that the tax base will migrate away. Taxes which, because of that fear, have been infeasible to date would become potentially viable.

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In addition, offshore financial sectors that are currently dependent on offering a low tax environment would shrink, with specific consequences for the host economies. This is potentially serious for a small number of very small countries (and territories – many of the tax havens of the developing world, including the largest, the Cayman Islands, are in fact dependencies of OECD countries such as the UK).

2.2.2 Efficiency:

(i) Avoiding tax-induced distortions and correcting market failure

Almost all taxes alter some relative price and hence change equilibrium behaviour. Where markets are already efficient, efficient tax design seeks to minimise distorting effects of this type; where there is market failure, the impact of an efficient tax will be to move relative prices in the direction of a socially efficient outcome.

It is well-understood that the financial sector is highly responsive to the design of tax rules. Product design and innovation and location decisions can be heavily dependent on their tax treatment. The effects can be large and rapid. Taking account of efficiency effects is therefore even more important for financial sector taxation than for taxation of other sectors: greater danger of imposing costs, greater opportunity for correcting market failure.

Another feature of the financial system is its great ability to adapt and even make profits from distortions including tax distortions. Sometimes the imposition of a new tax rule generates a business opportunity for financial firms who may then become lobbyists for its retention even if the tax is having a damaging and distorting effect on the rest of the economy. This means that financial sector lobbyists are not a reliable source of information about where financial taxes are creating problems for society. More generally, the interests of the financial sector cannot be considered as paramount in determining optimal financial sector tax design.
Recognizing this, but perhaps underestimating the role of a healthy financial system in underpinning sustained economic growth, there was a tendency until fairly recently for the financial sector in different countries to be subjected to distorting taxes and quasi-taxes such as unremunerated reserve requirements, transactions taxes, taxes on gross interest receipts or payments, prohibition on the deduction of incurred but not realized loan losses\(^5\) and the like. At that stage, economists concentrated most of their financial sector taxation to advice to developing country policymakers on the need to remove the most distorting taxes.

Subsequently, two factors made national authorities more alert to the distortions that financial sector taxes could introduce into the economy. The first of these factors was growing awareness of the systemic importance of the financial sector in underpinning and accelerating economic growth: that implied that distortions to this sector could be especially damaging to economic welfare on a broad front. The second factor was the rapid increase in financial globalization which had the effect of increasing the elasticity of financial sector responses to any given tax, as financial tax bases simply migrated abroad.

Now the pendulum has swung beyond its midpoint. No longer satisfied with merely achieving tax neutrality, policymakers are again paying attention to the corrective potential of taxation. Like the perceived need for ramped-up regulation, this responds to the conspicuous failures and excesses exposed by the financial crisis.

Can the design of tax policy be used actively to realign financial sector activity with social welfare of the economy as a whole, for example, reducing systemic prudential risks? After all, if finance responds powerfully to price and rate of return incentives, the job of the regulator is

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\(^5\) Until recently, the dominant interpretation of IFRS has been that such losses could not even be reported in a bank’s accounts, let alone deducted from revenue before the calculation of taxable income.
eased if tax-inclusive prices and returns faced by financial firms correspond to the social costs and benefits of the relevant activities and products.\(^6\)

(ii) Transactions taxes, market volatility and mispricing

In years gone by, the main focus for use of corrective taxation in the financial sector had been excessive asset price and exchange rate volatility, and possible sustained “mispricing” of financial assets (or deviations from fundamental equilibrium prices) resulting from short-term speculative flows.\(^7\)

Keynes, focusing on mispricing in securities markets, argued for an STT on these grounds. This idea has been subjected to a variety of empirical tests which do indeed suggest, not surprisingly, that an STT has consequences, not least through lowering the price of assets which by their nature are likely to be traded frequently (S. Bond et al., 2004). But it remains quite unclear from this literature whether an STT would increase or decrease volatility. After all, speculation in a liquid market can be stabilising, and this turns out to be possible in practice as well as in theory.

The original Tobin tax (CTT) proposal was to put “sand in the wheels of finance” to inhibit speculative cross border flows in foreign exchange markets, again with the aim of reducing volatility and mispricing. Here again it is unclear whether such a tax would indeed be stabilising.

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\(^6\) In parallel to new thinking on tax policy, there has been much current discussion of the incentive effects of other aspects of government financial policy. For instance, under asymmetric information (moral hazard and adverse selection), the incentive effects of alternative intervention and bail-out strategies by the authorities can matter a lot. Good design of such strategies exploits these incentive effects to achieve an improved overall outcome as financial firms adjust their behaviour to take account of the altered probability of being bailed-out. Tax policy can be seen as aligning financial firm behaviour in dimensions that are less sensitive to strategic failure behaviour, but instead relate to the more predictable aspects of financial firms’ activities.

\(^7\) Formal theoretical models such as that of Westerhoff, Frank H. and Dieci, Roberto. "The Effectiveness of Keynes-Tobin Transaction Taxes When Heterogeneous Agents Can Trade in Different Markets: A Behavioral Finance Approach." *Journal of Economic Dynamics and Control*, 2006, 30(2), pp. 293-322. confirm that there are theoretical reasons to believe that such a tax could be stabilising if introduced in all relevant markets (no tax havens).
Close analysis of the minute-by-minute microstructure of the foreign exchange market reveals that most foreign exchange transactions (spot and forward) have nothing to do with speculation, but are instead undertaken to hedge risk and ensure liquidity.\(^8\) (The same would be true of interest rate swaps.)

This observation, which can probably be extrapolated to markets whose microstructure is less well understood, provides a very strong additional reason why transactions taxes might not stabilise markets. As will be mentioned later, this alternative perspective on the motivation for the bulk of transactions in securities markets has implications for revenue also.

(iii) Transactions taxes and complex derivatives

Following the collapse of the mortgage-backed securities market and its knock-on effects on the rest of World’s financial and economic systems, asset price volatility has been somewhat overshadowed as a target for policy by comparison with imprudent or reckless lending and especially the use of over-complex financial derivatives as a means of apparently reducing risk while actually increasing it. Regulation of contract types and agent reward structures has been the focus of much policy attention here, but a tax solution – even if partial – could also be considered. The question is, what workable tax rule could be brought into play as a useful complement to regulation, by adapting incentive structures so as to ensure that they better align to social welfare in this area, and hence act as corrective taxes, reducing the adverse impact of market failures?

\(^8\) Evidence on this point from the literature on market microstructure is provided by Mende and Menkhoff (2003). That this consideration undermines the “corrective tax” case for a financial transactions tax has been acknowledged by radical economists such as Grahl, John and Lysandrou, Photis. “Sand in the Wheels or Spanner in the Works? The Tobin Tax and Global Finance.” *Cambridge Journal of Economics,* 2003, 27(4), pp. 597-621. On the other hand, Galati, Gabriele and Melvin., Michael. ”Why Has Fx Trading Surged? Explaining the 2004 Triennial Survey.” BIS Quarterly Review, 2004. is representative of observers who continue to assign medium-term speculative and hedging motives to the bulk of foreign exchange market transactions.
2.2.3 Revenue

The financial sector has long been a reliable revenue source for governments – even though from time-to-time (as at present) bank failure events have triggered large fiscal outlays to limit depositor losses and protect the smooth functioning of the payments system. Revenue raising has been the objective of most of the financial transactions taxes that have been brought into effect, especially the bank debit taxes of Latin America.

(2.2.3.i) Currency Transaction Taxes

As mentioned above, the Tobin CTT tax was originally conceived of as a corrective tax, but it has increasingly been seen as a suitable revenue source for development assistance. Because of the concentration of foreign exchange trading in just a few international financial centres (according to the latest BIS survey, fully three-quarters of traditional foreign exchange market transactions are conducted in just 6 centres: UK, US, Switzerland, Japan, Singapore and Hong Kong), proponents of the Tobin tax as a revenue source have seen it chiefly as being international in its revenue goals, and not suitable as a source of national revenue (Paul Bernd Spahn, 2002). Of course, another problem with getting national revenue from the tax is the fact that unilateral tax increases on foreign exchange dealings are likely to result in considerable base migration.

Despite earlier proposals for a CTT tax of as high as 1 per cent, a consensus had emerged in the literature by the mid-1990s that 0.1 per cent should be regarded as a ceiling on CTT rates beyond which they would reduce liquidity too much, thereby deterring international trade.

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9 The influential Leading Group on Innovative Financing for Development (http://www.leadinggroup.org), which was founded "after the Paris Ministerial Conference on Innovative Development Financing Mechanisms in 2006" and comprises 55 countries, together with IFIs (including the World Bank) and NGOs, has been looking at the CTT, and notes that it would generate "stable and predictable flows." France and Belgium have already committed to the adoption of a CTT provided all of the other member states of the EU also adopt one.
Nissanke examines the revenue potential of rates in the region 0.01% to 0.02%, which she believes would reduce transaction volumes only modestly and generate worldwide annual revenue in the range of USD 17-30 billion (on the basis of 2001 transactions). Interestingly, Mende and Menkhoff (2003) claim that sorting the Tobin tax proposals by their date of issue reveals that the suggested rates have become lower and lower over time. Spratt’s (2006) version of this tax has a rather comprehensive base said to be over €100 trillion covering all spot and derivative foreign exchange transactions, but he proposes a very low tax rate of just 0.005% designed to raise about €5 billion for development assistance. At this rate the tax should evidently have no or very little effect on speculative flows; it does not have a corrective objective.

(2.2.3.ii) Securities Transactions Taxes

Securities transactions taxes (STT) are now as likely to be advocated for their revenue potential as for any dampening effect on speculation. That of Schulmeister et al. (2008) is quite comprehensive for wholesale transactions, applying to spot transactions for stocks and bonds, and derivative transactions (both exchange-traded and over-the-counter --OTC). On the other hand, they consider low tax rates, ranging from 0.01% to 0.1% of the transaction value. This results in projected revenue yields of up to about 1% of GDP for Austria, France, Italy, Belgium and the Netherlands; 2% in Germany and 13% in the UK. In the latter two countries, exchange traded derivative transactions are important: elsewhere the bulk of the revenue comes from OTC transactions. Schulmeister does not appear to include cash withdrawals from the banking system as part of their base.

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10 This reflects the fact that spread in the wholesale interbank foreign exchange market are well below 0.1 per cent.
11 Spahn (2002) proposed a rate of 0.01% for a projected annual revenue of €17 billion (based on 2001 data).
More comprehensive financial transactions taxes, such as Feige’s (2000) APT (discussed further below) have even larger ambition, including, in Feige’s case, the replacement of all existing sources of tax revenue.\textsuperscript{12}

\subsection*{(2.2.3.iii) Bank debit taxes}

The transactions taxes that have actually generated the biggest revenues in practice have had a much more limited base. The most important of these have been in Latin America, where they have generally been introduced for revenue purposes. Their history is somewhat chequered (Isaias Coelho et al., 2001); (Andrei Kirilenko and Victoria Summers, 2003); (Jorge Baca-Campodonico et al., 2006). Revenue from the Latin American bank debit taxes has varied widely, but has typically been of the order of 1 per cent of GDP. The highest revenue achieved in relative terms was the 3.4\% of GDP reached in Ecuador’s short-lived ICC (1999-2000), was, however, creditable against income tax for which it had been intended as a replacement.\textsuperscript{13}

The biggest bank debit tax in absolute terms, Brazil’s unpopular CPMF (“check tax”),\textsuperscript{14} dating back to 1993, had levied a charge 0.38\% (originally 0.25\%) on all withdrawals from checking accounts and raised as much as USD 10 billion per annum or about 4\% of total government revenue. This tax expired in December 2007 (though another transactions tax IOF was retained, albeit subject to modifications during 2008).\textsuperscript{15}

\textsuperscript{12} Crisp proposes a \textfrac{1}{500} rate on USD 1,000 trillion of bank payments (said to apply to the US in 2002), for a revenue of $5 trillion comfortably in excess of twice current tax revenues.

\textsuperscript{13} Analysing the transactions taxes of Argentina, Brazil, Colombia, Ecuador, Peru, and Venezuela, Baca-Campodónico et al. (2006) find that revenue decreases over time and that the rate of decrease is a direct function of the rate of the levy.

\textsuperscript{14} CPMF stands for Contribuição Provisória sobre Movimentação ou Transmissão de Valores e de Créditos e Direitos de Natureza Financeira. For a critique of the effects of this tax see Albuquerque, P. H. “Bad Taxation: Disintermediation and Illiquidity in a Bank Account Debits Tax Model.” \textit{International Tax and Public Finance}, 2006, 13(5), pp. 601-24..

\textsuperscript{15} Older forms of revenue tax such as the stamp duty on cheques in the US and the UK and the Bank Account Debit tax in Australia were not applied at proportional rates. (For example, the Australian tax was $0.15 on amounts up to $100, but only $2 on any amount of $10,000 or more). The US and UK stamp taxes on checks were at a fixed amount per check, regardless of the face value. Lastrapes, William D. and Selgin, George. “The Check Tax: Fiscal Folly and the Great Monetary Contraction.” \textit{The Journal of Economic History},
The much higher tax rate of 1\(\frac{1}{2}\)% was imposed by Venezuela in its bank debits tax of 2007, but was limited to debits on behalf of enterprises (with individuals exempt) (Salon, 2007).

(Patrick R. Colabella and Richard J. Coppinger, 1996) were more ambitious for the revenue of their WXT bank debit tax. Its base was to be limited to non-debt generating withdrawals from banks, but they proposed the rather implausibly high rate of tax of 5% on this base, easily sufficient in their view to compensate for the abolition of all other taxes.

Interestingly, not all bank debit taxes have had a revenue purpose. The Indian Banking Cash Transactions Tax (BCTT) of 2005-9, imposed at a rate of 0.1% on cash withdrawals from banks, was said by the Finance Minister to have "served a very useful purpose in enlarging the information system of the Income Tax Department." Its withdrawal was attributed to the relevant information being available through "other instruments introduced in the last few years"; it had yielded little more than 0.01% of GDP.

### 2.2.4 Win-win

One of the great attractions of any corrective tax is the potential to generate a "double-dividend": reducing the social bad and generating revenue. This has long been a goal of tax reformers whether focused on improving society’s health through taxes on tobacco or improving the environment and limiting global climate change with a carbon tax. To an extent, the double-dividend may be elusive not least because a tax on a social bad that eliminates the bad has likely^{16} destroyed its own base.

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1997, 57(4), pp. 859-78. examine the US check tax during the early to mid 1930s, concluding that it led to "about a 15 per cent increase in the currency-demand deposit ratio, and about a 12 per cent decline in the M1 money stock." (pp. 859) Importantly for the present discussion, transaction size substantively increased while the number of transactions significantly decreased (p.868 and footnote 43). Revenues were only about half of what had been hoped for (see their footnote 39). As with the annual charge of €40 on a credit or debit card applied by Ireland, taxes that are not proportional to the value of transactions are inherently limited in their revenue potential and need not be considered further here.

^{16} Though not necessarily, if non-linear tax schedules are permitted.
That the double-dividend is also a goal of current financial taxation reformers is well-evidenced in their writings.

While the CTT was originally proposed by Tobin as a means of dampening destabilising currency speculation, it received renewed interest from the revenue perspective in the 1990s reflecting, in Nissanke’s view, not only “growing recognition that there is an urgent need for creating a new international financial architecture governing cross-border capital flows in the face of the repeated severe financial crises”, but also “its potential to serve as an important source of finance for ‘global public goods’”.

However, numerous authors point out that speculative attacks on a currency peg might not be deterred by a small CTT rate suitable for raising steady revenue. In the words of (Alexander Mende and Lukas Menkhoff, 2003), “a low Tobin tax will not curb speculation, and a high rate will significantly reduce liquidity.”

For STTs also, reformers see a double-dividend. Thus Baker (2008) remarks:

A modest financial transactions tax could easily raise an amount equal to 1% of GDP, or $150bn a year at present. This is real money – enough to finance a 10% across-the-board reduction in the income tax. A tax of 0.25% on a stock trade or 0.02% on the purchase of credit default swap will have no measurable impact on productive financial transactions, but will likely put a serious dent in speculative activity.

As mentioned above, the capacity of the tax to deal with the particular social bad being targeted in that quotation is somewhat questionable: a securities transactions tax may actually

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17 Cf. Nissanke (2004), Spahn (2002). The latter advocates adoption of a time-varying CTT rate could be adopted according to which the tax rate would jump (through a type of trip-wire mechanism) when the currency regime was under pressure.
worsen price misalignments and volatility. However, the objective of a double dividend has obvious attraction.

Sharp falls in the stock prices of banks and other vulnerable firms during 2008 prompted a critique of short-selling in the equity market and price spikes in the credit default swap market, to the point where it was suggested that manipulation of these markets had contributed to the bankruptcy of some firms.

2.3. Could a transactions tax have stemmed excesses leading to the recent crisis?

However, volatile prices and short-term speculation have taken a back seat in current discussions about financial market failure, being replaced by concerns about (i) the valuation and rating of structured financial products, especially collateralised debt obligations (CDOs) constructed directly or indirectly from portfolios of mortgage-backed loans (Joshua Coval et al., 2009), and (ii) the misallocation of risk, and possible market manipulations associated with credit default swaps (CDS).

CDOs

Interestingly, the failures in this structured finance market have little to do with frequent trading, or with complex sequences of transactions such as would be discouraged by a transactions tax. The complexity is largely in the combination of and reallocation of contractual claims, rather in the payments themselves. Even though derivatives transactions represent the bulk of financial transactions, a comprehensive financial transactions tax would have no appreciable impact on the construction and sale of mortgage-backed securities and their derivatives. These are typically buy-to-hold securities and certainly are not sufficiently liquid to be repeatedly traded on a minute-to-minute basis as are foreign exchange and major financial indices. The major problem with these assets relates to the fact that so many of them “about 60
per cent of all global rated structured products were AAA-rated in contrast to less than 1 per
cent of corporate issues”, and these ratings were highly sensitive to assumptions notably about
likely default correlations of the underlying assets and about the likely default rates on
underlying securities, both of which were grossly underestimated by the rating agencies (Joshua
Coval, Jakub Jurek and Erik Stafford, 2009).

With a high proportion of structured finance products that had initially been rated AAA
having been downgraded to junk status, investors lost confidence in this market. By late 2008,
the structured finance market had virtually closed down, with almost no new issues, and
specialists did not expect it to reopen for years. Evidently, then, no tax could have a further
corrective effect in discouraging issues.

Nor was there ever much revenue potential in these securities. Quarterly issuance of them
peaked in 2006-7 at around USD 100 billion per quarter. As primarily buy-and-hold securities,
the transactions tax revenue from the primary issue would be a high fraction of the total
lifetime tax revenue from that issue – a mere USD 10 million for the peak quarter (assuming a
tax rate of 0.01 per cent).

**CDS**

The relatively sudden emergence of the credit default swap market starting in the late 1990s
has been identified as a significant contributor to the growing distortions of the credit market
during the following decade (Gillian Tett, 2009). By 2008, the gross amount of debt insured
through CDS was thought to exceed USD 60 trillion, though many of the contracts were back-
to-back and resulted in negligible net risk. The net amount of CDS-insured debt may not have

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18 Transactions data on CDOs is not collected by the BIS.
19 The BIS half-yearly estimate of the nominal value of outstanding Credit derivatives (most of them CDS)
peaked at USD 58 trillion at end-December 2007. At that date, the gross market value of the contracts was
USD 2 trillion, a figure which jumped to USD 5 trillion by the end of 2008 because of the movements in premia
and hence in the replacement values of each of the outstanding positions.
exceeded USD 15 trillion. These amounts have subsequently declined. Even on this net amount, the flow of premia was only a fraction of the sums insured (especially considering that most of the debt insured was highly rated. Indeed, the first CDS contracts entailed annual premia of just 0.02 per cent of the nominal amount insured. Riskier debt of course carries a much higher premium. Even on the sovereign debt of some European Union countries, CDS premia have approached 400 basis points (4 per cent) at times during the recent crisis.

