RICE UNIVERSITY

Essays on Capital and Personal Income Taxation

by

Margaret McKeehan

A Thesis Submitted
in Partial Fulfillment of the
Requirements for the Degree

Doctor of Philosophy

Approved, Thesis Committee:

George R. Zodrow, Chair
Allyn R. and Gladys M. Cline Chair of Economics

John W. Diamond
Adjunct Assistant Professor; Edward A. and Hermena Hancock Kelly Fellow in Tax Policy

T. Clifton Morgan
Albert Thomas Professor of Political Science

Houston, Texas

May, 2017

ABSTRACT

Essays on Capital and Personal Income Taxation

by

Margaret McKeehan

A principal consideration in evaluating any tax policy is the response of economic agents, which determines the economic costs and consequences of levying a tax. In three chapters, I study these responses both theoretically and empirically, extending the literature examining the impact of the corporate income tax, the interaction between corporate income taxation and individual-level capital income taxation, and the labor supply effects of the Earned Income Tax Credit (EITC). Chapter one is a theoretical exploration of optimal capital income tax reform, focusing on the choice between source-based and residence-based capital income taxes. By incorporating imperfectly mobile capital and allowing for income sheltering, this chapter adds to the literature by addressing the implications of an increasingly global economy, finding that capital distortions, not income sheltering, are the primary factors determining the nature of an optimal capital income tax reform. Chapter two is a project which studies the factors that affect the desirability of source-based corporate income taxation in a small open economy. Using both analytical derivations and computational simulations, this chapter formally balances the factors that strongly motivate the use of corporate income taxation, notably the opportunity to costlessly raise revenue by taxing firms based in foreign countries that provide foreign tax credits, the need to limit opportunities for individual income sheltering, and the desire to tax the returns earned by foreign-owned immobile capital, against those that discourage corporate income taxation, notably concerns about driving out highly-mobile capital investment and the availability of alternative opportunities to tax immobile capital directly. In a calibrated setting, this paper determines the relative importance of these factors, noting that the extent of foreign-owned immobile capital may be the most important determinant of optimal corporate tax rates. Chapter three is an empirical study that investigates the labor supply sensitivity of a group that has received minimal attention in prior studies: dependent adults. Focusing on the 1993 expansion of the EITC, this study finds that non-nuclear relatives increased their labor supply in response to their own newfound EITC eligibility, but that adult children decreased their labor supply in response to their parents' expanded credits.

Acknowledgments

Foremost, I would like to thank my advisor Professor George Zodrow for his support throughout the Ph.D. program. His careful reading, insightful comments, and extensive knowledge of taxation led to immeasurable improvement in all of the papers presented here. Beyond this, his teaching and incredible generosity in connecting me to the larger tax community has been a source of constant inspiration and motivation.

Besides my advisor, I would like to thank the other members of my thesis committee, Professor John Diamond and Professor T. Clifton Morgan, for their encouragement, thoughtful comments, and quick responses as I prepared this dissertation. Additionally, I would like to thank Professor Richard Boylan, whose early guidance helped me to develop a research discipline which has been a cornerstone of any success achieved here.

I have reached this point not only through the support of faculty, but also through the support of my peers. Other graduate students, whether next to a white board in Baker Hall or under the oaks at Valhalla, have provided many hours of feedback, discussion, and encouragement over the last five years. Particularly, I would like to express the good fortune I had in entering Rice with Mark Agerton, Raúl Bajo-Buenestado, and Nick Frazier, who have been incredibly supportive companions throughout this process.

Lastly, I would like to thank my partner Tate and the members of my family, Mom, Dad, Ann, Robert, Diana, Jim, Susan, and Thomas, whose unwavering support and constant attention to my health and happiness ensured that I could emerge from this Ph.D. program ready for the next challenge.

This dissertation is dedicated with love to my sister Mary.

Contents

Illustrations

Tables

Chapter 1

Introduction

The term *income tax* is used to describe a variety of alternative tax systems, which can vary in their definitions of taxable income, tax rate structures, and method of administration. For example, taxable income could alternatively be defined as wage income, income from financial investments (capital income), lottery winnings, or all of these in a single comprehensive income tax. The motivations for alternative forms of income taxation similarly vary, with tax liability possibly reflecting the value of government services received or financial ability to pay. Despite these alternative motivations, economic evaluation has increasingly moved towards one method of comparison — evaluating taxes in terms of their effects on social welfare, where social welfare is an aggregate measure of individual utilities. This evaluation technique has become increasingly popular because of its theoretical clarity and defensibility; economic changes only affect the choice of a preferred tax if they matter to individuals. However, this method of evaluation requires extensive understanding of how taxes interact with the economy and the associated distortions of individual and firm decisions. Recognizing the increasing need for a comprehensive understanding of these interactions and distortions, this dissertation studies the effects of two alternative types of income taxation: capital income taxation and personal income taxation.