The critique of CDS as a destabilising force is two-fold. First, it is argued that these contracts served to transfer risk from those who wished to shed not to those able to absorb it, but to those who didn’t understand it – or alternatively to those who did understand it as a tail risk which would be passed to the taxpayer (as indeed it was in the case of the failed insurance company AIG). This refers mainly to the primary market and not to repeated trading in the secondary market. Second, it is argued that this market can be manipulated because of the thinness of the secondary market\(^\text{20}\) in CDS or because the volume of insurance bought on particular names greatly exceeds the volume of their debt outstanding. By operating in both the primary market for a company’s debt and in the CDS market, a manipulative investor could make money by driving the company into default. This refers mainly to trading in the secondary market, though not necessarily repeated trading.

This double critique of CDS as destabilising the financial system is not unproblematic. Clearly these instruments could also be used – and were – as a way of spreading and distributing risk in a stabilising way also. Arguably, if subjected to certain administrative controls and traded only in well-organised exchanges, these instruments could be a strong force for stability. However, even if one granted the premise that CDS have been destabilising and need to be discouraged, it

\(^{20}\) Transactions volume on CDS is not collected by the BIS.
would be hard to argue that a transactions tax applied at a low rate would be effective in reducing the damage.

After all, a transactions tax applied only to the actual premiums paid would of course have no effect on secondary market trading, and indeed a standard transactions tax applied to CDS premium payments would have negligible effects both in revenue and market behaviour.\textsuperscript{21} Applying a transactions tax to the nominal volume of debt insured would be more promising from the revenue point of view but, at the much-less-than-one-per-cent levels envisaged for a standard transactions tax, would not have much effect on the two efficiency problems mentioned for CDS – wrong ultimate holder and market manipulation.

**Correcting agent incentives**

There is of course a broader critique of finance which rightly points the finger at distorted incentive structures for agents. This would include both traders and other operational officers of financial intermediaries and of CEOs and other senior staff who should be supervising operations and ensuring that the institution is set on a prudent course. Tax structures could be used to alter the incentive profile of senior staff, but so far attempts to design such structures have not been successful. For example, the cap since 1993 of USD 1 million on tax deductibility (for the firm) of senior directors’ remuneration seems to have had little effect (Nancy L. Rose and Catherine Wolfram, 2002). Clearly, while transactions taxes could have a significant effect on the profits of various lines of business that could indirectly affect the incentive structure facing individual traders and CEOs, they could not easily be fine-tuned to achieve the desired re-alignment of the private incentives of these individuals with public goals.

\textsuperscript{21} If the average premium on USD 60 trillion is 50 basis points, a 0.01 per cent transactions tax would probably not discourage many of these transactions, but would generate only USD 50 million in annual revenue.
These considerations cast doubt on the potential for achieving a double-dividend coming from a financial transactions tax that would somehow discourage the accumulation of toxic debt, while still yielding sizable revenue.

2.4. *Some statistics on the starting base of a comprehensive transactions tax*

Data on financial transactions (as distinct from financial stocks) have been growing rapidly in the past decade or so, but are still rather patchy.

**Payments transactions**

Payments data, covering both the number and the aggregate value of payments is available on an annual basis for some 13 countries in the so-called CPSS Red Book (2009). Data is shown separately for different payments methods employed by nonbanks, such as credits, direct debits, cheques, e-money payment transactions, and card transactions of different types. Interbank transactions through the major automated clearing systems are also shown.

In 2007, aggregate payments of nonbanks reported in the Red Book came to USD 479 trillion, with USD 2459 trillion in interbank payments. Adding these two together gives us a round figure of USD 3000 trillion in payments. Since this is almost one hundred times the aggregate GDP of the countries included in the Red Book, it becomes clear why it could seem superficially plausible that a very small tax rate – a fraction of one per cent – might generate almost all the revenue any government could need.

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22 The first cross-country publication including statistics on payments systems covered the Group of 10 industrial countries and Switzerland and referred to 1977-78. Since then, an annual survey, now conducted under the auspices of the Committee on Payment and Settlement Systems, has expanded and deepened its coverage but added only two additional countries (Hong Kong and Singapore), as well as the Euro zone, to the original 11.

23 The ratio is actually 89 for 2007, and varies between 75 and 89 in the period 2000-2007.
Interestingly, though, there is a sizable variation across countries in the ratio of payments transactions to GDP, varying — for the most recent year available, i.e. 2007, from 36 times in Italy and 55 times in Sweden (2006) to 129 in the US and 147 in Hong Kong (even though the Hong Kong data only includes interbank transactions.

This is not merely a function of whether or not the country hosts a global financial centre: Germany and France also have multiples in excess of 100, while Singapore is the fourth smallest country.

The wide variation suggests that payments transactions may not be stable in response to influences such as the imposition of a transactions tax. The volatility over time in the ratio is also sizable in some countries (Figures 2, 3; Tables 1, 3), with a coefficient of variation as high as 40 per cent in Switzerland — though it is likely that much of that is attributable to some institutional or definitional changes.

Turning to non-interbank payments transactions, the aggregate value ratio to GDP for the reporting countries is much lower at under 15. Furthermore, the figure for the UK — 77 — is a wide outlier, certainly reflecting its status as a financial centre and likely especially reflecting London’s dominant role in the foreign exchange market. Removing this outlier reduced the aggregate value ratio to GDP to under 9. Suddenly, one realises that a bank debit tax which does not apply to interbank transactions and is applied at a small rate simply cannot raise current levels of revenue. Even if transactions were completely insensitive to the rate of tax, the required minimum tax rate to replace all other taxes and cover government expenditure jumps from an average of less than 0.5% to over 3% (Table 2).

These points are further elaborated in Appendix A.

Derivatives transactions
What of other financial transactions? Spot foreign exchange transactions worldwide in 2007 can be estimated at about USD 250 trillion, based on grossing up the daily average figures in the BIS triennial survey for that year. Presumably, these spot foreign exchange transactions are already counted in the payments transactions data of the CPSS. That would also be true of outright securities purchases and sales.

But not all of the large and growing volume of derivative transactions is included in payments transactions as to their full national value, as settlement for these is generally on some form of net basis. If the scope of general transactions was extended to derivatives also, and applied to their full nominal value, this would expand the base of the tax considerably.

Data on over-the-counter transactions in foreign exchange and interest rate derivatives are collected on a sample basis for one month every three years from 54 reporting countries (Bank for International Settlements, 2007). More comprehensive data on exchange-traded derivative is also collected from the main organised exchanges (Bank for International Settlements, 2009b, Table 23). Finally every six months the (Bank for International Settlements, 2009a) collects figures on the outstanding stock of (but not the transactions in) OTC derivatives, including credit and equity-related derivatives not counted in the triennial survey.

An overall summary of the transactions data is as follows: Total turnover (nominal value) of futures and options derivatives quoted on organised exchanges came to USD 2214 trillion in 2008. (About two thirds were interest rate futures and rather more than a quarter were interest rate options.) Estimated turnover in OTC exchange rate and interest rate derivatives came to USD 1250 trillion, of which two-thirds related to exchange rate contracts and the remainder to
interest rate contracts. Thus in broad terms, the total turnover of derivatives is of the same order of magnitude as payments transactions, if slightly smaller. Unfortunately, we have no full breakdown of how many of these transactions relate to non-financial firms.

Extending the scope of a general transactions tax from payments transactions to transactions involving derivatives and applied to the total nominal value of the objects of those derivatives about doubles the initial base of the tax.

As discussed in the next section, the elasticity of the base of tax on derivatives to the tax rate may, however, be much higher.

2.5. Impact on behaviour and on the base

The base of a transactions tax is likely to be very elastic in response to a tax. The top of the Laffer curve might be reached at a surprisingly low level.

(Alexander Mende and Lukas Menkhoff, 2003) have argued rather convincingly that even a very small tax would dramatically alter the way in which wholesale participants in the foreign exchange market operate. Drawing on a specialised literature which studies the microstructure of the foreign exchange market (cf. Lyons, 2001), they point out that the strategy of the typical bank participant involves buying and selling foreign exchange as if it were a hot potato. Their goal in this is to minimise the risk that they are uninformed about a change in prospects. For that reason they will not want to accumulate a significant stock. They report as an example a bank with a median open position of about USD 2 million, which nevertheless trades about USD 50 million per day. It is inconceivable that a strategy necessitating such frequent trading would

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24 In contrast, the stock of OTC exchange rate related derivatives is only one-eighth that of interest rate derivatives. The exchange rate derivatives have a much higher ratio of turnover to end-period stock, probably reflecting in part their very short median maturity and the microstructure of this market discussed above.
survive even a very small transactions tax. Instead, banks would deal in the market in some entirely different way.

A similar argument could apply also to the microstructure of trading in the interest rate derivatives market. Take interest rate swaps, which account for over two-thirds of the OTC turnover in interest-rate related derivatives. Although invented to allow corporate borrowers to lock in a long-term interest rate even though they had borrowed at floating rates, use of interest rate swaps has “since grown into one of the most useful and liquid derivatives markets in the world...used across the fixed-income markets to manage risks, speculate, manage duration and lock in interest rates (Pimco, 2008).” Indeed, swap rates are now in some respects a more important indicator of bond market conditions than Treasury Bill rates.

It seems impossible in this context to fully decompose the multiple uses of such derivatives in hedging and assuming risk. We can conjecture that such a multifunction instrument traded with such low transactions costs will have a very high elasticity of demand with respect to these costs.

This view is reinforced by a reading of the theoretical and empirical literature on securities market microstructure in general. This literature which emphasises the way in which the pattern of price quotations and trading can be influenced by modest differences in flow of information and the organization of the market (for example in some markets informed traders place quantity orders, whereas in others the wholesale liquidity providers post prices at which they are prepared to trade).

Formal models illustrate how, when new information arrives, whether from the flow of orders received by specialist traders, or otherwise, the required adjustments in the optimal portfolio (of any class of assets) both of informed and uninformed investors can be very
considerable (cf. O'Hara, 2003). However, different assumptions about the way in which information arrives in the market, how it is distributed and the way in which the market is organised, have very different implications for the volume of trading and how it varies. There can also be multiple equilibria with higher volumes of trading associated with lower spreads and higher social welfare (see for example (Bruno Biais et al., 2005, pp.225-227). This could explain the way which trading volume clusters at certain times of the day.

If the continuous flow of information in the market necessitates repeated readjustments of dealer inventory and portfolio rebalancing, the imposition of a transactions tax could, for example, lead to market arrangements shifting from continuous trading to a periodic “call”. This might not cause much welfare loss, but substantially lower revenue from the tax.

Even setting aside the high end financial market transactions, the distorting effect of a transactions tax can be significant even if it referred directly only to real sector transactions. Other consequences – for the way in which wages are paid: cash or credit, or in the degree to which suitcases of cash are carried physically across borders – could also have damaging side-effects.

Ignoring the effects on financial intermediation, (Rodrigo Suescun, 2004) models the cascading of a transactions tax through the production process and “disregards its effect on financial intermediation” and thus the resulting effects, showing that deadweight loss calculations are sensitive to the modelling of economic growth.

Although deadweight costs for a given tax rise with the square of the tax rate, it is fallacious to suppose that different taxes can be ranked as to their deadweight costs by reference only to the rates of tax. The elasticity of the tax base also matters. A low rate of tax applied to a very
elastic market could result in more costly distortions of that market than results from a higher rate of tax applied to a market with lower elasticity.

2.6. Concluding remarks

Although conditions are better than ever for the introduction of a broad-based financial transactions tax, expectations for such a tax are likely to be disappointed. Even if the bolt-hole of tax havens to which transactions might migrate is effectively shut off, neither the revenue nor the efficiency gains hoped for by big picture tax reformers are likely to materialise.

The tax base, whether measured by the total value of automated payments transactions, or broadened to include the gross nominal value of derivatives transactions is certainly large. But much of the base is strikingly concentrated in a small number of countries. This reflects the dominance of multiple technical transactions among wholesale financial market participants as they manage the risks of acting as market makers in foreign exchange and securities trading. The volume of such transactions would collapse with the imposition of even a small transactions tax undermining its potential to generate sufficient revenue to replace all other taxes as has been hoped for by some.

Market-makers would change their method of handling risk in any of a variety of ways that would sharply reduce the volume and total value of transactions. To the extent that these alternative risk management procedures left the market makers with higher risk, spreads in these markets would increase and liquidity (as measured for example by the degree to which large trades could be absorbed without moving prices) would decline.

And a transactions tax would have little effect in discouraging the activities of the credit default swap market, the market in securitised sub-prime mortgages, or other derivatives-based markets whose malfunction is thought to have contributed to the recent crisis.
Certainly not a panacea, and more likely a damp squib in terms both of revenue and of efficiency gains (and perhaps more likely to result in efficiency losses), financial transactions taxes could be a threat to fiscal stability if overoptimistically seized upon as a reason for abolishing more reliable revenue sources.
Table 2-1: Summary Statistics of various transactions - GDP ratios

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<th>Mean</th>
<th>Std. Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total payments/ GDP</td>
<td>82.2</td>
<td>42.2</td>
<td>6.5</td>
<td>220.7</td>
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<tr>
<td>Nonbank payments/ GDP</td>
<td>21.8</td>
<td>28.4</td>
<td>2.8</td>
<td>112.3</td>
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</tbody>
</table>

Table 2-1 Notes:

- Payment data from BIS
- Total payment include transactions where one party is a banking institution
- Nonbank payments include only payments where one party in the transaction is not a financial institution.
- Source: Bank for International Settlements, 2009c, Author’s Calculations
Table 2-2: Rate of transactions tax required to generate requisite revenue

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<th>Std. Dev</th>
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<th>Max</th>
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</thead>
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<tr>
<td>Tax rate all payments</td>
<td>0.46%</td>
<td>0.44%</td>
<td>0.04%</td>
<td>3.8%</td>
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<tr>
<td>Tax rate nonbank payments</td>
<td>3.24%</td>
<td>2.42%</td>
<td>0.09%</td>
<td>10.7%</td>
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</table>

Table 2-2 Notes:

- Tax rate represents the average necessary tax rate to cover all current government expenditures yielding neither long run surplus nor deficit.
- The tax rates represented above is averaged across all country-years to accommodate the international nature of a transaction tax.
- These numbers do not account for countries which would run either systemic surpluses or deficits under this policy regime. Expenditures on aggregate would be accommodated across all countries.
- Source: Bank for International Settlements, 2009c, Author’s Calculations
Table 2-3: Rate of transactions tax required to generate requisite revenue

<table>
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<td>0.26</td>
<td>0.21</td>
<td>0.24</td>
<td>0.19</td>
<td>0.21</td>
<td>0.19</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.49</td>
<td></td>
<td>0.52</td>
<td>0.50</td>
<td>0.54</td>
<td>0.50</td>
<td>0.50</td>
<td>3.79</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.04</td>
<td>0.05</td>
<td>0.04</td>
<td>0.09</td>
<td>0.10</td>
<td>0.10</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.28</td>
<td>0.28</td>
<td>0.31</td>
<td>0.31</td>
<td>0.32</td>
<td>0.34</td>
<td>0.31</td>
<td>0.34</td>
</tr>
<tr>
<td>United States</td>
<td>0.24</td>
<td>0.23</td>
<td>0.26</td>
<td>0.26</td>
<td>0.26</td>
<td>0.26</td>
<td>0.25</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Table 2-3 Notes:

- This table represents the necessary tax rate to against all transactions to generate revenue sufficient to cover all governmental expenditures in the given year.
- Indicates the wide range of tax rates necessary for each country to reach the same theoretical policy objective
- Source: Bank for International Settlements, 2009c, Author’s Calculations
Figure 2-1: Nonbank payments / GDP (2006) for all available countries

Figure 2-1 Notes:

- Shows the distribution of payments as a multiple of GDP for selected countries
- Uses only payments in which a financial institution is not a central player in the transaction
- Demonstrates the disproportional nature of nonbank payments
- Indicates an uneven tax base across countries
- Source: Bank for International Settlements, 2009c
Figure 2-2: Total payments / GDP (2006) for all available countries

Figure 2-2 Notes:

- Shows the distribution of payments as a multiple of GDP for selected countries
- Uses all transactions in the equation
- Reveals that using all payments, and not just nonbank transactions, provides a more level tax base across countries
- Source: Bank for International Settlements, 2009c
Figure 2-3: Payments as % GDP over time.

Figure 2-3 Notes:

- Represents how transactions across countries have trended over time
- Indicates the potential stability of the tax base over time
- Helps reveal any potential shocks a transaction tax may face
- Source: CPSS 2009
Appendix 2.A: Calculating lower bound for a unitary tax on automated payments

As a first step to judging the revenue potential for transaction taxes, it is instructive to estimate the ratio of government expenditure to the tax base. If the tax base were insensitive to the imposition of a tax, a transactions tax at this rate would generate enough revenue to pay for all the expenditure. In principle, then, one could imagine all other taxes being replaced by the transactions tax. Therefore we call this rate the minimum unitary transactions tax rate. It is a minimum because it does not take account of the elasticity of the tax base; unitary because it could replace all other taxes. Of course this calculation also neglects other endogenous responses of the economic system to such a drastic change in conditions. It is only a baseline indication of the scale of taxes required.

The tax rate was generated using data from the Bank for International Settlements and from the International Monetary Fund. These data were designed by taking the total level of expenditures in a country for a given year and dividing this total by a summation of nonbank payment transactions and all intermediation transactions in a country.

---

25 Although the Feige proposal intended to increase government expenditures by removing indirect subsidies, quantification of the value of indirect subsidies and estimating how many of them will be carried forward into direct subsidies contains too many assumptions to contribute anything meaningful to the debate.
26 All data was calculated in terms of Billions of US Dollars. When exchange rates were needed, the average exchange rate for the local currency to the US Dollar was used for the given year. When fiscal years do not occur within the calendar year, the numbers are assumed to be consistent for cross year comparison so that no adjustments were made. IMF data generally used rows a1 and a2 whenever possible. However, data limitations necessitated the use of c1 and c2 for some nations. Whenever both were available, preference was given to a1 and a2. Occasionally, when both were available for some years, c1 and c2 were used to provide consistency with data obtained for previous years. Data available upon request.
Figure 2-4 depicts the tax rate needed to cover current general expenditures for selected countries (the data is also shown as Table 2-4). These rates exemplify the different needs across countries. Each nation has different needs and transaction tax bases upon which to tax.

As discussed in the text, the response of interbank payments to even a small transactions tax could be very large. An alternative calculation of the minimum unitary tax excluded interbank payments and this is shown in Table 2.A1 and Figure 2.A3. As is clear, much higher figures are obtained.

---

29 Sweden was dropped due to a significant statistical outlier occurring with 2007 which was not statistically within the valid range. Hong Kong has been omitted from this analysis due to a lack of information about end-user based transactions and government expenditure / revenue.
Table 2-4: Required Rates for Unitary Payments Tax

<table>
<thead>
<tr>
<th>Type</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>All payments taxed</td>
<td>0.46%</td>
<td>0.44</td>
<td>5.03</td>
<td>37.6</td>
<td>3.8%</td>
</tr>
<tr>
<td>Nonbank payments only</td>
<td>3.24%</td>
<td>2.42</td>
<td>0.86</td>
<td>3.4</td>
<td>10.7%</td>
</tr>
</tbody>
</table>

Table 2-4 Notes:

- Extends data by providing Skewness and Kurtosis
- Demonstrates the rather relatively high levels of both Skewness and Kurtosis when all transactions are used in the payment base
- Implies the difficult paradox between the higher taxes required with nonbank payments being taxed with the instability of using all payments.
- Source: Bank for International Settlements, 2009c, Author’s Calculations
Figure 2-4: Minimum unitary tax rates: 11 countries 2000-2007: all payments taxed

Graphs by Encoding of Country

Tax Rate Needed to Cover Expenditure
(Using all transactions)

Belgium
Canada
France
Germany

Italy
Japan
Netherlands
Singapore

Switzerland
United Kingdom
United States

GDP


Figure 2-4 Notes:

- This shows the ratio of total government expenditure to the total value of payments transactions.
- If transactions were insensitive to the imposition of a tax, this would represent the rate of transactions tax required to yield enough revenue to match government expenditure.
Ideally, the requisite tax rate would be the same for all countries within the APT tax perimeter. If the tax rate was not the same, then a normally distribution of tax rates would provide a solid foundation for creating the international consensus necessary to implement the multi-national dimension of the APT tax proposal. The Skewness and Kurtosis present in the tax rate using all transactions suggest that the distribution of tax rates for each country-year is not Gaussian.

Nonparametric estimation techniques allow for a more representative depiction of the distribution of tax rate density. Because tax rates are fundamentally continuous, the distribution should be analysed as a continuous variable rather than discrete. Figure 2-5 depicts the density estimates using an Epanechnikov kernel of the tax rate distribution. This figure shows a non-trivial density building around a transaction rate of 1 per cent. This density suggests the possibility, even when using all transactions, of some form of tax-clubs forming due to differences in expenditures.
Figure 2-5: Smoothed probability density of the minimum unitary tax rates for 11 countries 2000-2007 - all payments taxed.

Figure 2-5 Notes:

- Uses Epanechnikov kernel for smoothing
- Shows the bimodal nature of tax rate needed across countries to meet expenditures
The distribution substantially changes when one looks at only end-user transactions. Figure A3 represents the distribution of tax rates for country-years relying only on the taxes generated from nonbank (end-user) transactions. This distribution represents a worst-case-scenario where all back-end transactions used for financial intermediation are removed from the tax base.\textsuperscript{30} Examination of Figure 2-6 reveals that many of the distortions in the distribution smoothed over. The mean tax rate increased and dispersion widened.

Figure 2-4, Figure 2-5, and Figure 2-6 illustrate the differences between each country in the desired tax rate. This illustrates the difficulties of deploying this proposal on a multinational scale.\textsuperscript{31} The differences in dispersion illustrate the difficulties which could arise if the financial sector changes its transaction demands based upon the tax. National governments may well find themselves facing revenue shortfalls and a need to increase the tax rate rapidly to cover any decline in revenue caused by arbitrage. The possibility of tax-clubs suggested from the nonparametric kernel density estimates should give pause to policy makers in selecting nations to include in this proposal. Further examination of the circumstances leading to Italy's higher requisite tax rate seems warranted.

\textsuperscript{30} Recall from the literature review of previous implementations of transactions taxes that many intermediation transactions were removed from the tax base.

\textsuperscript{31} As recently illustrated, recent statements from policy makers on trying to develop mechanisms addressing tax havens may provide a mechanism to prevent arbitrage caused by rate differences within the APT tax perimeter.
Figure 2-6: Smoothed probability density of the minimum unitary tax rates for 11 countries 2000-2007 – only nonbank payments taxed

Univariate Kernel Density Estimate: End-user Transactions

Tax Rate Needed To Meet Expenditures

Figure 2-6 Notes:

- Uses Epanechnikov kernel for smoothing
- Demonstrates the relatively more normal distribution of tax rates needed when using only nonbank transactions
- Indicates the much wider distribution of tax rates required to cover expenditures when using nonbank transactions
Appendix 2B: Options Market Arbitrage

One could reasonably ask, what would happen to the arbitrageurs in the options market if this tax were imposed. The arbitrageurs add significant liquidity to the system by exploiting small inefficiencies in the market to make a riskless profit. By using the options market as an example, one can extrapolate or adapt this analysis to other markets to see if similar results exist.

Adapting the put-call parity equation from the options market one finds:

Equation 2-1: Put-Call Parity

\[ C_{kt} - P_{kt} = S_0 - \frac{k}{(1 + r)^t} \]

Where:

- \( C_{kt} \) is defined as the price of the call option with a strike price of \( k \) and time until expiration of \( t \)
- \( P_{kt} \) is defined as the price of the put option with a strike \( k \) at time \( t \)
- \( S_0 \) is defined as the stock price at time zero
- \( k \) is defined as the strike price
- \( r \) is defined as the riskless rate of interest
- \( t \) is defined as the time until options expiration

The left hand side of Equation 2-1 writes a call option and buys a put option. This is a net short position. The right hand side of the equation sells the stock (take the short position) and lends the money received from the short at the prevailing risk free interest rate until the options contract expires.

With only mild algebraic manipulation one may alter the above equation into the price of the call option alone.

\[ C_{kt} - P_{kt} = S_0 - \frac{k}{(1 + r)^t} \]

---

Equation 2-2: Call Price

\[ C_{kt} = S_0 + P_{kt} - \frac{k}{(1 + r)^t} \]

Equation 2-2 equates the price of writing a call option to shorting the stock, writing a put, and lending the money. To create an arbitrage action, one must inverse the right hand side of this equation. Thus, if one wanted to write a call to sell to a prospective buyer in the options market, one would buy the stock, borrow the money, and buy the put against the stock.\(^{33}\) Thus, if one knows the strike price of the stock, the current asking price of the puts, the risk-free interest rate, and the time until expiration, one can work out the price of a call option one can offer the market for arbitrage.

The above equation leads to the possibility of an APT wedge in the offering price of the call option. Because the above equation equates returns and not tax exposure, one can clearly see that an APT leads to asymmetric tax liability. Therefore, if one knows the same information as before, what is the difference in the price of the call option that an arbitrageur is willing to offer the market?

Recall that all transactions that lead to an ingression of cash must be adjusted to the net of tax amount. Furthermore, the amount paid into the market must be adjusted to the net of tax amount requisite to achieve the same effect. Thus one finds the following:

Equation 2-3: Call Price with tax

\[ (1 - \tau_c)C_{kt} = (1 + \tau_c)S_0 + (1 + \tau_c)P_{kt} - (1 - \tau_c)\frac{k}{(1 + r)^t} \]

However, careful consideration of Equation 2-3 does not satisfy the riskless arbitrage criteria. While these positions equate in theory, taxation on the unwind of the position also provides a further wedge! So let us look at the possible arbitrage outcomes.

\(^{33}\) Or in Wall Street parlance, one would buy a married put while borrowing the money for the position.
There are three main categories of possibilities assuming the option is held to expiration. These are: option 1) $S_1 < k$ the stock is lower than the strike price, 2) $S_1 > k$ the stock is greater than the strike price, and 3) $S_1 = k$ the stock is equal to the strike price. Let us examine the additional tax paid by the arbitrageur in each of these three scenarios.

Under scenario 1, the stock is less than the strike price leading the call to expire worthless. As a result, there is no tax paid on the call option. The stock being lower than the strike price allows for the put to be exercised with a maximum tax liability of the tax rate times the strike price. When the cash is received, the strike value must be repaid leading to another tax liability of the tax rate times the strike price.

\[
\text{scenario 1: } S_1 < k \Rightarrow \max r = 2k\tau_c
\]

Notice that the tax rate on selling the stock and the tax on selling the put sum to the same quantity here (assuming no other transactions costs in execution). The call option will never be exercised early under this condition due to the price paid for the stock being lower than the strike. Should such ever occur, there are now additional trading gains to pay any additional tax. Now let us consider scenario 2.

Under scenario 2, the stock is greater than the strike price. Under this condition, there are three possibilities: A) the option is exercised at expiration, B) the option is exercised before expiration, and C) the option is not exercised. Let us consider each one at a time.

First under scenario 2A, the option is exercised at expiration. The stock (considered a good or service) will transfer to the exerciser and the strike price value will be paid to the arbitrageur. This transaction has a tax liability to the arbitrageur of the tax rate times the strike price. The put option will expire worthless. The money borrowed will equate to the strike price when $t=0$. Thus, the tax liability to the arbitrageur will again be the tax rate times the strike price. This leads to a total tax liability at unwind of:
scenario 2A: $S_1 > k \Rightarrow \max \tau = 2k\tau_c$

Under scenario 2B, the option is exercised before expiration. If this is the case, the tax liability on the exercise will be the same as if it were exercised at expiration. Therefore the exercise has a tax liability to the arbitrageur of the tax rate times the strike price. This leaves only the put and the borrowed money remaining. The arbitrageur can choose to hold his money and pay the loan back at the due period (assuming the loan cannot be repaid early). In this instance, the tax liability on unwinding the loan will simply be the same as in scenario 2A. The extra interest earned while holding the cash pending unwind will cover any additional taxation from the interest. This leaves only the put option. If the put ends up expiring worthless, then no tax is incurred. If the put is sold or exercised, again there are additional gains to cover the additional tax. Therefore, the maximum uncovered tax liability (in the case of no additional gains to the arbitrageur) will be the same as in scenario 2A.

scenario 2B: $S_{0<r<1} > k \Rightarrow \max \tau_u = 2k\tau_c$

Where: $\tau_u$ represents uncovered tax liability

Under scenario 2C the call option is not exercised. Therefore, both the call and the put expire worthless. This leaves only the stock and the borrowed money left for analysis. The tax liability on repayment of the borrowed money is known as the tax rate time the strike price. The tax on the stock is less clear. The stock has appreciated in value and thus would carry tax liability greater than before. Consider this new tax liability as being composed of two components, the first component being equal to the tax rate times the strike price and the second being equal to the tax rate times the differential between the strike price and the current stock price. This corresponds to the tax on the uncovered amount and an additional tax burden covered by the gains in the increase of the stock price. If the tax rate on the differential is less than the additional increase in the stock price above the strike price (which must be for all tax rates less than 100%), then the additional tax is
covered by the additional gains. Thus, under this scenario one finds that the maximum uncovered rate is the same as the other scenarios.

\[ \text{scenario 2C: } S_1 > k \Rightarrow \max \tau_u = 2k \tau_c \]

Under Scenario 3, both the call and the put options expire worthless. Thus the only tax liability occurs with regards to the stock and the borrowed money. The stock price being equal to the strike price means that both of these transactions incur the same liability. Therefore the total liability for scenario 3 is the same result as in the other two possibilities.

\[ \text{scenario 3: } S_1 = k \Rightarrow \max \tau = 2k \tau_c \]

Therefore, under every arbitrage scenario the uncovered tax liability is the same. This tax liability is known to the arbitrageur before conducting the transaction as both the tax rate and strike price are known. Therefore, this additional tax cost can be factored into the ask price of the call option when sold.

Recall from before that the call offer equation without consideration of the unwind was:

\[ (1 - \tau_c)C_{kt} = (1 + \tau_c)S_0 + (1 + \tau_c)P_{kt} - (1 - \tau_c) \frac{k}{(1 + r)^t} \]

Solving for the price of the call options reveals:

\[ C_{kt} = \frac{(1 + \tau_c)S_0 + (1 + \tau_c)P_{kt} - \frac{k}{(1 + r)^t}}{(1 - \tau_c)} \]

Because the price of unwinding the arbitrage is known and must be carried into the price of the option (adjusted for the cascading effect of the tax). Thus, the final cost of the option is:
Recall that the price of the call option without the tax is:

$$C_{kt} = S_0 + P_{kt} - \frac{k}{(1+r)^t}$$

This shows a stark contrast. In addition to a positive value for the unwind tax carry-through, all the terms save borrowing are increased. The net effect of the tax is an increase in ask price of the call option. A simple numerical example may illustrate this point. The table below illustrates how the ask prices will change due to the presence of the APT.
### Table 2-5: Demonstration of STT price difference

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_0$ (Initial Stock Price)</td>
<td>€35.00</td>
</tr>
<tr>
<td>$P_{kt}$ (Put Price)</td>
<td>€3.45</td>
</tr>
<tr>
<td>$k$ (Strike Price)</td>
<td>€35.00</td>
</tr>
<tr>
<td>$\tau_c$ (Intermediation Tax)</td>
<td>0.3%</td>
</tr>
<tr>
<td>$C_{kt}$ (Call ask price with no APT)</td>
<td>€3.80</td>
</tr>
<tr>
<td>$C_{kt}$ (Call ask price with APT)</td>
<td>€4.03</td>
</tr>
<tr>
<td><strong>Change due to tax</strong></td>
<td><strong>€0.23</strong></td>
</tr>
</tbody>
</table>

**Table 2-5 Notes:**

- Demonstrates the price wedge created for the theoretical equity
- All data are not representative of any individual equity
- Source: Author's Calculations
Appendix 2C: Demonstration of Price Differential

Let the Revenue of a given firm be denoted as:

**Equation 2-6: Firm Revenue**

\[ R = \lambda P_s Q_s + (1 - \lambda) P_c Q_c \]

Where:  
- \( \lambda \) represents the fraction of sales paid for by specie  
- \( P_s \) represents the price of good Q when paid for by specie  
- \( P_c \) represents the price of good Q when paid for by credit  
Note that the good is homogenous although the prices are not!

The costs of the firm are denoted as:

**Equation 2-7: Firm Costs**

\[ C = w_c L_c + w_s L_s + r_c K_c + r_s K_s + \tau \]

Costs (Equation 2-7) are equated to the wages paid to workers in specie and credit and capital paid in specie and credit plus the taxes paid for all transactions.

**Equation 2-8: Total Tax Bill**

\[ \tau = \tau_c [(1 - \lambda) P_c Q_c + r_c K_c + w_c L_c] + \tau_s [\lambda P_s Q_s - w_s L_s - r_s K_s] \]

The total tax bill (Equation 2-8) represents the APT on automatic transactions (incoming revenue from credit, capital payments by credit, and wages paid by credit) plus the specie tax (incoming revenue from specie less the amount of specie able to be paid in wages and rents). Inserting this into the cost equation yields the following:

**Equation 2-9: Firm Costs with Taxes**

\[ C = w_c L_c + w_s L_s + r_c K_c + r_s K_s + \tau_c [(1 - \lambda) P_c Q_c + r_c K_c + w_c L_c] + \tau_s [\lambda P_s Q_s - w_s L_s - r_s K_s] \]

Expansion of Equation 2-9 allows for:
Equation 2-10: Firm Costs with Taxes (ALT1)

\[ C = w_c L_c + w_s L_s + r_c K_c + r_s K_s + \tau_c (1 - \lambda) P_c Q_c + \tau_c r_c K_c + \tau_c w_c L_c + \tau_s \lambda P_s Q_s - \tau_s w_s L_s - \tau_s r_s K_s \]

Combining terms shows that:

Equation 2-11: Firm Costs with Taxes (Alt2)

\[ C = (1 + \tau_c)w_c L_c + (1 - \tau_s)w_s L_s + (1 + \tau_c)r_c K_c + (1 - \tau_s)r_s K_s + \tau_c (1 - \lambda) P_c Q_c + \tau_s \lambda P_s Q_s \]

With workable Revenue and Cost equations, one may define profits for the firm as revenue less costs. This can be shown as:

Equation 2-12: Firm Profit

\[ \pi = \lambda P_s Q_s + (1 - \lambda) P_c Q_c - (1 + \tau_c)w_c L_c - (1 - \tau_s)w_s L_s - (1 + \tau_c)r_c K_c - (1 - \tau_s)r_s K_s - \tau_c (1 - \lambda) P_c Q_c - \tau_s \lambda P_s Q_s \]

Again combining terms from Equation 2-12 shows that profits convert to:

Equation 2-13: Firm Profit (Alt1)

\[ \pi = (1 - \tau_c)(1 - \lambda) P_c Q_c + (1 - \tau_s)\lambda P_s Q_s - (1 + \tau_c)w_c L_c - (1 - \tau_s)w_s L_s - (1 + \tau_c)r_c K_c - (1 - \tau_s)\lambda P_s Q_s - (1 - \tau_s)r_s K_s \]

Insertion of a production function will allow for optimisation. Consider a Cobb-Douglas production function where the shares are split between two different inputs and within the inputs split between two groups. Thus:

Equation 2-14: Cobb-Douglas Production Function

\[ Q = (K_c + K_s)^{\alpha}(L_c + L_s)^{1-\alpha} \]

At this point, it is important to note that the goods are homogenous and substitutable. Thus:
Equation 2-15: Homogenous Good

\[ Q_c = Q_s = Q \]

If this holds, then the profit equation Equation 2-13 can be rewritten by using Equation 2-15 as:

Equation 2-16: Firm Profit (Alt2)

\[ \pi = Q[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] - (1 + \tau_c)w_c L_c - (1 - \tau_s)w_s L_s - (1 + \tau_c)r_c K_c - (1 - \tau_s)r_s K_s \]

Insertion of the production function (Equation 2-14) into Equation 2-16 now allows for a complete profit statement:

Equation 2-17: Final Profit Statement

\[ \pi = (K_c + K_s)^{\alpha}(L_c + L_s)^{1-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] - (1 + \tau_c)w_c L_c - (1 - \tau_s)w_s L_s - (1 + \tau_c)r_c K_c - (1 - \tau_s)r_s K_s \]

Capital and Labour outputs are choice variables, wages and rents will be market determined, the shares paid to capital and labour are parameterised and thus exogenous, and the tax rates are determined by legal code. Therefore, profit maximisation will have four first order conditions (FOCs):

Equation 2-18: FOC - Capital with Credit

\[ \frac{\partial \pi}{\partial K_c} = \alpha(K_c + K_s)^{\alpha-1}(L_c + L_s)^{1-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] - (1 + \tau_c)r_c \]

Equation 2-19: FOC - Capital is Specie

\[ \frac{\partial \pi}{\partial K_s} = \alpha(K_c + K_s)^{\alpha-1}(L_c + L_s)^{1-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] - (1 - \tau_s)r_s \]
Equation 2-20: FOC - Labour with Credit

\[ \frac{\partial \pi}{\partial L_c} = (1 - \alpha)(K_c + K_s)^\alpha(L_c + L_s)^{-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] - (1 + \tau_c)w_c \]

Equation 2-21: FOC - Labour with Specie

\[ \frac{\partial \pi}{\partial L_s} = (1 - \alpha)(K_c + K_s)^\alpha(L_c + L_s)^{-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] - (1 - \tau_s)w_s \]

A quick check of the second order conditions necessary for a maximum reveals that all concavity conditions are met as expected. Thus:

Equation 2-22: SOC - Capital with Credit

\[ \frac{\partial^2 \pi}{\partial K_c^2} = \alpha(\alpha - 1)(K_c + K_s)^{\alpha-2}(L_c + L_s)^{1-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] \]

\[ \Rightarrow \frac{\partial^2 \pi}{\partial K_c^2} < 0 \]