Understanding the effects of any tax requires a mix of methodologies. Theory identifies the potential effects of various taxes and empirics identify evidence of these effects. In combination, theory and empirics can inform policy makers, guiding choice of an optimal tax system. Each chapter of this dissertation seeks to highlight the effects of income taxation and support informed policy making. The first essay directly compares two alternative approaches to capital income taxation, using a theoretical model to understand how globalization affects the choice between a source-based and residence-based capital income tax. The second essay focuses on source-based capital income taxation, using a theoretical model to understand how a variety of economic conditions affect the overall desirability of a source-based capital income tax. The last essay focuses on personal income taxation, empirically studying how the U.S. Personal Income Tax affects the labor supply of dependent adult individuals. In combination, these essays inform our understanding of the effects and optimal structure of income taxation.

The first essay, *How Should We Tax Capital Income? Optimality Under Policy Constraints in a Global Economy*, compares source-based and residence-based capital income taxation, focusing on how globalization affects their relative desirability. Both of these taxes apply to the return on capital investment, but the definition of a taxable return varies significantly between approaches. Under a source-based capital income tax, the return on investment produced within a region is taxed regardless of the investor. Consequently, these taxes are typically levied at the firm level; corporate income taxes are a common example of source-based taxation. Under a residence-based capital income tax, the return to capital is taxed for individuals based on their region of residence regardless of where the investment is made. Consequently, these taxes are typically levied at the individual level; capital gains taxes are a common example of residence-based taxation. These are the two most common approaches to taxing capital income, and their relative optimality has been addressed (e.g. Bucovetsky and Wilson, 1991; Lejour and Verbon, 1998). I add to this literature in two ways. First, I incorporate income sheltering opportunities at both the individual level and the firm level. Second, I allow the optimizing government to rely on a mix of these two approaches, potentially levying both taxes simultaneously.[1] With these

[1]This reflects common practice. For example, the U.S. tax code includes both a corporate income tax (a variant of a source-based capital income tax) and capital gains taxes in the personal income tax systems (a variant of a residence-based capital income tax).

considerations incorporated I focus on how globalization, modeled as a combination of increasingly mobile capital and increased opportunities for income sheltering, affects the optimal balance between approaches.

The two attributes of globalization have very different implications for the choice between source-based and residence-based capital income taxation. Increases in income sheltering opportunities have ambiguous effects on optimal tax rates, even if the opportunities are asymmetrically available to firms and individuals. On the one hand, sheltering activity is costly and non-productive, and decreasing the relevant tax rate can mitigate this socially inefficient behavior. On the other hand, sheltering activity decreases effective tax rates and reduces the primary economic distortions associated with taxation (e.g., changes in the location of an investment to avoid source-based taxes). These tradeoffs produce indefinite recommendations for responding to increases in income sheltering. In contrast, increasingly mobile capital makes the two alternative approaches to capital income taxation increasingly distinct. When capital is perfectly immobile (when all domestic saving is invested domestically and all domestic investments are owned by domestic individuals), each of these capital income taxes have the same base and primary economic effects. However, as capital mobility increases, the strength of the association between these two taxes declines and the economic effects become more distinct. Source-based taxes distort the location of investment, since the taxes are applied to all investment made within a region. Residence-based taxes distort savings decisions and the timing of consumption, since individuals pay taxes on the return to saving regardless of where they invest. Since the economic effects of these two approaches become more distinct in an increasingly global economy, while income sheltering ambiguously affects the relative desirability of each tax, these results suggest an optimal tax reform will choose the form of taxation based on the estimated economic impacts on investment and savings decisions, not the differential effects of income sheltering.