Equation 2-23: SOC - Capital with Specie

\[ \frac{\partial^2 \pi}{\partial K_s^2} = \alpha(\alpha - 1)(K_c + K_s)^{\alpha-2}(L_c + L_s)^{1-\alpha}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] \]

\[ \Rightarrow \frac{\partial^2 \pi}{\partial K_s^2} < 0 \]

Equation 2-24: SOC - Labour with Credit

\[ \frac{\partial^2 \pi}{\partial L_c^2} = -\alpha(1 - \alpha)(K_c + K_s)^\alpha(L_c + L_s)^{-\alpha-1}[(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] \]

\[ \Rightarrow \frac{\partial^2 \pi}{\partial L_c^2} < 0 \]
Equation 2-25: SOC - Labour with Specie

\[ \frac{\partial^2 \pi}{\partial L_s^2} = -\alpha (1 - \alpha) (K_c + K_s)^\alpha (L_c + L_s)^{\alpha - 1} [(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] \]

\[ \Rightarrow \frac{\partial^2 \pi}{\partial L_s^2} < 0 \]

Setting the above FOCs (Equation 2-18 through 2-21) equal to zero and some basic simplification allows the above equations to be rewritten as:

Equation 2-26: Maximised Capital with Credit

\[ \frac{\partial \pi}{\partial K_c} : \alpha \left[ \frac{(K_c + K_s)}{(L_c + L_s)} \right]^{\alpha - 1} [(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] = (1 + \tau_c)\tau_c \]

Equation 2-27: Maximised Capital with Specie

\[ \frac{\partial \pi}{\partial K_s} : \alpha \left[ \frac{(K_c + K_s)}{(L_c + L_s)} \right]^{\alpha - 1} [(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] = (1 - \tau_s)\tau_s \]

Equation 2-28: Maximised Labour with Credit

\[ \frac{\partial \pi}{\partial L_c} : (1 - \alpha) \left[ \frac{(K_c + K_s)}{(L_c + L_s)} \right]^{\alpha} [(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] = (1 + \tau_c)\tau_c \]

Equation 2-29: Maximised Labour with Specie

\[ \frac{\partial \pi}{\partial L_s} : (1 - \alpha) \left[ \frac{(K_c + K_s)}{(L_c + L_s)} \right]^{\alpha} [(1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s] = (1 - \tau_s)\tau_s \]

Dividing the capital FOC by the labour FOC for both credit and specie yields the following observations:
Equation 2-30: Capital - Labour Ratio with Credit

\[
\frac{K_C}{L_C} = \frac{\alpha \left[\frac{(K_C + K_s)}{(L_C + L_s)}\right]^{\alpha - 1} \left[1 - \tau_C\right] \left[1 - \lambda\right] P_C + (1 - \tau_s) \lambda P_s}{\left(1 - \alpha\right) \left[\frac{(K_C + K_s)}{(L_C + L_s)}\right]^{\alpha} \left[1 - \tau_C\right] \left[1 - \lambda\right] P_C + (1 - \tau_s) \lambda P_s} = \frac{(1 + \tau_C) r_C}{(1 + \tau_C) w_C}
\]

Equation 2-31: Capital - Labour Ratio with Specie

\[
\frac{K_S}{L_S} = \frac{\alpha \left[\frac{(K_C + K_s)}{(L_C + L_s)}\right]^{\alpha - 1} \left[1 - \tau_C\right] \left[1 - \lambda\right] P_C + (1 - \tau_s) \lambda P_s}{\left(1 - \alpha\right) \left[\frac{(K_C + K_s)}{(L_C + L_s)}\right]^{\alpha} \left[1 - \tau_C\right] \left[1 - \lambda\right] P_C + (1 - \tau_s) \lambda P_s} = \frac{(1 - \tau_s) r_S}{(1 - \tau_s) w_S}
\]

Simplification of the above terms reveals:

Equation 2-32: Final Capital - Labour Ratio with Credit

\[
\frac{K_C}{L_C} = \frac{\alpha \left(\frac{L_C}{L_C + L_S}\right)}{\left(1 - \alpha\right) \left(\frac{K_C + K_s}{L_C + L_s}\right)^{\alpha}} = \frac{r_C}{w_C}
\]

Equation 2-33: Final Capital - Labour Ratio with Specie

\[
\frac{K_S}{L_S} = \frac{\alpha \left(\frac{L_C}{L_C + L_S}\right)}{\left(1 - \alpha\right) \left(\frac{K_C + K_s}{L_C + L_s}\right)^{\alpha}} = \frac{r_S}{w_S}
\]

This becomes the normal Cobb-Douglass result. However, upon careful inspection, one finds that the subscripts denote that this result is applicable only in relative terms. Attempting to convert into absolute terms reveals a more stark difference!

Inserting this result back into one of the FOCs and adjusting the subscript yields:

Equation 2-34: Wages Paid by Credit

\[
\alpha \left[\frac{(K_C + K_s)}{(L_C + L_s)}\right]^{\alpha - 1} \left[1 - \tau_C\right] \left[1 - \lambda\right] P_C + (1 - \tau_s) \lambda P_s = (1 + \tau_C) \left[1 - \alpha\right] \left[\frac{(L_C + L_s)}{(K_C + K_s)}\right] w_C
\]

And:

\[
\frac{(K_C + K_s)}{(L_C + L_s)}^{\alpha - 1} \left[1 - \tau_C\right] \left[1 - \lambda\right] P_C + (1 - \tau_s) \lambda P_s = (1 + \tau_C) \left[1 - \alpha\right] \left[\frac{(L_C + L_s)}{(K_C + K_s)}\right] w_C
\]
Equation 2-35: Wages Paid by Specie

\[ \alpha \left( \frac{K_c + K_s}{L_c + L_s} \right)^{a-1} \left[ (1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s \right] = \left( \frac{\alpha}{1 - \alpha} \right) \left( \frac{L_c + L_s}{K_c + K_s} \right) w_s \]

Some simplification reveals:

Equation 2-36: Final Wage Paid by Credit

\[ \frac{(1 - \alpha)}{(1 + \tau_c)} \left( \frac{K_c + K_s}{L_c + L_s} \right)^\alpha \left[ (1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s \right] = w_c \]

And:

Equation 2-37: Final Wage Paid by Specie

\[ \frac{(1 - \alpha)}{(1 - \tau_s)} \left( \frac{K_c + K_s}{L_c + L_s} \right)^\alpha \left[ (1 - \tau_c)(1 - \lambda)P_c + (1 - \tau_s)\lambda P_s \right] = w_s \]

This reveals that the workers who are paid via a different mechanism face different wages.

However, this is not the end of the story!

Note that the firm offers two different prices to the consumers, one for credit transactions and one for specie transactions. This reveals that consumers using specie may face a different price level than consumers using credit. The difference in the price level provides a wedge in the real wage and thus allows for calculation of an exchange rate.

This result has been demonstrated through the use of credit card transaction fees. The following photo was taken in the United States and demonstrates price differentials caused by bank transaction charges.
Figure 2-7 Notes:

- Represents an existing price differential for payment via specie versus payment with credit
- Price differential caused by existing transaction fees imposed on intermediation of payment via credit in the United States
- Vendor willing to invest in expensive capital stock (machines to take cash during unmanned hours) to exploit price differential caused from intermediation fees
- Photo taken in Bangor, Maine, United States
- Source: (Allison S. Parker, 2012) - Used by permission
Chapter 3: Tax Moments

Introduction

Policy makers constantly look to Economics for guidance regarding how to effectively implement taxation policy. Traditionally, advice given to policy makers focuses on reducing the deadweight losses associated with a given taxation policy. However, the discipline of Political Economy has revealed that optimal taxation policy may not be implemented for various reasons. This paper illustrates a quantitative approach to looking at taxation properties using mathematical properties. This approach does not attempt to guide policy makers about what they “should” do. Rather, it highlights the various properties of different taxation regimes. These properties include the expected revenue, the reliability of revenue, how many shortfall years happen when compared to surplus years, and finally how frequently significant events should occur with a given tax policy.

This paper examines the existing properties of revenue generation for various countries and examines how revenue characteristics help to account for variations in expenditure between countries. The regressions indicate that an increase in skewness accounts for an increase in governmental expenditure. This effect diminishes as a country becomes wealthier. An increase in kurtosis appears to have a negative effect on governmental spending for governments with less income. The effect appears to reduce as countries become wealthier.

Policy makers will find this analysis of most value when considering a drastically new taxation policy. This analysis attempts to deal with imperfect information by policy makers and the voting public regarding the possible effects of a proposed policy. If both groups have experience with the taxation policy, then this analysis does not greatly contribute beyond suggesting a means of blending the historical revenue sources along the new policy lines and looking at the outcome. However, when the proposed policy is significantly different than existing policies, this analysis helps to
provide insight and minimise shocks to policy makers expected to be found in the first few years under a new policy.

It is believed that any problem arising from higher levels of skewness and kurtosis can be reasonably mitigated by a government, and by extension an informed electorate. Thus, expanding analysis of future tax proposals to include these items will enable more informed policy decisions and prevent any issues arising from ignorance relating to these particular properties.

This paper proceeds as follows. The next section discusses some interesting relationships observed in the data and how these relationships tie into the existing literature. Section 3 describes each of the mathematical moments in detail and possible ways policy makers could interpret the numbers. Section 4 lays out an empirical model, several hypotheses available for testing, and describes in detail the data used. Section 5 lays out the results of the empirical analysis. Section 6 concludes.

**Interesting Relationships**

Figure 3-1 represents a cross country natural log of expenditure to GDP ratio with the skewness of revenue in 2010\(^\text{34}\). The relationship suggests a negative trend showing that the more positively skewed the revenue stream, governments tend to spend less. Previous year's data result in a similar graphical picture (slight negative trend).

---

\(^{34}\) All countries used for this sample are represented later in the data section.
Figure 3-1 Notes:

- Demonstrates the correlation between the log of government expenditure as a ratio of GDP and the skewness of revenue for the relevant government
- Multiple countries are represented in this sample
- Graph presented for sample year 2010 was similar in structure to other years viewed
Additionally, the same graph was done for Kurtosis (Figure 3-2). This graph suggests a similar negative relationship between Kurtosis and the expenditure revenue ratio as was found with skewness. These graphs reveal that very few countries demonstrate high levels of Kurtosis. As a result, the negative relationship suggested may simply be driven by these few outliers. Yet, these high kurtosis countries appear to represent a consistent trend when looking at multiple years.
Figure 3-2 Notes

- Demonstrates the correlation between the log of government expenditure as a ratio of GDP and the kurtosis of revenue for the relevant government
- Multiple countries are represented in this sample
- Graph presented for sample year 2010 was similar in structure to other years viewed
One may ask about the relationship between the expenditure and revenue ratios with the variance in the revenue stream. The follow graph demonstrates that this relationship appears positive. Again this result is consistent over multiple years. This would be moderately consistent with the hypothesis regarding procyclical spending policy for developing countries as put forward in (Aaron Tornell and Philip R. Lane, 1999) and further examined in the models of (Ernesto Talvi and Carlos A. Végh, 2005).
Figure 3-3: Expenditure and Revenue Variance

Expenditure and Revenue Variance
Cross Country Representation for 2010

Figure 3-3 Notes:

- Demonstrates the correlation between the log of government expenditure and the log of revenue variance for the relevant government
- Multiple countries are represented in this sample
- Graph presented for sample year 2010 was similar in structure to other years viewed
The variance expenditure graph (Figure 3-3) interestingly does not appear to tell the whole story. For when expenditure appears scaled by GDP as was done in the previous graphs in this section the relationship reverses. Again this new trend appears consistent over time.
Figure 3-4 Notes:

- Demonstrates the correlation between the log of government expenditure as a ratio of GDP and the log of revenue variance for the relevant government
- Multiple countries are represented in this sample
- Demonstrates how the strongly positive relationship appears to disappear then scaled by GDP
- Graph presented for sample year 2010 was similar in structure to other years viewed
Because scaling expenditure by GDP makes such a significant graphical result with revenue, one would expect to find a significant graphical relationship between the natural log of GDP and the natural log of revenue variance. Indeed, Figure 3-5 reveals just such a strongly positive relationship.
Figure 3-5: GDP and Revenue Variance

GDP and Revenue Variance
Cross Country Representation for 2010

Figure 3-5 Notes:

- Demonstrates the correlation between the log of GDP and the log of revenue variance for the relevant government
- Multiple countries are represented in this sample
- Graph presented for sample year 2010 was similar in structure to other years viewed
This begs the question if both revenue skewness and revenue kurtosis exhibit the same
behaviour. Examination of the GDP skewness graph (Figure 3-6) suggests that no relationship exists
between GDP and revenue skewness.
Figure 3-6: GDP and Revenue Skewness

GDP and Revenue Skewness
Cross Country Representation for 2010

Figure 3-6 Notes:

- Demonstrates the correlation between the log of GDP and the log of revenue skewness for the relevant government
- Demonstrates the lack of any noticeable correlation in this relationship
- Multiple countries are represented in this sample
- Graph presented for sample year 2010 was similar in structure to other years viewed
The Kurtosis graph (Figure 3-7) presents an interesting conundrum. The high kurtosis countries do not have reliable data available for GDP for 2010 (or most other years for that matter). As a result, the relationship shown in the graph should not be fully trusted.
Figure 3-7: GDP and Revenue Kurtosis

GDP and Revenue Kurtosis
Cross Country Representation for 2010

Figure 3-7 Notes:

- Demonstrates the correlation between the log of GDP and the log of revenue kurtosis for the relevant government
- Multiple countries are represented in this sample
- Graph presented for sample year 2010 was similar in structure to other years viewed
These graphs raise some important questions. First, what is the relationship between revenue variance and expenditures? Does skewness and kurtosis play a role in accounting for variation between countries' governmental expenditures? Would policy makers benefit from considering skewness and kurtosis when selecting between policy regimes?

**Policy Relevance**

Considering possible skewness and kurtosis effects become more relevant when the frictionless traditional economic models become more reflective of real life. Several frictions may lead to the properties reflected above having more significance in the policy application process. These frictions help to understand how traditional economic models may be enhanced to reflect more real-world scenarios.

One classic friction is when financial markets fail to function well. This can be demonstrated where countries are unable to borrow money at any price (i.e. interest rate). Importantly, a high interest rate for sovereign debt does not necessarily reflect a market failure.

A second friction occurs when political actors are taken into account. Skewness and Kurtosis may mislead policy makers into suboptimal policies in the first few years of implementation of a taxation policy from misestimating the actual revenue projections and saving requirements through high dependence upon mean estimates. This occurs because policy makers frequently must decide between multiple policy regimes without having a clean test area for each policy; estimates of taxation revenue forecasts become necessary. Yet, these forecasts ignore structural characteristics which may be important. For example, would a policy maker make painful cuts to expenditure to balance budgets when facing an election year? Pending government elections could lead to suboptimal long run policies being adopted in favour of political expediency.

**Mechanisms**
The policy relevance of using skewness and kurtosis with regards to taxation policy stems directly from the mechanisms leading to any interactions. Three mechanisms provide possible reasons for the effects. These are artefacts in the underlying tax bases, the nature and structure of the taxes themselves, and institutional / behavioural interactions between taxation and spending. Logically, the connection must come from either the tax base, the tax, or in the translation of the tax revenue into spending considerations.

The first possible mechanism deals with the tax base itself. If the economic activity being taxed (either through traditional income taxation or a VAT style expenditure taxation) is tied to a tax base that is highly cyclical, then the revenue stream itself will reflect this cyclicality. Mathematical properties of the tax base (such as an economy deeply cyclical and thus highly exposed to cyclical shocks) will likely translate into the tax revenue properties. Such properties may account to changes in expenditures directly through the shock-absorbers in times of economic distress. Historically, this line of thinking goes all the way back to Jules Dupuit (1844). Dupuit noted that the losses associated with a tax were proportional to the square of the tax rate. As a result, policy makers have generally sought taxes with broad bases in order to keep rates low.

The second possible mechanism comes from the nature of the tax being levied. Realising that countries commonly deploy a set of taxation policies, one must consider the aggregate of such policies. Countries could choose to tax industries or types of economic activity differently to achieve different revenue profiles. An example of this comes from taxation of income or expenditure at the State level in the United States. Some states choose to tax only expenditures and property thus selecting not to tax income (example: Washington) versus others which choose to only tax income and not expenditures (example: Oregon). Another example comes in 2003 when Honohan advocated that policymakers examine the inter-temporal characteristics of taxes with regards to both the effects of inflation and the effects of tax arbitrage upon any policy recommendation (Patrick Honohan, 2003).
Finally, institutional or behavioural interactions can play a critical part in this discussion. Some countries may face credit constraints which lead to suboptimal borrowing as suggested in (Michael Gavin and Roberto Perrotti, 1997). Additionally, (Aaron Tornell and Philip R. Lane, 1999) suggest that political behaviour and concentration may lead to competition for resources leading to deeply increasing expenditures when facing windfalls. Institutional considerations also come from the possibility of imperfect markets as suggested by (Alvaro Riascos and Carlos A. Vegh, 2003).

**Tax Moment Analysis**

In general terms, central moments can be derived using the following equation (Daniel Zwillinger, 1996):

$$\mu_k = E((X - \mu)^k)$$

This equation states that the $k^{th}$ moment (represented by $\mu_k$) is simply the expectation of each individual realisation less its mean raised to the $k^{th}$ power. If $k$ equals zero then the zero-th central moment equates to a value of unity. The first central moment (occurring when $k$ equals one) has a value of zero. However, the first moment (not centralised about the mean) is the mean itself.

The second through fourth central moments have particular interest for this paper. However, in order to achieve comparability between different taxation regimes, each tax regime must be normalised. The normalisation process renders the resulting values scale invariant. Thus, normalised moments may be compared for policy purposes. The normalisation procedure will be discussed in more detail below.

**First Moment**

Policy makers are frequently interested, and familiar, in the first moment. One defines the first moment as the arithmetic mean of revenue or, put another way, the expected revenue derived from the tax. While many people love to argue about the sensitivity of the tax base to the tax (its
elasticity) the first moment assumes that the revenue from the new tax has already accounted for any reduction in the tax base caused by the imposition of such a tax.

Equation 3-1: First Moment - Mean

$$\hat{\mu}_r = \frac{\sum R_r}{T_r}$$

In this equation, $\hat{\mu}_r$ denotes the revenue mean for policy regime (r) in each year (t) is summed and then divided by the total number of years (T) used in the evaluation of that regime. This equation can be adjusted for analysis with only one country. Additionally, it is assumed that currency units are constant (i.e. inflation adjusted).

Policy uses for the first moments are both simple and direct. Policy makers compare the value from the two taxation regimes (the current tax regime and the proposed tax regime). The intent is to find the taxation regime which yields the higher estimate of taxation revenue.

Second Moment

Policy makers have been interested, and in recent times troubled, by the second moment. The second moment reflects the variance of tax revenue realised in any given tax year from the expected revenue. As variance increases, policy makers will be forced to borrow (if the markets allow for borrowing) or use precautionary saving for future downfalls in revenue.

Equation 3-2: Second Moment - Variance

$$\sigma^2 = E((R_r - \mu_r)^2)$$

This equation, using the second central moment, produces the variance of government revenues (denoted as $\sigma^2_r$ for each policy regime). This variance assumes constant value of each unit of currency.
Policy makers may interpret this second moment as the stability of the tax revenue. While revenue volatility does not seem tied to economic growth, the research demonstrated that spending volatility does negatively affect growth in EU countries (Antonio Afonso and Davide Furceri, 2010). Governments must either save as a precaution against a significant shortfall in revenue or be able to access the financial markets to smooth spending. This leads to an important question for policy makers post financial crisis: if revenues are volatile and financial markets are unable or unwilling to assist, what quantity of revenue must be taken off of the estimated tax revenues in the form of precautionary savings to compensate for the increase in volatility?