The second essay, *Balancing Act: Weighing the Factors Affecting the Taxation* *of Capital Income in a Small Open Economy*, focuses on the optimal level of capital income taxation rather than the optimal form and was written in collaboration with Dr. George Zodrow. Notably, there are several arguments supporting and opposing source-based capital income taxes in small open economies. To account for these arguments, the model includes immobile and mobile capital, tax evasion, and the possibility of residual foreign tax payments. The analytical framework incorporates these considerations into a simple two-sector model. Sector one is a "domestic" sector that produces a non-traded good using labor and immobile capital. Sector two is a "multinational" sector that produces a traded good (with perfect international substitutability) using labor and mobile capital. Within this context, we incorporate two tax instruments, a capital income tax and a lump-sum head tax, which are used to finance government purchases of the traded good. To solve for the optimal capital income tax policy, we assume a single representative resident with inelastic labor supply and identify the taxes that maximize this individual's welfare. In the analytical setting this produces a few key insights: (1) Zero capital income taxation is only optimal if all location-specific capital is owned domestically and there is no residual taxation; and (2) If all of the capital income earned by the multinational firm is subject to residual taxation, the optimal capital tax rate is at least as great as the residual tax rate.

The computational model in this study expands on the one described above in several ways. First, the individual's problem is extended to account for endogenous labor. This allows us to convert the head tax to a proportional tax on labor, and permits the possibility of endogenous labor income shifting to the capital income tax base. Second, we add another input in both production sectors: perfectly mobile "ordinary" capital, whose fixed rate of return is determined by international markets. This implies that domestic production also includes internationally mobile capital, so that both production sectors might be affected by capital flight. Finally, we add an explicit tax on location-specific capital as an additional tax instrument available to the government. Calibrating this model so that it aligns with empirical observations, we highlight the relative importance of several economic factors. First, the optimal capital income tax rate increases proportionally with the amount of foreign-owned immobile capital, and may exceed the tax rate on labor income. However, if immobile capital is not foreign-owned, optimal rates are not very sensitive to the balance between immobile and mobile capital. Second, any foreign residual taxation provides a strong rationale for capital income taxation. Third, the optimal capital income tax rate increases with the opportunities for labor income shifting unless the capital income tax rate exceeds the labor income tax rate. Fourth, optimal capital income tax rates fall significantly if an alternative tax is available which targets immobile capital; for example, in the resource sector, this could be a separate resource rent tax. Finally, the optimal capital income tax is only slightly affected by international income shifting due to the several offsetting effects generated by international income sheltering. In combination, these observations highlight the complexity involved in the choice of an optimal capital income tax rate. However, in the absence of an instrument that can directly tax immobile capital, positive capital income taxation appears to be generally desirable.

The third and final essay, *The EITC and the Labor Supply of Adult Dependents: Direct Effects and Family Income Effects*, empirically measures the labor supply responses of adult dependents to changes in the tax code. To be claimed as a dependent, an adult must have very low income (earning less than $3,950 in 2014), and rely on family members for the majority of their financial support. Tax data suggests the size of this population has been growing. Between 1992 and 2012, the ratio of dependent claims to the total number of returns filed more than doubled, ignoring children under the age of 18 or under the age of 24 and in school, reaching a maximum of nearly 15 million individuals in 2011 (IRS Statistics of Income 1992–2012). While this suggests an increasing number of adult dependents, it is less clear how tax policy affects this growing population. This paper takes a first step towards answering this question by providing evidence on how dependents responded to the Earned Income Tax Credit (EITC) expansions of mid-1990s.

For dependents, the EITC expansion had two primary impacts. Most significantly, starting in 1994, individuals without dependent children could claim the EITC. This extension followed the general structure used for all EITC schedules: a credit which increases over very low wage earnings, plateaus to a constant value, and then is phased-out as earned income continues to increase. However, the credit amount available to childless individuals ($306) was significantly smaller than that available for individuals with dependent children ($2,038). Additionally, the value of the EITC increased for any eligible primary filers, particularly if the primary filers claimed EITC-qualifying children. These two changes to the EITC have conflicting expected effects on dependent labor supply. The first change, which made adult dependents newly eligible for the EITC, is expected to increase their labor force participation since it increases the return to labor. The second change, which expanded family credits, is expected to decrease their labor force participation as long as it led to an overall increase in family income which would be shared with the dependent. In combination, the expected net effect of the EITC expansion is ambiguous.

To estimate and decompose the net effect of the EITC expansion, I use difference-in-differences estimation, comparing the labor force participation rates for adult dependents before and after the reform along two separate dividing lines. First, to capture the overall effect, I compare adult dependents attached to low-income households to those attached to high-income households. Generally, only dependents attached to low-income households should be affected by the EITC expansion. If family income is high, the family will not be eligible for the EITC and will always optimally choose to claim the dependent (forgoing any individual EITC credits). Using this comparison, I find that non-nuclear family members increased their labor force participation by about 5 percentage points in response the EITC expansion. However, I do not find robust evidence for a response among adult children or parents of the household head. Second, to decompose this response, I compare adult dependents attached to low-income households with young children to those without. Since the EITC increase was considerably larger for families with young children (under 18 or under 24 and in school), this comparison isolates the effect of increased family credits. Using this comparison, I find that adult children attached families with young children relatively decreased their labor force participation after the reform. This suggests that the absence of a net response for adult children may be a consequence of the two contradictory effects of the EITC, rather than an insensitivity to tax changes.

While the essays of this dissertation rely on a breadth of methodological approaches, they share a common goal: clarification of the effects of alternative income tax systems. The first essay theoretically identifies how the effects of capital income taxation vary with the form of the tax, contrasting source-based and residence-based capital income taxes in the context of increasing globalization. The second essay, which also relies on theoretical modeling, identifies the welfare effects of capital income taxation, assuming a source-based approach. The third and final essay, which employs empirical estimation, studies the practical effects of wage subsidies, focusing on adult dependents participating in complex family structures. Collectively this research illustrates the variety of ways economic analysis can contribute to the determination of socially beneficial tax policies.

Chapter 2

How Should We Tax Capital Income? Optimality Under Policy Constraints in a Global Economy

In a closed economy without international trade or cross-border capital flows, the distinction between capital income taxation at the firm level and the individual level is primarily administrative; both taxes distort inter-temporal consumption and investment decisions equivalently. However, in a small economy open to international trade the two taxes can have quite different effects on saving and investment. Capital income taxation at the firm level (generally referred to as source-based taxation) effectively taxes all capital income earned on domestic investments by both residents and non-residents, inducing capital flight and lowering the return to domestically supplied labor (Zodrow and Mieszkowski, 1983; Gordon, 1986; Razin and Sadka, 1991). Capital income taxation at the individual level (generally referred to as residence-based taxation) taxes all capital income earned by domestic residents, whether earned domestically or abroad, and thus distorts inter-temporal consumption decisions (Atkinson and Stiglitz, 1976; Judd, 1985; Chamley, 1986), but not the location of investment. Since the effects of these taxes become more disparate as capital mobility increases, an increasingly open economy makes the choice between these two taxes increasingly important. Additionally, opportunities for income sheltering may further differentiate the impact of the two taxes, particularly when these tax avoidance opportunities vary between firms and individuals. In this paper, I construct an analytical model that simultaneously incorporates savings decisions, individual and corporate income sheltering opportunities, and varying degrees of capital mobility. With this model I examine the combined effects of these factors in an open economy setting. I find that while differences in sheltering opportunities and behavior determine the choice between source-based and residence-based taxation in closed economies, increasingly elastic international capital flows complicate the choice between the two forms of capital income taxation, especially since the effects of increased income sheltering are indeterminate: Increased sheltering increases the inefficiency of capital income taxation, but simultaneously lowers the effective tax wedge generated by taxation. Another implication of the analysis is that increasingly global markets justify renewed attention to the key parameters which determine the efficiency cost of each form of capital income taxation, such as inter-temporal elasticities of substitution and production cost shares of capital.

While increasingly global markets introduce a variety of economic changes, this paper focuses on two primary considerations: increasingly mobile capital investments and increased income sheltering opportunities. Both considerations have led to intensified scrutiny of capital income taxation internationally, and most recent reform proposals focus on ways to limit capital flight and reduce income sheltering opportunities and incentives. Proposals focusing on international income sheltering frequently recommend a shift away from firm-level taxation toward individual-level taxation (e.g., Toder and Viard, forthcoming; Graetz and Warren, forthcoming; and Grubert and Altshuler, forthcoming) and implicitly suggest that sheltering opportunities are more abundant at the firm level. However, studies of income sheltering reflect complex efficiency implications for capital income taxation. Slemrod and Wilson (2009) show that tax havens reduce welfare in non-haven countries because sheltering opportunities induce two non-productive, costly activities — firm income sheltering and government enforcement — and raise the cost of generating revenue, discouraging public good expenditure. In contrast, Hong and Smart (2010) emphasize how opportunities for income sheltering may reduce the real tax elasticity of capital investment since sheltering mitigates the costs of relatively high tax rates, leading to an increase in social welfare in some cases. By explicitly modeling income sheltering opportunities in the derivations below, I am able to capture these trade-offs and develop a more comprehensive picture of how sheltering opportunities affect the choice between source-based and residence-based capital income taxation.