As a result, governments who wish to protect their countries from market exposure (including bond market exposure and currency raids) must decrease their spending to save. The quantity of required savings is a direct function of the revenue volatility and the spending level desired to be maintained in the event of a revenue drop-off.

**Third Moment**

The third mathematical moment has not received as much attention from policy makers in the taxation arena recently. However, many financial experts use a variant of the third moment. This variant of the third moment reflects the skewness of the tax revenue (commonly denoted as $\gamma_1$). The skewness of a distribution can be interpreted by policy makers as the measure of deception faced by policy makers in using the expected (i.e. mean) revenue of a tax.

To provide a basis for comparison, the normal distribution demonstrates a skewness of zero. Zero skewness represents perfect symmetry. In policy terms, zero skewness would indicate that the relative frequency and intensity of any revenue shortfall years would be offset perfectly by surplus years. The basic equation for the skewness utilising the third moment is given below.
Equation 3-3: Third Moment - Skewness

\[ \gamma_{1,r} = \frac{E((R_r - \mu_r)^3)}{\sigma_r^3} \]

In this equation, skewness for each taxation regime is represented by \( \gamma_{1,r} \) and is derived by taking a normalised third central moment. This normalisation is achieved by scaling all differences by the cube of the relevant standard deviation. Thus, any increase in the third moment realised by scale would be offset by the scale in the standard deviation. This renders the third moment scale independent. As a result, the estimated version of the equation is simply derived below.

Equation 3-4: Third Moment - Estimated Skewness

\[ \hat{\gamma}_{1,r} = \frac{E((R_r - \hat{\mu}_r)^3)}{\hat{\sigma}_r^3} \]

Policy makers may interpret this number in two ways. Positive numbers of skewness reflect tax revenues that would generally underperform the expected revenue. This underperformance would be made up with a few years of higher-than-common tax revenue. The larger the skewness value (in terms of absolute value), the more pronounced its effect. In contrast, a negative skewness would indicate taxation revenues would commonly be higher than the mean suggests. This revenue would be offset with a few bad years for revenue collection. Below is an example of a distribution with positive skewness.
Figure 3-8 Notes:

- Demonstrates a positively skewed distribution of outcomes
- Information is strictly demonstrational and is not based upon any country's actual tax data
- Shows that the point of highest probability in the distribution is below the zero standard deviation mark
- Shows that the majority of the probabilities represented in the distribution (area under the curve) below zero represents more than half
As one may see from Figure 3-8, the mode (point of highest probability density) of the graph is significantly below the zero line. Because the graph is normalised, zero represents the expected value (mean) of the taxation revenue.

One may also note that the probability density above zero (demonstrated by the area without shading) is relatively small in comparison to the probability density below zero (demonstrated by the shaded area below the line). This reflects the "few" years of higher revenue which make up for the frequent underperformance of revenue in other years.

Policy makers may utilise this knowledge to keep spending levels lower during uncommon periods of high revenue (i.e. precautionary saving). Policy makers may also utilise this data to avoid political misstatements to the public and financial markets regarding their expected fiscal position. Improved understanding of policy makers will assist in expenditure, debt, and augmented revenue decisions. This metric could also be used for other political purposes which shall not be elaborated upon in this paper.

**Fourth Moment**

The modification of the fourth normalised central moment represents the excess kurtosis (commonly denoted $\gamma_2$). The excess kurtosis may be interpreted by policy makers as the "surprise factor". It represents both the scale and the frequency of a surprise (or infrequent) event. A large infrequent event in one policy regime may be comparable to many much smaller events in another policy regime. As a result, taxation regimes with larger values may be interpreted by policy makers as having relatively more events which will require policy attention.

For example, if the government were to realise significantly higher revenue than average, policy makers are generally forced to decide what to do with all the excess revenues. Additionally, if the government were to face significant shortfalls well below expectations and models, policy makers
will also be forced to address the issue. As a result, the kurtosis will signify how frequently policy makers have to interact with this policy.

This becomes more important when considering policy in democratic countries. Political realities of upcoming elections may make policy action more or less desirable than at other points. As a result, high kurtosis policies may force policy makers into addressing a politically undesirable situation more frequently than otherwise.

As a point of comparison, the normal distribution has an excess kurtosis value of two. The general equation for the fourth moment is given below.

Equation 3-5: Fourth Moment - Kurtosis

\[ \gamma_4 = \frac{E((R_t - \mu_t)^4)}{\sigma_t^4} - 3 \]

This yields an operational equation to estimate as:

Equation 3-6: Fourth Moment - Estimated Kurtosis

\[ \hat{\gamma}_4 = \frac{E((R_t - \hat{\mu}_t)^4)}{\hat{\sigma}_t^4} - 3 \]

Importantly, the kurtosis equation is independent of revenue scale as it is normalised by the fourth power of the standard deviation. Any increase in the fourth moment is offset by the corresponding increase in the standard deviation. Thus, Kurtosis is scale independent.

**Pulling it all together**

When taken together, the various versions of mathematical moments presented above will assist policy makers in comparing the expected revenue of taxation, determining and comparing the stability of two different taxation regimes, identifying significant policy challenges arising from the characteristics of the revenue collection over multiple years, and determining the relative frequency and intensity of those challenges.
Revenues can have differing attributes in terms of variance, skewness and kurtosis because of dependence upon the business cycle, exposure to economic elements beyond governmental control, and environmental characteristics. Each country has different exposure to business cycle elements. Countries with heavy dependence upon natural resources for their national income (e.g. Russia or OPEC states) have a different cyclical exposure than countries which produce primarily for domestic markets through a service based economy. These differences to the global business cycle can produce different profiles with regards to skewness and kurtosis.

Economic elements beyond direct government control (such as exchange rates) provide another major mechanism for differences of skewness and kurtosis between countries. For example, Ireland depends highly on its exchange rate with both the British Pound and the US Dollar to drive its tourism and export sector of the economy. This exchange rate is well beyond direct Irish National Government control.

Countries with environmental exposures also may face revenue skewness due to shocks within their countries. Consider the tsunami in Japan or earthquake in Haiti as examples. Both the Japanese and Haitian national governments knew that these were possible events for their country. Furthermore, precautionary savings were not adequate to solve the drop-off in revenues faced by these disasters. Countries in Africa face famine in regular intervals which lead to skewness in their economies (particularly as their primary output is a global commodity via either agriculture or natural resources). As a result known environmental exposures, even when anticipated, lead to different profiles in government revenues.

Of the above mentioned reasons for differences in country profiles, the tax revenue dependence upon different sectors of the economy with exposure to the global business cycle is the most obvious and controllable. Governments may consider two taxation policies (intended to be mutually exclusive) targeting different areas of the economy. Clearly one targeting secular areas of the economy would have a different profile than one targeting cyclical areas of the economy.
Data, Model, and Hypothesis

Data Description

This research uses revenue, expenditure, and GDP data provided through the World Bank (2013). Table 3-1 reveals the country and years used in the analysis for this paper.
<table>
<thead>
<tr>
<th>Country</th>
<th>Years</th>
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<tbody>
<tr>
<td>Australia</td>
<td>1999-2011</td>
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Table 3-1 Notes:
- Shows which countries and years for those countries used in the following analysis
Each of the country-years listed above meet certain properties. First, a minimum of 12 years of revenue data must be available to calculate the variance, skewness, and kurtosis for revenue. Any country which does not have a minimum of 12 years of available revenue data were omitted from this list. It was deemed important that no country's information should be used if a minimum of 2 business cycles had not passed. Using data from the NBER, the trough to trough duration of a business cycle post 1945 is estimated to be 69.5 months (Public Information Office, 2010). As a result, all countries with fewer than 12 years of data will not be reflected in the regression outputs.

Secondly, the year included in the analysis must have inflation adjusted expenditure, revenue, and GDP data available. If one of these items were missing for a given year, that year was omitted. As a result of the selection criteria, some countries were able to generate the variance, skewness, and kurtosis numbers (having over 12 years of revenue data) but only had a few years of expenditure data. These countries were included in the analysis only for the years they had complete data.

As a result of the data selection criteria above, the following graphs represent the distribution of log-variance (Figure 3-9), skewness (Figure 3-10), and kurtosis (Figure 3-11) used in the regression analysis.
Figure 3-9: Density Representation of Log-Variance

Density Representation of Log-Variance
Selected countries used in regression analysis

kernel = epanechnikov, bandwidth = 0.9319

Figure 3-9 Notes:

- Shows the density of the revenue variance in log scale used in the regression analysis
- Indicates the distribution of the variance in the sample
- All country – years used in the regression analysis are represented in this graph
- Kernel Used is Epanechnikov
- Source: Author’s Calculations
Figure 3-10: Density Representation of Skewness

Density Representation of Skewness
Selected countries used in regression analysis

Figure 3-10 Notes:

- Shows the density of the revenue skewness used in the regression analysis
- Indicates the distribution of the skewness in the sample
- All country–years used in the regression analysis are represented in this graph
- Kernel Used is Epanechnikov
- Source: Author’s Calculations
Figure 3-11: Density Representation of Kurtosis

Density Representation of Kurtosis
Selected countries used in regression analysis

Figure 3-11 Notes:

- Shows the density of the revenue kurtosis used in the regression analysis
- Indicates the distribution of the kurtosis in the sample
- All country – years used in the regression analysis are represented in this graph
- Kernel Used is Epanechnikov
- Source: Author's Calculations
These graphs demonstrate some important features (and limitations of the analysis). As demonstrated above, there appears to be a wide representation of revenue variance (Figure 3-9). The skewness graph (Figure 3-10) demonstrates that most of the selected countries demonstrate a revenue profile indicating positive skewness.\(^{35}\) In terms of Kurtosis (Figure 3-11), most of the countries appear to cluster around the normal kurtosis levels of two. The lack of variation in the kurtosis metric may (and indeed does) provide some problematic issues with identification of an effect in the analysis.

Looking at the log transformed expenditure (Figure 3-12) and GDP metrics (Figure 3-13), the following graphs represent these variables.

\(^{35}\) While it is possible to weight the negative skewness observations more heavily or change the sample selection criteria to include more negatively skewed countries, this analysis decided to keep the sample selection intact. Further study with deeper and broader data would be desired as time progresses and more data are available.
Figure 3-12: Density Representation of Log-Expenditure

Density Representation of Log-Expenditure
Selected countries used in regression analysis

text

Figure 3-12 Notes:

- Shows the density of the expenditure in log scale used in the regression analysis
- Indicates the distribution of the expenditures used in the sample
- All country – years used in the regression analysis are represented in this graph
- Kernel Used is Epanechnikov
- Source: Author’s Calculations
Figure 3-13 Notes:

- Shows the density of the GDP in log scale used in the regression analysis
- Indicates the distribution of the GDP used in the sample
- All country - years used in the regression analysis are represented in this graph
- Kernel Used is Epanechnikov
- Source: Author's Calculations
Both graphs (Figure 3-12 and Figure 3-13) represent broadly similar patterns with a wide range of variation. Because of the similarity of the two graphs represented above, one would expect a strong correlation between expenditure and GDP to be revealed in the data.

The table below shows some summary statistics for the variables used for each country.
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</tr>
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<td>Peru</td>
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<td>25.55 (0.28)</td>
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<td>0.55</td>
<td>2.37</td>
</tr>
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<td>28.96 (0.26)</td>
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<td>2.10</td>
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<td>22.72 (0.15)</td>
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<td>OBS</td>
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<td>Log-GDP</td>
<td>Log-Variance</td>
<td>Skewness</td>
<td>Kurtosis</td>
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<td>22</td>
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<td>2.27</td>
</tr>
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</tr>
<tr>
<td>Uruguay</td>
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<td>Venezuela, RB</td>
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<td></td>
<td>(0.08)</td>
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<td></td>
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</tr>
<tr>
<td>Congo, Dem. Rep.</td>
<td>18</td>
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<td>26.61</td>
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<td>1.79</td>
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<td>(0.14)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Zambia</td>
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<td>26.75</td>
<td>28.65</td>
<td>57.97</td>
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<td>2.89</td>
</tr>
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<td>(0.21)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 3-2 Notes:

- Shows the name, number of observations, mean and standard deviation of log expenditure, mean and standard deviation of log GDP, log variance, skewness and kurtosis used in the regression analysis
- As observable in Table 3-1, some gaps appear in the data for various country years
- Summary statistics represent only the data used in the regression analysis. If other data was available but not used in the regression for other years, that data was omitted.
Econometric Model

Following the basic procedure for panel data, the econometric testing procedure began with a pooled OLS regression. The regression model is demonstrated by estimating the following equation.

Equation 3-7: OLS Expenditure Regression Model

\[ \text{LN}(\text{EXP}) = \beta_0 + \beta_1 \times \text{LN} (\text{GDP}) + \beta_2 \times \text{LN} (\text{Rvar}) + \beta_3 \times \text{LN} (\text{Rvar})X + \beta_4 \times \text{Rskew} + \beta_5 \times \text{Rskew}X + \beta_6 \times \text{Rkur} + \beta_7 \times \text{Rkur}X + \epsilon \]

The error term is assumed to have zero mean and constant variance in accordance with classical estimation procedure. The variables in this model are detailed in Table 3-3 below.
### Table 3-3: List of Variables Used

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN(EXP)</td>
<td>Natural log of Government Expenditure</td>
</tr>
<tr>
<td>LN(GDP)</td>
<td>Natural log of Real GDP LCU</td>
</tr>
<tr>
<td>LN(Rvar)</td>
<td>Natural log of revenue variance</td>
</tr>
<tr>
<td>LN(Rvar)X</td>
<td>Natural log of revenue variance * Natural log of Real GDP LCU</td>
</tr>
<tr>
<td>Rskew</td>
<td>Revenue Skewness</td>
</tr>
<tr>
<td>RskewX</td>
<td>Revenue Skewness * Natural log of Real GDP LCU</td>
</tr>
<tr>
<td>Rkur</td>
<td>Revenue Kurtosis</td>
</tr>
<tr>
<td>RkurX</td>
<td>Revenue Kurtosis * Natural log of Real GDP LCU</td>
</tr>
</tbody>
</table>

**Table 3-3 Notes:**

- Provides a description of the variables used in the regression analysis
- Refers to the variables listed in Equation 3-7, Equation 3-8, Equation 3-9, Equation 3-10, and Equation 3-11.
After estimating the OLS model, a Fixed Effects model was used. The fixed effects model estimated is represented in the equation below.

Equation 3-8: Fixed Effects Expenditure Regression Model

\[
\text{LN}(\text{EXP})_{it} = \beta_{A} + \beta_{1} \cdot \text{LN}(\text{GDP})_{it} + \beta_{2} \cdot \text{LN}(\text{Rvar})_{it} + \beta_{3} \cdot \text{Rskew}_{it} + \beta_{4} \cdot \text{Rkur}_{it} + e_{it}
\]

A is an integer taking a value between 1 and 77 for each group excluding the base case group. This regression does not have basic variance, skewness, and kurtosis terms because they prove perfectly collinear with the fixed effects term \(\beta_{A}\). The variables in this model are detailed in Table 3-3.

The test against the intercept terms for each of the groups was then tested to determine if group-wise heteroskedasticity was present. The test rejected the null hypothesis that group-wise heteroskedasticity was not present (all \(\beta_{A}\) terms beyond the base case equalled zero) in favour of an alternative hypothesis (that all of the \(\beta_{A}\) terms beyond the base case were not equal to zero) with a p-value of 0.000 and an alpha level of 0.05. The result of this test rejected the OLS model due to incorrect standard errors.

This model proved unsatisfactory because the LN(Rvar), Rskew, and Rkur variables had to be dropped due to collinearity with the intercept terms. The lack of variance of these terms over time meant that this model was unable to provide information on the variables of most interest.

Two main possibilities remained. The first possibility was the regression on group means (aka Between Regression). This seemed attractive because primary interest is the variation between various countries' expenditure. This paper uses a linear prediction model against the means of each group. This model effectively averaged all the time elements for each country together and then regressed the means of each group. Equation 3-9 represents this regression. The variables in this model are detailed in Table 3-3.
Equation 3-9: Group Means Expenditure Regression Model

\[
\ln(\text{EXP})_j = \beta_0 + \beta_1 \cdot \ln(\text{GDP})_j + \beta_2 \cdot \ln(\text{Rvar})_j + \beta_3 \cdot \ln(\text{Rvar})X_{ij} + \beta_4 \cdot \text{Rskew}_i + \beta_5 \cdot \text{Rskew}X_{ij} + \\
\beta_6 \cdot \text{Rkur}_i + \beta_7 \cdot \text{Rkur}X_{ij} + \epsilon_{ij}.
\]

This method was unsatisfactory for two reasons. First, the averaging assumes that each country's time element is the same. However, data for each country are not available for each particular year in the study. It seems presumptuous to assume that the average effect of four years of regressable data in the 1990s would or should be comparable to 22 years of data. Second, this method limits my effect observation set to the groups themselves. This leaves me with only 78 observations. The reduction of observations would reduce any power in hypothesis testing. While the results of this method are reported in the results table for the reader's interest, this method was rejected as the preferred method.

The final option is a Random Effects model. The Random Effects model assumes that the correlation of error found between groups and the regressor matrix \((xB)\) is zero. If this does not hold, then the model would present a bias in the estimates. This assumption may be problematic. Considering variation between groups, nations facing similar revenue characteristics and GDP characteristics have several reasons to have an external shock creating error between the groups. One example of this is an external military threat. One may argue that the presence of an external threat would both increase national expenditure as a country puts itself on war footing and possibly be correlated with the GDP of that country (the correlation could be either positive or negative depending upon various factors).

Given the limited results of the Fixed Effects model, it was possible to test to see if the estimated differences in the estimates were systematic. The null hypothesis for this test was that the differences in the estimates were not systematic; the alternative of the differences in the estimates
were systematic with an alpha level of 0.05. The test resulted in a p-value of 0.12 and thus failing to reject the null hypothesis.

The Random Effects model is represented in Equation 3-10. The variables in this model are detailed in Table 3-3.

**Equation 3-10: Random Effects Expenditure Regression Model**

$$\ln(\text{EXP}_{it}) = \beta_0 + \beta_1 \ln(\text{GDP})_{it} + \beta_2 \ln(\text{Rvar})_{it} + \beta_3 \ln(\text{Rvar}X_{it}) + \beta_4 \text{Rskew}_{it} + \beta_5 \text{RskewX}_{it} +$$

$$\epsilon_{it}$$

This model assumes that $E(\mu_i) = E(\epsilon_{it}) = 0$. It also assumes that each error term has constant variance. The robustness of this model's specification is discussed later in the results section.

The final estimated model is similar to the random effects model however allows for an autoregressive error disturbance of the $\epsilon_{it}$ term. Logically, a shock given in one country year may reasonably be carried over into the next country year. This regression model (Equation 3-11) would therefore have the following characteristic:

**Equation 3-11: Random Effects Expenditure Regression Model with AR1 Disturbance**

$$\ln(\text{EXP}_{it}) = \beta_0 + \beta_1 \ln(\text{GDP})_{it} + \beta_2 \ln(\text{Rvar})_{it} + \beta_3 \ln(\text{Rvar}X_{it}) + \beta_4 \text{Rskew}_{it} + \beta_5 \text{RskewX}_{it} +$$

$$\beta_6 \text{Rkur}_{it} + \beta_7 \text{RkurX}_{it} + \mu_i + \epsilon_{it}$$

The variables in this model are detailed in Table 3-3. The results section will discuss the need for this model in more detail.

**Hypothesis**

These models lend themselves to confirm hypotheses in existing literature and provide support for some explanations regarding the effects of the structure of revenue upon expenditure. As a result, four basic hypotheses are being examined.
The first hypothesis relates between GDP and expenditure. As GDP increases, one expects countries to be able spend more. As a result, the estimated coefficient for LN(GDP) is expected to be positive.

The variance interaction is more complex. The literature suggests that as variance increases, countries with lower levels of GDP would increase expenditures while those with higher levels of GDP would decrease expenditures. As a result, the coefficient for the LN(Rvar)X term is expected to be negative. It remains unclear in the literature if the LN(Rvar) term would take on any particular sign.

The nature of positive skewness indicates that the median and the mode are below the mean. In terms of governmental policy, I suspect that the mode (rather than the mean) is more significant in that it represents the revenues that governments are most likely to realise in a given year. As a result, one would expect governments facing revenue streams with positive skewness should spend less. It then follows that the expected term on the skewness coefficient would be negative.

Finally, with regards to Kurtosis, the parameter on kurtosis and the interaction term are expected to be different as wealth should play a significant factor. The kurtosis term lends itself to the theory that governments facing higher frequency of more severe shocks would demonstrate precautionary savings. As a result the Kurtosis term is expected to be negative. Countries with higher levels of GDP are more likely to be able to access credit markets. As a result, shocks realised through higher kurtosis levels but with high income levels should play less of a role in accounting for government expenditures. Therefore, the interaction term of kurtosis with GDP should be positive because countries would not need to save.

**Results**

Table 3-4 reports the results of each regression analysis. The dependent variable is the natural log of governmental expenditure.
<table>
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<tr>
<th>Variable</th>
<th>OLS</th>
<th>FE</th>
<th>BETWEEN</th>
<th>RE</th>
<th>RE ARl</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN(GDP)</td>
<td>0.765***</td>
<td>0.598***</td>
<td>0.810***</td>
<td>0.612***</td>
<td>0.645***</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.150)</td>
<td>(0.155)</td>
<td>(0.099)</td>
<td>(0.113)</td>
</tr>
<tr>
<td>LN(Rvar)</td>
<td>-0.035**</td>
<td>N/A</td>
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<td>-0.007</td>
<td>-0.008</td>
</tr>
<tr>
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<td>(0.017)</td>
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<td>(0.065)</td>
<td>(0.049)</td>
<td>(0.054)</td>
</tr>
<tr>
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<td>0.002</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
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<tr>
<td>Rskew</td>
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<td>2.771***</td>
<td>2.318</td>
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<tr>
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<td>(0.546)</td>
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<td>(2.019)</td>
<td>(1.278)</td>
<td>(1.495)</td>
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<tr>
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<td>-0.088</td>
<td>-0.129*</td>
<td>-0.127***</td>
<td>-0.110*</td>
</tr>
<tr>
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<td>(0.077)</td>
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<td>Rkur</td>
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<td>-1.095</td>
</tr>
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<td>(1.150)</td>
<td>(0.599)</td>
<td>(-0.736)</td>
</tr>
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<td>0.065**</td>
<td>0.041</td>
<td>0.065***</td>
<td>0.045</td>
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<tr>
<td></td>
<td>(0.012)</td>
<td>(0.028)</td>
<td>(0.045)</td>
<td>(0.023)</td>
<td>(0.029)</td>
</tr>
<tr>
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<td>5.191**</td>
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<td>(0.525)</td>
<td>(3.674)</td>
<td>(2.599)</td>
<td>(2.930)</td>
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**JOINT TESTS**

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<tr>
<th></th>
<th>F(2,1260)</th>
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<th>F(2,70)</th>
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<th>Chi2(2)</th>
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<tr>
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<td>0.541</td>
<td>0.0000</td>
<td>0.0000</td>
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</tr>
<tr>
<td>Skewness</td>
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<td>3.98**</td>
<td>21.54***</td>
<td>17.40***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.0231</td>
<td>0.0000</td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td>Kurtosis</td>
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<td>0.50</td>
<td>8.51***</td>
<td>3.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.609</td>
<td>0.0142</td>
<td>0.2170</td>
<td></td>
</tr>
<tr>
<td><strong>P-Value</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0000</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-4: Regression Results
Table 3-4 Notes:

- *** indicates the variable was significant at an alpha level of 0.01 or smaller
- ** indicates the variable was significant at an alpha level of 0.05 but not smaller than 0.01
- * indicates the variable was significant at an alpha level of 0.10 but not smaller than 0.05
- Standard errors are below the estimates in parentheses for all point estimates
- The corresponding P-Values for the joint tests are listed below the relevant F or Chi2 test statistic
The first hypothesis stated that GDP should have a positive effect on governmental expenditure. Indeed the coefficient on the GDP term is both positive and significant in all regressions. The parameter suggests that the elasticity of governmental expenditure with regards to GDP is 0.612.

The second hypothesis stated that the interaction term between revenue variance and GDP was expected to be negative. The coefficients on the interaction terms were neither negative nor statistically significant beyond the significance found in the OLS regression. As a result, no support is provided for the second hypothesis. The reason for the insignificance may arise from the high correlation between GDP and Variance. Joint tests on the significance of the two variance terms were highly significant in the OLS and both Random Effects regressions. This suggests that there is an effect between variance and expenditure when controlling for GDP and that high (but not perfect) collinearity is a problem with these data.

The third hypothesis stated that the relationship between skewness and spending would be negative. In most models, the skewness term was positive and significant while the interaction term with GDP was negative and significant. This result suggests that the way governments deal with skewness in their revenue stream depends upon the income level of the country. A one point increase in skewness accounts for a 2.7% increase in expenditure when no GDP effect is present. This effect is diminished by increasing wealth. While the random effects regression controlling for an autoregressive correlation in standard errors rendered the skewness parameter insignificant and the interaction term marginal, the joint F test rejects the null hypothesis that both are equal to zero.

The final hypothesis states that kurtosis should yield a negative parameter and that the interaction term should be positive. Indeed, some kurtosis terms were negative in the regressions (although not statistically significant in all regressions). The interaction term was positive and significant in many regressions. This again suggests a difference in effect between poorer countries and more wealthy countries in the way they deal with kurtosis in their revenue. More should be
done to confirm if precautionary savings is the motivation and mechanism for the decrease in expenditure.

**Robustness**

The robustness considerations for this research come in three forms. The first comes from the sample selection of only using countries with 12 years of data and limiting analysis to only those years where income is given for that particular year. The second consideration comes from the nature of the regressions facing heteroskedasticity or autocorrelation of residuals. Finally, a quick discussion of possible endogeneity is required.

The logic for the sample selection was to provide a robust two business cycle of data of information. Dropping this requirement and assuming variance, skewness, and kurtosis were valid for years where expenditure was available but no income was reported led to an increase in magnitude in the estimated parameter of the income variable. The variance signs were consistent with previous regressions but were insignificant. The skewness and kurtosis signs both changed and were rendered insignificant. The joint test on the variance terms failed to reject the null hypothesis that all the variance terms equalled zero. The joint test on the skewness terms rejected the hypothesis that both skewness terms equalled zero with a p-value of 0.0227. The test failed to reject the null hypothesis on the kurtosis terms.

With regards to heteroskedasticity, it was shown to be present and corrected. The Fixed Effects model was tested against the Random Effects model and the differences between the two models was shown to not be systematic statistically. The Breusch-Pagan / Cook-Weisberg test for heteroskedasticity against the OLS model rejected the null hypothesis of constant variance in the OLS model with a test statistic of 491.37 and a corresponding p-value of 0.0000.

Because of the time-series nature of the data, one would expect some autocorrelation with each group of residuals to be present. Intuitively this would seem reasonable as government spending
facing a shock in one year may well be correlated to the spending in another period, ceteris paribus.

A random effects regression with a first order autoregressive correction was run. If autocorrelation of residuals is not present, the autocorrelation parameter would equate to zero. If the autocorrelation parameter is greater than one, then a more systemic problem would exist within the time-series nature of the data. The regression estimated the autoregressive parameter rho to have a value of 0.537. This value is significantly higher than zero and well less than one.

The structure of the regression model leaves the possibility of some level of endogeneity. First, it is unlikely that endogeneity exists with regards to the revenue moments. Variability, skewness, and kurtosis of revenue may be caused by the presence of shock-absorbers and expenditure policy. However, it is assumed that this effect is negligible over time and across panels to be a major issue. The time element of this relationship was the reason for the two business cycle criteria for determining revenue values.

GDP represents a more troubling endogeneity problem. Clearly government expenditure is counted in GDP, through the expenditure identity. GDP (and expected GDP) will have an effect on government expenditure. Therefore, the positive relationship found in the regression is unsurprising. Solving the GDP endogeneity problem requires a variable strongly correlated with GDP but unable to cause an increase in governmental expenditure.

One approach would be to use expenditure as a ratio of GDP as the dependent variable. This regression saw both variance terms positive and insignificant. The skewness term was negative and the interaction term was positive, again both insignificant individually. The Kurtosis term was positive and the kurtosis interaction term was negative. The kurtosis terms were both marginally significant only with an alpha level of 0.1. The joint test on variance was insignificant. The joint test on skewness was significant with a test statistic of 6.72 and an associate p-value of 0.0347. While the Kurtosis individual tests were marginally significant, the joint test failed to reject the null
hypothesis that both parameters equate to zero. This regression corrected for autocorrelation of errors.

**Conclusion**

Tax proposals should include both the basic economic analysis with deadweight loss estimates arising from the tax and a set of structural characteristics (even if only estimated) regarding the tax for policy planning purposes. As each country has different political systems, it then follows that each country will have differing tolerances for tax structures with various characteristics. Omission of the tax characteristics may lead to significant surprises for policy makers in the future.

Specifically, policy makers should consider the first moment (mean), second moment (variance), third moment (skewness), and the fourth moment (kurtosis) for every tax policy. The first moment will provide an average expectation regarding the quantity of revenue the tax would likely generate. The second moment will provide visibility regarding the dependence of policy makers on either savings or on financial markets to smooth revenue streams in good or bad years without having to make significant changes to spending which may lead to decreased economic growth. The third moment provides an indication as to the relative potential bias of shortfall or surplus years. This gives policy makers a more realistic expectation about the likelihood of observing initial revenue estimate in a given policy year. The fourth moment provides policy makers with an expectation of how frequently significant tax revenue events may occur which would likely require the attention and potential action of policy makers.

The regressions indicate that an increase in skewness accounts for an increase in governmental expenditure. This effect diminishes as a country becomes wealthier. An increase in kurtosis appears to have a negative effect on governmental spending for governments with less income. The effect appears to reduce as countries become wealthier.
This research provides some key areas for extension into the mechanisms through which the moments of revenue lead to changes in expenditure. First, the determination of the mechanism through the nature of the tax base could be analysed by using a metric for the cyclic nature of the tax base. Metrics showing each economy's relative exposure to a global business cycle or a metric indicating deviation from either full employment or a sustained long run growth path could lead to an interesting insight. Second, research into each nation's revenue generating structure may provide an indication if the mechanism is an artefact of the taxation (or expenditure) regulation itself. One example of expenditures would be the presence of automatic stabilisers. On the revenue side, the use of tax credits for cyclical or secular industries would alter the moments of a government's revenue stream. Finally, a model for institutional and behavioural interactions could be added. The behavioural and institutional models will likely be highly stylised to each country given the wide variety of political and policy making institutions (even among democratic countries).

I would like to thank Paul Scanlon, Patrick Honohan and Gaëtan Nicodème for their timely support and comments. As always, all errors and omissions in this paper are purely the fault of the author and in no way reflect upon these kind people.
Chapter 4: Effective Modelling of Elections during Wartime: A Comparison of Methods

Introduction

Economic issues matter in elections. One example is the famous sign posted in then candidate William Jefferson Clinton’s office reading “It’s the economy stupid!” (James Carville, 1992) However, do economic issues interrelate with other political considerations? Recent research modelling elections includes a variable to indicate the election as held during wartime. But does this relationship change over time? Does the process generating election returns in the first election after a war begins accurately represent the process of generating election returns after multiple years of war? What if the economic costs (both in terms of treasure and blood) are increasing beyond what was initially expected? This paper examines if an increasing war cost model or an election time model outperform the standard use of a dummy variable in the existing literature.

This paper also attempts to isolate any interaction between war costs realised and economic variables in driving the voting process. Would war costs interact with domestic issues to yield differing returns? If so, then the effect of an economic variable (such as unemployment or per capita income) could be misinterpreted in the presence of a war. This effect may be compounded when a war continues for many years.

The results suggest that all variations of a model which more accurately captures war costs outperform the dummy variable model. The mechanism for this difference cannot be seen clearly in the data available.

Existing Literature

Most predictive models for elections in the United States combine economic information with information collected from surveys or polls. The use of polls can be traced back to (Edward R. Tufte, 1978). Many models have extended and augmented peace/prosperity variables in their regressions.
An example of this is found in Lewis-Beck and Stegmaier (2000). This variable uses Gallop polling data to control for war time preferences of voters and ignore any actual war underway. In analysing the use of Gallop polls, Lewis-Beck found that “polls failed to provide two fundamental ingredients of good forecasting: lead time and accuracy” (2001). While this paper is not looking at issues relating to the forecasting of elections, it raises serious doubts about using polls in posterior analysis.

Among the more quantitatively intensive models, the work of Ray Fair is popular. Modelling presidential vote shares, Fair has updated and expanded his prediction models ever since. In the most recent paper, Fair also examines votes for the US House of Representatives (2009). This paper presents a good examination of structural economic equations at work during elections. However, this work tends to underplay the role of a war in key election decisions.

In the line of Fair’s models, one finds the work of David Walker (2006). David Walker expanded on the work of Ray Fair by including a dummy variable to account for Korea and Vietnam and resolve some nagging serial correlation issues. The dummy variable was interacted against some economic variables (such as inflation) to improve predictive power of the models.

Each model uses economic data to help predict elections. The logic for this is established well in the popular consideration and in the literature. Steven Rosenstone shows “Economic hardship increases the opportunity costs to voting and reduce a person’s capacity to attend to politics” (1982).

The bread and peace models examine only economic and war variables (Douglas A. Hibbs Jr., 2000). The Hibbs model, after multiple iterations and work, finds that two-party presidential vote share is best explained by disposable income per capita and the number of military personnel killed in Korea and Vietnam.

Each of the models referenced above analyse the share of vote in a two-party election (sometimes allowing for a third party by way of a dummy variable). Logically extending the literature, if economic factors drive turnout behaviour, then vote share equations may simply
capture which part of the electorate becomes motivated to vote. The Hibbs model accounts for increasing costs to the war. However, the Hibbs model fails to interact the war term with economic variables. As a result, Hibbs' models fail to determine econometrically if the economic variables have a different effect during wartime than during peacetime. Hibbs uses a cumulative body count of US forces killed during Korea and Vietnam conflicts to inform his analysis. This paper follows Hibbs in using casualty figures during the Iraq conflict.

The Hibbs bread and peace model represents modelling simplicity. The lagged disposable income growth coupled with the cumulative body counts account for a significant amount of vote. However, the bread and peace model only measures the share of two-party vote. This analysis looks at actual votes cast. By using votes cast, one can see if economic or war issues attract more people into the political process generally. This effect would not be seen by the bread and peace model. Furthermore, this analysis extends the bread and peace models by looking for interaction effects of war costs with other economic variables.

There has been much research into the relationship of the public and those making policy during wartime. Lunch and Sperlich suggest that "the war in Vietnam seems to have altered, at least temporarily, the normal relationship between elites and masses in the area of foreign policy" (William L. Lunch and Peter W. Sperlich, 1979). Gartner and Segura looked at the use of casualty data in public polling predictive models. They believe that casualty numbers are an important predictor in determining wartime opinion. Their research further suggests that marginal casualties (showing the increase and escalation of a conflict) should be included with cumulative casualties in models trying to predict opinion polls (Scott Sigmund Gartner and Gary M. Segura, 1998).

More recently Berinsky and Druckman argue that models which have public support for a war as a function of initial support for the war and the perception of the likelihood of success are flawed. Berinsky and Druckman argue that casualty tolerance tends not to model war support but more
accurately described as being able to model latent support for a war but not of current opinion (Adam J. Berinsky and James N. Druckman, 2007).

**Hypotheses**

Models which utilise only a dummy variable fail to utilise all available information due to omitted variables. Simply put, the fact that a war continues through two election cycles correlates the residuals for these election cycles. Furthermore, the war costs may be correlated also with other explanatory variables leading to issues in model identification.

In order to identify if data is being lost, a model will be run using a dummy variable for years during the Iraq war. This model will be augmented with one measure of the cost of the war and the quadratic term of the cost. The use of the quadratic term looks for any diminishing return effects to the prolonged nature of the war. Additionally, the use of the Quadratic term accounts for a "rally around the leader" effect in American politics in which war support (and with it support for the party in power) increases during the early days of a war and tapers off as the conflict continues. If the war cost variable and the quadratic term are significant in spite of the presence of the war dummy, then information is being lost in the regression. This test will indicate that the lost information adds explanatory power to the model and can be considered an omitted variable.

Assuming information is being lost, I hypothesise that the war costs would interact with various economic and demographic variables. The costs associated with the war (both in terms of lives lost and financial costs) are unlikely to be distributed uniformly through an economy. Furthermore, increasing costs of the war may change future expectations of economic performance leading to changes in votes. Therefore, using existing economic numbers would fail to capture the differences in cost dispersion and expectations upon electoral outcomes. To help deal with this issue, the level of analysis was reduced to the county level (rather than the state or national level which is common in the literature). Variations in economic variables between counties help reveal how such variation affects vote tallies. Furthermore, using actual votes cast rather than vote share helps demonstrate
differences in turnout. Turnout differences caused by wartime effects are likely more pronounced in areas bearing a higher level of war costs. Vote share would fail to directly capture these differences in voting behaviour.

Because the model used in this paper targets a simple and concise demonstration of lost explanatory power and does not intend to maximise all available information in generating vote predictions, the ability to see cross-effects is expected to be rather limited. The presence of cross-effects remains of interest. If cross-effects are found they would provide insight into the mechanism of voters’ internalisation of both war costs and potential war benefits and its impact with their vote. As a result, this paper deploys a test for absence of cross-effects as demonstrated by interaction terms between war costs and economic variables. These interaction terms will be tested jointly to see if their coefficients equate to zero. The null hypothesis is that the terms are jointly insignificant and, therefore, all the terms equate to zero. The alternative hypothesis is that one of the terms does not equate to zero. This test intends to identify if further research should be done in the area of cross-effects to isolate the precise mechanisms.

Data and Methodology

This study looks at county level vote totals for the candidate put forward by the Democratic Party in federal and gubernatorial elections in Maine between 1992 and 2008.\(^{36}\) The congressional districts changed little during this time. Kennebec notwithstanding, each observational unit (county) remains in the same congressional district for voting purposes. As a result, this sample utilises 364 observations across 16 counties.\(^{37}\)

The model estimates the natural logarithmic transformation of the summation of votes received for the Democratic (or Republican) candidate for a given county-election-year as provided by the

\(^{36}\) The presidential race in 1992 does not have the requisite data available and was dropped from the sample.

\(^{37}\) Two observations from Kennebec County were lost due to the split congressional districts. The 2002 and 2008 years saw incumbents in one congressional district while an open seat in the other. This was adjusted by dropping these two observations rather than splitting the county.
The use of actual votes versus two-party vote share comes from several distinct factors. First, Maine has a political history of possessing "a distinctive personality—ornery, contrary-minded, almost bullheaded, rough-hewn" (Michael Barone and Richard E. Cohen, 2007). This translates to a significant quantity of votes being sent to third parties. For example, Maine elected an Independent (not a member of the Republican or Democratic Party) to the governorship in the 1994 elections. Governor Angus King served until 2003 when he was replaced by a Democrat. Later, in the 2010 gubernatorial elections, the presence of a very strong third party candidate, Elliot Cutler, coupled with the tea-party surge in that year's election led to the Republican Paul LePage being elected governor with only 38.33% of the vote. The two-party vote share would indicate a difference in the 2010 gubernatorial election of 19.21 towards the Republican. Yet, analysis of votes cast tells a dramatically different tale. This is further compounded because the presence of the independent candidates falls directly in the study time window. As a result, in Maine, independent candidates have a real possibility of winning office in Maine. This reality does not well hold throughout the entire United States. While two-party vote share may work well when looking at aggregate races throughout the entire United States, it does not capture well the political realities in a state such as Maine.

A second reason to use votes versus two-party vote share comes from controlling for population migration. When a geo-political area faces immigration or emigration, the net political views of those coming and leaving have to be assumed to be net neutral when using two-party vote share. The only variable of interest by using two-party vote share is the percentage of the vote. Yet, if turnout increases disproportionately, this would not be tallied by two-party vote share. Because the observational unit in this research is at the county level, two-party vote share would likely mask differences in turnout. This becomes an issue with highly populated counties (such as Cumberland)
which can command a large part of the two-party vote share in comparison to a less densely populated county (such as Washington). The differences between rural and urban voters potentially play an important part of the story. As a result, vote tallies help to ensure less data is lost by using vote shares.

Some attempt to deal with the migration problem by using two-stage models (such as a Heckman model). The first stage would attempt to predict turnout while the second stage would attempt to predict candidate selection. Some issues exist with these models. First, many people vote only for one race in a given election. Thus, someone who was less than satisfied with the available choices for US President may yet cast a ballot leaving US President blank but selecting the other candidates. Secondly, many people do not exhibit a two-stage decision process. Partisans tend to either be satisfied with their party’s candidate or not. If they are satisfied (or feel otherwise compelled to vote) they will vote and only vote for their party’s candidate. If they are not satisfied, partisans generally will not vote rather than vote for the opposing party. As a result of partisan behaviour, two-stage Heckman models fail to correctly model partisan voting behaviour. Admittedly, there are fewer pure partisans in Maine than in many other states. However, this factor added to the third party trend in voting seems to be sufficient reason to jettison the two-stage approach for the purposes of this study.

In order to isolate the effects of the war in Iraq, various economic, demographic, and political control variables were used. The economic controls are the local unemployment rate (Center for Workforce Research and Information (CWRI), 2010b) and per capita personal income (Center for Workforce Research and Information (CWRI), 2010a). Per capita income has been shown to be significant in Hibbs’ research (Douglas A. Hibbs Jr., 2000). Unemployment has a direct logical link to elections. Scholars dispute if this variable should be included in this type of regression (Leo Kahane, 2009, Gerald H. Kramer, 1971). Inflation has not been controlled for in this regression as county level data was not available. The use of some economic controls for congressional races is in some
dispute. Lynch argues that economic variables do not assist much in predicting mid-term congressional elections in the 20th century (G. P. Lynch, 2002). In contrast, countless models such as Lewis-Beck and Stegmaier serve as an example of the opposite finding (M. S. Lewis-Beck and M. Stegmaier, 2000).

Inflation has been omitted from this analysis. Inflation data at the county level is not available for each of the election years. The state-wide inflation level would therefore be applied to all counties. The marginal value the state inflation data would add would be confused with the election year controls. As a result, election year controls were deemed more important. A more robust vote prediction model would likely include inflation as a parameter. Because the focus of the paper's analysis is comparative in nature, the omission of inflation is not deemed to provide a structural flaw.

The demographic control variables are population (Bureau of Economic Analysis, 2010) and the mean age of the population (Population Division, 2009). Because the regression utilises actual votes rather than vote share, a control for population becomes necessary. Logically, if more people live in a certain area, one would expect more votes cast.

The political controls include the number of registered voters (Elections and Commissions Bureau of Corporations, 2010b), dummy variables for incumbent Democrats and Republicans, dummy variable for a presidential election year, dummy variables for the type of office, and the previous number of votes received by a candidate for the same office in the prior election cycle (Elections and Commissions Bureau of Corporations, 2010a). If more voters are registered to vote in a given area, then one would expect the number of votes cast to be higher. Existing literature has well established an advantage for incumbents in American politics (Andrew Gelman and Gary King, 1990). Therefore, an incumbency dummy assists in capturing and isolating this effect. The

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38 In the case of the US Senate, the prior cycle represents the votes cast the last time citizens could vote for any Senate seat and not the votes cast for the particular seat in question.
presidential year dummy variable tries to control for potential misspecification as noted by Ray Fair (2009). The dummy variables for type of office being elected are used to check for group-wise heteroskedasticity. Finally, the number of votes received by the candidate for the same office in the prior election cycle effectively acts as an autoregressive control in the first order.

In order to accurately capture the costs of the war, two methods are available. The first method is to use Governmental appropriations in an attempt to find the actual cost. This method is rather difficult because many of the costs for the war are hidden behind several appropriations and across multiple departments. One could look at differences in the trends of government spending. However, due to the attack on the United States in 2001, one could reasonably argue that the trend was significantly changing due to governmental reorganisation (e.g. the creation of the Department of Homeland Security). As a result, while the use of financial war costs is desirable, a robust financial baseline trend does not seem plausibly available.

The second method is to count the number of military casualties suffered during the war. This method provides direct isolation of the "costs" associated with only the war. Defining casualties in this instance proves moderately problematic. First, the domain of casualties needs to be identified. The domain possibilities include all combatants, all persons (including civilian), only allied personnel, and only US combatants. Because the target study is on the effects of the war on US voting behaviour, it seems that the most likely effect would come from US deaths. Clearly some people would be motivated by all casualties (including civilian). However, those motivated by civilian deaths would likely not appear in the data as causing much variation. Those troubled by civilian deaths likely opposed the war from the beginning and thus never changed their voting behaviour on account of an increase or escalation in the war.

Secondly, one must decide if casualties are both wounded and killed or only killed. The following graph displays the number of those killed and those wounded in the Iraqi conflict over time. Clearly more US forces were wounded than killed over time in operation Iraqi Freedom. Using
wounded numbers presents some scale problems. A wounded soldier tally indicates neither how the soldier was wounded (accident, enemy action injury, or friendly fire incident) nor the extent of the injuries. Thus, some labelled wounded may be able to return to duty. Also, this study focuses on the effect of the war on the public mind and consciousness. While wounded soldiers matter, dead bodies arguably matter more. It matters so much, the Bush Administration put a full ban on media coverage of honour guard ceremonies of caskets returning from the war zone. This policy was reversed by the Obama administration (Ralph Begleiter et al., 2009).

39 This paper precludes the idea found during the Vietnam War of soldiers “enhancing” the extent of their injuries in order to be relieved of duty. This was done because the United States did not institute conscription during operation Iraqi Freedom. Any remaining measurement error from such cases is considered negligible.
Time Trend of US Forces Killed and Wounded in Iraq
(Operation Iraqi Freedom Only)

Figure 4-1 Notes:

- Shows the cumulative number of US forces killed and wounded in Iraq
- Source: (GlobalSecurity.org, 2010) via US DOD
Clearly nobody would dispute that deaths should be included in any measure of a war's cost. However, injuries clearly matter in war costs. (Linda Bilmes and Joseph Stiglitz) estimated that the costs to the war (which were not being captured by the Congressional Budget office at the time) included "lifetime healthcare and disability payments to returning veterans, replenishment of military hardware, and increased recruitment costs" (2006). These costs clearly matter in an economic sense. As a result, those motivated by war costs could face this on two different points. The first is the humanitarian toll. The dead bodies would highly motivate this group. The second point could come from those considering the long term economic costs of the war (in a manner suggested by Bilmes and Stiglitz). Thus, bringing these two groups together appears to present a more accurate representation of war costs.

Figure 4-2 displays the yearly increase (rather than the running total) of wounded and killed forces in Operation Iraqi Freedom. Because Operation Iraqi Freedom began in 2003 (between federal election years) only 3 federal election years are included in this study (2004, 2006, and 2008). Recall that in 2007, US President George W. Bush announced an increase in troops to deal with increasing sectarian violence (Jonathan Karl, 2007). This may explain the drop of force casualties between 2006 and the 2008 elections.
Figure 4-2: New Casualties of US Forces

New Casualties of US Forces
(Operation Iraqi Freedom Only)

Figure 4-2 Notes:

- Shows the marginal increase of US forces killed or wounded in a given federal election year.
- Federal elections occur in the United States every two years (ending in an even number).
- Does not include data for special federal elections occurring outside the normal cycle as none occur in Maine during this period.
- Source: (GlobalSecurity.org, 2010) via US DOD
As a result, the war cost variable is generated from casualties suffered from war in Iraq. This comes from the total number of US forces killed and the total number of US forces wounded as available from GlobalSecurity.org (by way of the US Department of Defense (GlobalSecurity.org, 2010)). Following Hibbs, the Iraq casualty numbers are cumulative and hold all body counts at the time of election (Douglas A. Hibbs Jr., 2000). This expands upon the intuition that the effect on voters in the first election following the outbreak of war is likely different than the effect of the war on the tenth election. As a result, dummy variables for war time appear inappropriate.

Summary statistics are available in Table 4-1 for all variables used in this paper.
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<th>County:</th>
<th>Votes for Democrats x(1,000)</th>
<th>Votes for Republicans x(1,000)</th>
<th>Total Voter Registration x(1,000)</th>
<th>Unemp Rate</th>
<th>Population x(10,000)</th>
<th>Income Per Capita x(10,000)</th>
<th>Median Age</th>
<th>Congressional District</th>
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<td>(8.01)</td>
<td>(3.71)</td>
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<td>(0.631)</td>
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Table 4-2 breaks out data by county.
Table 4-2 provides age as a metric. The age variable was not available for a significant number of county-years and thus was dropped from all regressions. It is included here only to provide an intuitive sense about the general makeup of the county. Table 4-3 breaks out the variables by the given race being observed.

### Econometric Models
In order to successfully test if an increasing costs model is superior to using only a dummy variable, five regressions will be performed. The first regression is a control regression demonstrating what the variable estimates would be without the presence of a war term. This is represented by Equation 4-1.

**Equation 4-1: Hypothesis 1 - Control Regression**

\[
\ln(DVOTE)_{i,t} = \beta_0 + \beta_1 \cdot PRESYR_{i,t} + \beta_2 \cdot USR_{i,t} + \beta_3 \cdot SEN_{i,t} + \beta_4 \cdot GOV_{i,t} + \beta_5 \cdot PREDEM_{i,t} + \beta_6 \cdot PREREP_{i,t} + \beta_7 \cdot INCDEM_{i,t} + \\
\beta_8 \cdot INCREP_{i,t} + \beta_9 \cdot LN(REG)_{i,t} + \beta_{10} \cdot LN(POP)_{i,t} + \beta_{11} \cdot LN(YGDP)_{i,t} + \beta_{12} \cdot UNEMP_{i,t} + \epsilon_{i,t}
\]

The alpha in this equation takes on a value for each county providing a fixed effect control at the county level. Additionally, one will note that race controls have been used. As a result of the race controls, the constant term represents the aggregate vote in the presidential race. The control for the US House of Representatives (USR), US Senate (SEN), and the gubernatorial race (GOV) are to be interpreted as offsets from the presidential base vote. Table 4-1 provides more data on each variable and its sourcing.

The second regression consists of the control regression (Equation 4-1) with the dummy variable for war years. This is represented by Equation 4-2. The DWAR variable is simply a dummy variable which takes on a value of 1 when a war is progressing. It has a value of 0 otherwise.

**Equation 4-2: Hypothesis 1 - War Dummy**

\[
\ln(DVOTE)_{i,t} = \beta_0 + \beta_1 \cdot PRESYR_{i,t} + \beta_2 \cdot USR_{i,t} + \beta_3 \cdot SEN_{i,t} + \beta_4 \cdot GOV_{i,t} + \beta_5 \cdot PREDEM_{i,t} + \beta_6 \cdot PREREP_{i,t} + \beta_7 \cdot INCDEM_{i,t} + \\
\beta_8 \cdot INCREP_{i,t} + \beta_9 \cdot LN(REG)_{i,t} + \beta_{10} \cdot LN(POP)_{i,t} + \beta_{11} \cdot LN(YGDP)_{i,t} + \beta_{12} \cdot UNEMP_{i,t} + \beta_{13} \cdot DWAR_{i,t} + \epsilon_{i,t}
\]

The third regression consists of the control regression (Equation 4-1) with a variable that increases by one for every election held with a continuing war. This is represented by Equation 4-3. The LWC variable in this regression takes on a value of unity in the first election after a war has begun. It increases by one for each election cycle afterwards as long as the war continues.
Equation 4-3: Hypothesis 1 - Linear War Costs

$$\ln(DVOTE)_{it} = \beta_0 + \beta_1 \cdot \text{PRESYR}_{it} + \beta_2 \cdot \text{USR}_{it} + \beta_3 \cdot \text{SEN}_{it} + \beta_4 \cdot \text{GOV}_{it} + \beta_5 \cdot \text{PREDEM}_{it} + \beta_6 \cdot \text{PREREP}_{it} + \beta_7 \cdot \text{INCDEM}_{it} +$$

$$\beta_8 \cdot \text{INCREP}_{it} + \beta_9 \cdot \ln(\text{REG})_{it} + \beta_{10} \cdot \ln(\text{POP})_{it} + \beta_{11} \cdot \ln(\text{YGDP})_{it} + \beta_{12} \cdot \text{UNEMP}_{it} + \beta_{13} \cdot \text{LWC}_{it} + \epsilon_{it}$$

The fourth regression utilises the control regression (Equation 4-1) with the linear and quadratic war cost variables. Equation 4-4 represents this regression. The WC term in this regression utilises the number of US Forces killed in Iraq. This regression also presents a quadratic term for the war costs variable.

Equation 4-4: Hypothesis 1 - Increasing War Costs

$$\ln(DVOTE)_{it} = \beta_0 + \beta_1 \cdot \text{PRESYR}_{it} + \beta_2 \cdot \text{USR}_{it} + \beta_3 \cdot \text{SEN}_{it} + \beta_4 \cdot \text{GOV}_{it} + \beta_5 \cdot \text{PREDEM}_{it} + \beta_6 \cdot \text{PREREP}_{it} + \beta_7 \cdot \text{INCDEM}_{it} +$$

$$\beta_8 \cdot \text{INCREP}_{it} + \beta_9 \cdot \ln(\text{REG})_{it} + \beta_{10} \cdot \ln(\text{POP})_{it} + \beta_{11} \cdot \ln(\text{YGDP})_{it} + \beta_{12} \cdot \text{UNEMP}_{it} + \beta_{13} \cdot \text{LWC}_{it} + \beta_{14} \cdot \text{WC}_{it}^2 + \epsilon_{it}$$

The final regression will consist of the fourth regression (using war costs) and including the dummy war term. Equation 4-5 represents this regression. This regression is a combination of Equation 4-2 and Equation 4-4.

Equation 4-5: Hypothesis 1 - Dummy with Increasing War Costs

$$\ln(DVOTE)_{it} = \beta_0 + \beta_1 \cdot \text{PRESYR}_{it} + \beta_2 \cdot \text{USR}_{it} + \beta_3 \cdot \text{SEN}_{it} + \beta_4 \cdot \text{GOV}_{it} + \beta_5 \cdot \text{PREDEM}_{it} + \beta_6 \cdot \text{PREREP}_{it} + \beta_7 \cdot \text{INCDEM}_{it} +$$

$$\beta_8 \cdot \text{INCREP}_{it} + \beta_9 \cdot \ln(\text{REG})_{it} + \beta_{10} \cdot \ln(\text{POP})_{it} + \beta_{11} \cdot \ln(\text{YGDP})_{it} + \beta_{12} \cdot \text{UNEMP}_{it} + \beta_{13} \cdot \text{LWC}_{it} + \beta_{14} \cdot \text{WC}_{it} + \beta_{15} \cdot \text{DWAR}_{it} +$$

$$\beta_{16} \cdot \text{WC}_{it}^2 + \epsilon_{it}$$

One expects several events to be true if the increasing costs model is superior to using only a dummy variable. First, one would expect all regressions to outperform the control regression. If this first condition does not hold, then the test should be considered invalid. Second, the fourth regression using war costs should have higher predictive power than the dummy variable regression.
Finally, a joint test on the war cost variables in the fifth regression (war costs with the war dummy variable) should reject a null hypothesis that the estimated parameters for the war cost variables equate to zero. The use of the joint test provides help to remediate any issue caused from collinearity leading to variance inflation. While the joint test is not fully conclusive, it does provide a strong indication that the net contribution of the variables (or another variable with the same form) provides value in the regression.

For testing the presence of interaction terms, control regression (Equation 4-1) will have a war costs variable plus selected interaction terms. Equation 4-6 represents this regression. For the test of the hypothesis to be successful, a joint test on all the interaction terms ($\beta_{14}, \beta_{15}, \beta_{16}$, and $\beta_{17}$) should reject a null hypothesis that all the interaction terms equate to zero.

Equation 4-6: Hypothesis 2 - Regression

$$\text{LN(DVOTE)}_{it} = \beta_0 + \beta_1 \cdot \text{PRESYR}_t + \beta_2 \cdot \text{USR}_t + \beta_3 \cdot \text{SEN}_t + \beta_4 \cdot \text{GOV}_t + \beta_5 \cdot \text{PREDEM},_t + \beta_6 \cdot \text{PREREP},_t + \beta_7 \cdot \text{INCDEM},_t +$$

$$\beta_8 \cdot \text{INCREP},_t + \beta_9 \cdot \text{LN(REG)}_{it} + \beta_{10} \cdot \text{LN(POP)}_{it} + \beta_{11} \cdot \text{YGDP}_{it} + \beta_{12} \cdot \text{UNEMP}_{it} + \beta_{13} \cdot \text{WC}_{it} + \beta_{14} \cdot \text{WC},_t + \beta_{15} \cdot \text{REG}_{it} + \beta_{16} \cdot \text{WC}_{it} + \beta_{17} \cdot \text{UNEMP}_{it} + \epsilon_{it}$$

All regressions shall utilise controls for fixed effects along the country groups. Additionally, the regressions contain a previous vote variable which acts as a first-order autoregressive term. The previous vote variable is matched to the votes cast for the office sought in the previous election cycle. This is needed because the result of one election clearly has an effect upon the results of the next election. Following Walker, autocorrelation does appear to be a problem when using election returns data (David A. Walker, 2006).

Results
The following components reveal that an increase in casualties by one body increases the votes cast for the democratic candidate by approximately 1.47E-04 per cent. Put another way, every additional 10,000 casualties account for an increase in the Democratic candidate's vote by 1.47% in the given county-election-year. Because of the structure of the testing, those killed in action versus only wounded have the same effect.

**Hypothesis Test Results**

The hypothesis that a war costs model outperforms a model utilising only dummy variables appears to hold. Table 4-4 demonstrates the regressions performed for this part. The predictive power of all the regressions surpassed the predictive power of the control regressions as expected. Therefore, this is considered to be a valid test of the hypothesis. The predictive power of the war costs model was slightly higher than the predictive power of the war dummy model (0.6419 versus 0.6276 respectively). While these numbers are very close, the second condition of the test holds true. The joint F-test regression five, that at least one of the war terms (in the presence of a dummy variable for the war) is significant, rejected the null hypothesis that both variables are insignificant at an alpha level of 5%. The F-test statistic was 6.68. This equates to a probability of 0.14%. Because all three conditions for the first test have been met, one concludes that the war costs model is a superior model to using only a dummy variable in models that predict votes.

The improvement of the linear and war cost models is 3.75% over the control and a 2.28% improvement over using just a dummy variable alone. This was found through comparison of the relevant coefficient of determination. While this improvement is rather modest, these results may find an increased effect in full prediction models. The use of a more robust prediction model would allow war costs to be seen in other areas of economic activity and political behaviour. For example, a two-stage model which allows for a decision to go to the polls followed by a second stage of deciding which vote to cast would likely see different impacts than the simple model presented.
here. Because this paper focuses on comparative analysis, adding significant levels of complexity to the model would not illustrate the point much more effectively.

The improvement of the linear and war cost models can be attributed to increasing costs of wartime activity. As a country deploys military forces, those most suited for the situation are sent into combat first. As a war continues over a longer period of time, comparatively less efficient resources are utilised in the war leading to higher costs. This model suggests that these increased costs, realised in conducting the war, account for some variation within Maine voting behaviour.

In accounting for the similar result between the war costs and the linear increasing costs model, examination of the data indicates that the war costs model scale nearly linearly over the period in question. For example, in the first power war election cycle the total number of forces killed was 1,377. This number increased to 4,376 by the third election cycle. Realising that 4,011 personnel killed would represent a 3 fold increase (and would have a corresponding value of 3 in the linear model), the additional 365 personnel killed over the three election cycles did not account for enough variation in the model in improving its predictive power in this case. As a result, the war costs model effectively scaled up the time model by 1,377.

The second hypothesis was that the war costs would interact with existing economic variables.
Table 4-5 contains the outcome from this regression. The F-test on the joint significance of all the interaction variables reported a test statistic of 0.30. The resulting probability is 73.97%. Given an alpha level of 5%, one fails to reject a null hypothesis that the interaction terms equate to zero. This is not a surprising result for two reasons. First, the collinearity between the variables and the interaction terms is quite high. The population and registration interaction terms had uncentred variance inflation factors of over 400. Income possessed a variance inflation factor over 144. Additionally, too few elections were available for analysis. More on this concept is covered in the robustness section.

While the model did not focus on point estimates of the various control variables, one should note the differences between the control / dummy variable models and the linear / war cost models. In the linear and war cost models, the point estimates for the effects upon a race for the US Senate, effects occurring in a presidential election year, effects for races for the state governor, previous democratic vote, changes in the voter registration, population, income, and unemployment all vary significantly. These differences range from an estimated 5.6% change in the case of a gubernatorial election to 152.9% change from population effects. As a result, even ignoring cross effects, point estimates without the proper accounting for war costs may be misleading.

**Robustness and Limitations**

Several issues are present when using election returns and war data within such a confined geographic space such as Maine. This section will discuss small sample considerations, possible geospatial correlation of residuals through clustering considerations, the time series testing of the war data, and some final notes about the modelling structure.

The war in Iraq started in 2003. As a result of the war, only 3 federal elections (and in the State of Maine, only 3 major state-wide elections) occurred at the time this paper was written. Depth of the data back into the 1990s allows for a good contrast and baseline. However, the results indicate
that any interaction terms on Maine voters will require an increase in power to find. Two possibilities exist for increasing the power of the test with regards to this analysis.

The first possibility is to increase this analysis to more elections. As more elections are tallied (e.g. 2010, 2012, 2014, and 2016) any effect will be more clearly seen. In the same line of thinking, one can expand the analysis beyond operation Iraqi Freedom to other conflicts. The challenge with doing this is the situation where multiple conflicts occur at the same moment in time (e.g. Afghanistan and Iraq).

Additionally, changing the unit of measurement may increase observational power in the analysis. If precinct level voter returns were able to be successfully tabulated for multiple years accounting for redistricting, then the increase in group observations would likely help find more sustainable results. Lamentably, economic data which varies by county does not vary by precinct. Yet, changes in vote tallies at the precinct level may be helpful through additional numbers.

An additional limitation in this study exists because any geospatial clustering effects are not accounted for in the residuals. Geospatial clustering effects likely could occur through one of two mechanisms. Because of the rural nature of Maine, major employment centres such as Portland, Lewiston, Augusta, and Bangor tend to attract people from counties beyond their own. As a result, the mixing of people may lead an effect in one major city centre to reach beyond the county level. Furthermore, major media markets tend to be centred in larger towns. These media markets likely influence counties in directly adjoining counties. This effect likely dissipates the greater distance one travels from the media market centre. Both of these effects are not accounted for in this study.

Testing was performed on the time series nature of the war costs variable to ensure a unit root did not exist. The testing was performed both on the accumulated casualties variable used in the regression and on the net increase in casualties (obtained by the first difference).
The accumulated casualty variable was tested as being centred about a mean and found to have a critical value of -1.615. This is well below the 5% alpha critical value of 3.88. This leads one to reject the null hypothesis that a unit root exists on the casualty variable. When looking at the same test by using a trend line, the critical value of -3.220 was below the critical value of 4.87. This also rejects at the 5% alpha. Both of the tests listed above failed to reject the null hypothesis at the 1% alpha level.

The net increase in casualties was tested in the same way and found to have similar results. The net increase variable with no trend had a critical value of -0.81 which was well below the 5% critical level of 3.88 but above the 1% threshold. The trend version of this test saw a more significant critical value of -3.27. This was well below the 5% critical threshold level of 4.87 but slightly greater than the 1% threshold level.

Because the standard of analysis in this paper is the 5% alpha level, it is concluded that no unit root exists in the war costs variable.

Some literature dealing with modelling of elections indicate that using presidential year and non-presidential year data together in US models results in the model being miss-specified. This was the reason for including a presidential year dummy variable in the regression. Clearly, turnout increases in presidential years. People, who choose to vote primarily for US President, occasionally cast ballots for other candidates and issues farther down the ballot.

When modelling across the entire United States, this effect can lead to specification error in US States such as Oklahoma and North Carolina. These states allow voters to cast a single "straight ticket" vote. In this system, a voter need only mark the ballot one time to select all the candidates affiliated with the selected political party in all areas of the ballot. When straight ticket voting is in

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40 This caused a bit of a problem in North Carolina where the straight ticket option does NOT include a vote for US President. Some voters reported confusion with this system thinking that by using the straight ticket, they have selected a US Presidential candidate as well.
place, an increase in turnout of a presidential year could have a significant “coat-tail” effect on down ballot races. Models which simply use one stage (such as the model in this paper) would have a specification issue if they are focused on vote forecasting and analysis.

This issue is believed not to be a major consideration for the analysis in this paper. Because the primary focus of this paper’s analysis is comparative in nature between models, any issue in one version of the model exists in all iterations of the model. As a result, it is unlikely that any errors resulting from including presidential year vote tallies with off-year elections pose a problem when looking at comparisons between the models.

**Conclusion**

Modelling votes by using dummy variables fails to capture an important aspect of human behaviour. The effects of a war are increasing over time. As a result, the effects of a war on elections change over time. Both a linear increasing cost model and the “more accurate” war costs model improved the amount of variation in votes accounted for by the model.

While the war cost model did outperform other models, it remains important to note that the lack of depth in war years can be misleading. The mathematical pattern of an exponentially increasing trend fits something other than war costs in the target period. Analysis of spending on elections indicate that elections are becoming increasingly costly (Jim Kuhnhenn, 2007). Until 2010, one would reasonably argue that this trend was limited mostly to federal, state-wide races. Full data on the 2010 elections are not fully available. However, given the 2010 US Supreme court ruling on Citizens United (Adam Cohen, 2010), spending on elections is likely to increase while casualties will fall eventually. This should provide (if given enough time) a definitive test about the cause of the phenomenon found in this paper.

Future work in this area would isolate the exact mechanism through which the increasing war costs play a part of the voting decision for voters. This would necessitate an expansion of the
sample beyond one U.S. state and perhaps across multiple wars (assuming accurate data were available). Additionally, the existing literature can be augmented directly with a simple linear war cost model to see if the prediction power of these models has increased.

Several people contributed both insight and effort in making this paper possible. Specifically, I would like to thank Joel Johnson for his assistance in collecting needed control data. Additionally, I would like to thank Amy Fried for her thoughtful discussions on this topic and key encouragement to press through the analysis. Finally, I would like to thank Pedro Vicente of Trinity College in Dublin for some timely recommendations with regards to the structural analysis within this paper. As always, all errors and omissions are solely the author.
Table 4-1: Summary Statistics

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Table 4-1 Notes:

- Aggregates all data for all races across all counties and congressional districts
- All data available upon request
- Scale conversions done before log transformation where applicable
Table 4-2: Summary Statistics by County

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<th>Total Voter Registration</th>
<th>Unemp Rate</th>
<th>Population</th>
<th>Income Per Capita</th>
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Table 4-2 Notes:

- Summarises data used by county
- Aggregates all races within each county
- Age variable for reference only and was not included as a valid term in any regression
- Scale of variables as indicated
Table 4-3: Summary Statistics by Election Type

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<th>Unemployment Rate</th>
<th>Population x(10,000)</th>
<th>Income Per Capita x(10,000)</th>
<th>Median Age</th>
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Table 4-3 Notes:

- Summarises data used by electoral contest
- Aggregates data from all counties for the given contest
- Variances in population, income, and unemployment rate occur because election for certain offices are not held in every election cycle
- Age variable for reference only and was not included as a valid term in any regression
- Scale of variables as indicated
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<td>*** 0.24</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.06)</td>
</tr>
<tr>
<td><strong>Incumbent Rep</strong></td>
<td>-0.26</td>
<td>*** -0.22</td>
<td>*** 0.27</td>
<td>*** -0.26</td>
<td>*** -0.27</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
<td>0.03</td>
<td>0.76</td>
<td>0.84</td>
<td>0.86</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>(0.67)</td>
<td>(0.71)</td>
<td>(0.67)</td>
<td>(0.70)</td>
<td>(0.70)</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>0.27</td>
<td>-0.46</td>
<td>-1.16</td>
<td>-1.13</td>
<td>-1.18</td>
</tr>
<tr>
<td></td>
<td>(0.77)</td>
<td>(0.80)</td>
<td>(0.81)</td>
<td>(0.81)</td>
<td>(0.83)</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td>0.53</td>
<td>*** 0.97</td>
<td>*** 1.51</td>
<td>*** 1.48</td>
<td>*** 1.52</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.19)</td>
<td>(0.23)</td>
<td>(0.23)</td>
<td>(0.27)</td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td>0.02</td>
<td>0.05</td>
<td>** 0.10</td>
<td>*** 0.10</td>
<td>*** 0.10</td>
</tr>
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<td></td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.03)</td>
</tr>
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Table 4-4: First Hypothesis Regressions (cont)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>Dummy</th>
<th>Linear</th>
<th>War Costs</th>
<th>Dummy +</th>
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<tbody>
<tr>
<td>War Costs</td>
<td></td>
<td></td>
<td>-0.0001 **</td>
<td>-0.00008</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.00007)</td>
<td>(0.0002)</td>
<td></td>
</tr>
<tr>
<td>War Costs Squared</td>
<td></td>
<td></td>
<td>2.54E-09</td>
<td>-8.78E-09</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.44E-08)</td>
<td>(4.48E-08)</td>
<td></td>
</tr>
<tr>
<td>War Dummy</td>
<td>-0.25 ***</td>
<td></td>
<td></td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td></td>
<td></td>
<td>(0.32)</td>
<td></td>
</tr>
<tr>
<td>Linear War Costs</td>
<td></td>
<td></td>
<td>-0.21 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within R-Squared</td>
<td>0.6185</td>
<td>0.6276</td>
<td>0.6419</td>
<td>0.6419</td>
<td>0.6420</td>
</tr>
<tr>
<td>N</td>
<td>364</td>
<td>364</td>
<td>364</td>
<td>364</td>
<td>364</td>
</tr>
</tbody>
</table>

Table 4-4 Notes:
- *** indicates the variable was significant at an alpha level of 0.01 or smaller
- ** indicates the variable was significant at an alpha level of 0.05 but not smaller than 0.01
- * indicates the variable was significant at an alpha level of 0.10 but not smaller than 0.05
- Standard errors are below the estimates in parentheses for all point estimates
Table 4-5: Second Hypothesis Regression

<table>
<thead>
<tr>
<th>LHS: Democratic Vote</th>
<th>Estimate</th>
</tr>
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<tbody>
<tr>
<td>Constant Term</td>
<td>-0.66</td>
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<tr>
<td></td>
<td>(2.31)</td>
</tr>
<tr>
<td>Presidential Election Year</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>House Race</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>Senate Race</td>
<td>-0.28</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
</tr>
<tr>
<td>Governor’s Race</td>
<td>-0.53</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td>Previous Dem Vote</td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>Previous Rep Vote</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>Incumbent Dem</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
</tr>
<tr>
<td>Incumbent Rep</td>
<td>-0.27</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>Log – Total Voter Registration</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>(0.74)</td>
</tr>
<tr>
<td>Log - Population</td>
<td>-1.01</td>
</tr>
<tr>
<td></td>
<td>(0.88)</td>
</tr>
<tr>
<td>Log – Income per capita</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
</tr>
<tr>
<td>Unemployment</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
</tr>
<tr>
<td>Interaction: Population</td>
<td>-6.57E-07</td>
</tr>
<tr>
<td></td>
<td>(2.27E-06)</td>
</tr>
<tr>
<td>Interaction: Income</td>
<td>6.87E-07</td>
</tr>
<tr>
<td></td>
<td>(4.80E-06)</td>
</tr>
<tr>
<td>Interaction: Registration</td>
<td>3.94E-08</td>
</tr>
<tr>
<td></td>
<td>(2.88E-07)</td>
</tr>
<tr>
<td>Interaction: Unemployment</td>
<td>-9.16E-07</td>
</tr>
<tr>
<td></td>
<td>(1.43E-06)</td>
</tr>
<tr>
<td>War Costs</td>
<td>-0.000001</td>
</tr>
<tr>
<td></td>
<td>(0.00002)</td>
</tr>
<tr>
<td>R-Squared (between)</td>
<td>0.4236</td>
</tr>
<tr>
<td>N</td>
<td>364</td>
</tr>
</tbody>
</table>

Table 4-5 Notes:

- *** indicates the variable was significant at an alpha level of 0.01 or smaller
- Standard errors are below the estimates in parentheses for all point estimates
Chapter 5: Conclusions

Conclusion

The analysis in this thesis provides a solid basis of examination for each of these topics. However, each study has limitations. As a result, policy makers and other readers should consider carefully the limitations before drawing any conclusions regarding the topics addressed within this thesis.

Chapter 2 demonstrated that increased revenue from financial transaction taxes are likely to underperform over the long run based both upon historical patterns and the structure of financial intermediation. Financial firms are able to pass along the costs of the tax through to society or avoid the tax all together. Additionally, chapter 2 shows that a tax generating revenue will not be large enough to provide sufficient disincentive to prevent speculation. There are several limitations of this study however.

Chapter 2 deals with transaction taxes as a whole. There are so many iterations of this tax proposed (e.g. Security Transaction Taxes in Europe and Bank Debits in the United States) for so many purposes, it is impossible for one paper to examine the effects of all these proposals. Thus, analysis must be focused on each proposal and its goals directly.

The mechanisms through which financial intermediaries avoid or mitigate their tax exposure are only partly understood. One example would be a conversion from a gross settlement payment system to a net settlement system. Many of these mitigation strategies, even ignoring tax evasion through the use of international tax havens, would significantly contract the projected tax base and thus lead to much higher rates than currently projected. These must be examined in much greater detail with attention paid to the particulars of each proposal.

Chapter 3 reveals that analysis of shaping characteristics through the use of mathematical moments (especially the third and fourth moments via skewness and kurtosis) provides relevant
information to policy makers when choosing between two competing taxation regimes. This information gives policy makers indications as to the reliability of the revenue's mean and an indication as to how frequently policy makers will be required to act due to significant events arising from outside windfalls or shortfalls in revenue. This analysis has a major shortcoming which should be addressed before being fully implemented.

Chapter 4 indicates that political forecasting models which ignore the presence of an on-going war or those which model the war with simply a dummy variable ignore significant information. The use of a time trend or capturing of war costs directly would improve predictive power in any political model. Two main limitations of this study exist.

First, the mathematical trend captured by both the time trend and the war cost model fits the escalating quantities of money raised by candidates during the time period studied. However, one must be able to segment out how much of this increase in money raised (and thus spent by the candidates) is a function of the on-going war. A correct instrument must be found for political spending to purify any war effect from spending and vice-versa.

Secondly, the study needs to conduct analysis over several wartime periods. This would help definitively answer the question if war costs are more important during war time than a linear trend. Use of multiple war periods would (if done in such a way as the political comparison is valid) would increase the power on the research and greatly assist in finding mechanisms through which the war effect translates meaningfully upon society.

**Areas for further research**

In every research project, there are areas which merit further research. This thesis is no exception. Each of the major topics investigated within this thesis have logical extensions which can be pursued in areas for further study.
The study of Financial Transaction taxes can be reasonably augmented through an in-depth analysis of the history of bank charges. Realising that any tax upon financial intermediation will likely be realised by the end consumer, the market reactions to charges such as credit and debit transactions will provide key insight into the true elasticity of vendors with regards to any intermediation tax. The data for this analysis exists but remains quite difficult to obtain given its proprietary and decentralised nature.

The second logical extension of transaction taxes would be to extend the analysis to various countries beyond those included within the scope of this study. While scope expansion is desirable, data availability remains the primary constraint from doing this at this time.

Chapter 3 regarding skewness and kurtosis offers the most opportunity for expansive future research. To begin, analysis and models may be fully generated regarding skewness and kurtosis. The analysis of skewness and kurtosis against deficit spending can be expanded to more countries. Furthermore, the reason for this relationship should be strongly investigated.

Chapter 4 offers two main areas for expansion as well. First, the scope of the analysis could be broadened to areas with different political attitudes. Ideally, every county within the United States would be included within the sample and appropriate adjustments made for political climate. This would provide much needed power to the analysis to find possible mechanisms.

Additionally, one must account for the main weakness of chapter four by accounting properly for political spending. This is moderately possible at a national macro level. However, given the targeted spending by campaigns resulting from the Electoral College system in the United States, macro level spending analysis may prove moderately unsatisfactory.
References:

"World Development Indicators," The World Bank, 2013.
____. "Enrolled and Registered Voters " Department of the Secretary of State, Augusta: State of Maine, 2010b, Election Results.
____. "Local Area Unemployment Statistics (Laus)," Maine Department of Labor, Augusta: State of Maine, 2010b.


Pimco. "What Are Interest Rate Swaps and How Do They Work?" 2008.