The implications of increasingly mobile capital are less ambiguous — mobile capital increases the capital flight associated with source-based taxation, while decreasing the associated distortion of inter-temporal consumption decisions. In an analytical framework, it is typically simplest to assume either a closed economy (with no capital mobility) or a small open economy (with perfectly mobile capital). In practice, no economy is either completely open or closed. As Zodrow (2010 p. 890) writes, "There is general agreement that capital is mobile and has become increasingly mobile over time... There is, however, far less agreement as to whether capital is sufficiently mobile that it is reasonable to assume perfect international capital mobility." For simplicity, I model the semi-open economy by making foreign investment costly for the domestic resident (Lejour and Verbon (1998) use a similar assumption). Inclusion of a foreign investment cost creates both a preference for domestic investment, generating the "home bias" noted by French and Poterba (1991), and a correlation between domestic saving and domestic investment, a pattern noted by Feldstein and Horioka (1980).[1] More importantly, I allow the foreign-investment cost to be adjustable, with a decreasing cost reflecting an increasingly open economy. This allows direct observation of how capital mobility and other considerations interact to affect the optimal balance between source-based and residence-based taxation.

In order to focus on capital market effects and keep the analysis tractable, I do not incorporate several features of an open economy in my model. First, I assume that all domestically produced goods are perfect substitutes for international goods, a simplifying assumption that eliminates the complication of domestic commodity price

[1]Both of these puzzles have led to extensive literatures seeking to explain or refute these observations. See Apergis and Tsoumas (2009) and Zodrow (2010) for reviews of the literature addressing the Feldstein-Horioka puzzle and Coeurdacier and Rey (2012) for a review of explanations for the French-Poterba Home Bias puzzle.

effects. Gravelle and Smetters (2006) study the implications of imperfect substitutability between domestic and foreign goods, showing that limited substitutability mitigates the capital flight associated with source-based taxation and, consequently, the share of the tax burden borne by domestic labor. Second, I do not consider the impact of increasingly mobile labor. Wilson (1995) and Brueckner (2000) both incorporate mobile labor into models of capital income tax competition, and show that source-based capital income taxes still lower the level of domestic capital investment, leading to inefficiently low source-based tax rates and under-provision of the public good.

One challenge in studying the choice between residence-based and source-based taxation is that both taxes are generally regarded as inefficient. As long as capital is internationally mobile, source-based capital income taxation distorts the location of investment. As demonstrated in Zodrow and Mieszkowski (1983), Gordon (1986), and Razin and Sadka (1991), this distortion is fully borne by immobile factors, implying direct taxation of immobile factors is more efficient. Similarly, as implied by Atkinson and Stiglitz (1976) and extended in Judd (1985) and Chamley (1986), residence-based capital income taxation that reduces the individual's return on investment is inefficient relative to optimal non-linear labor taxation since it distorts inter-temporal consumption decisions.

Nevertheless, several papers have highlighted cases where some capital income taxation is optimal, even when classically efficient taxes are available. The literature supporting non-zero residence-based taxation of capital income is unusually prolific and is surveyed by Kaplow (2008). Generally, these studies fall in one of three categories: models that relax the standard assumptions regarding individual preferences (e.g., Erosa and Gervais, 2002; Saez, 2002), models that relax market behavior assumptions (e.g., Hubbard and Judd, 1986; Naito, 1999; Cremer, Pestieau, and Rochet, 2001), and models that acknowledge policy limitations (e.g., Boadway and Pestieau, 2003). This paper eschews imposing restrictions on individual preferences and consequently reflects the observation of Erosa and Gervais (2002): The efficiency cost of residence-based capital income taxation falls as the complementarity of consumption and leisure increases with age. However, I do not consider heterogeneous individuals, and thus do not model the factors supporting residence-based taxation noted in Saez (2002; heterogeneous tastes) or Cremer, Pestieau, and Rochet (2001; heterogeneous endowments).

As with residence-based taxation, some special cases may make non-zero source-based capital income taxation desirable. If a portion of the domestic capital stock is immobile, the distortion associated with source-based taxation is reduced and, if this capital is owned by non-residents, source-based capital taxation becomes especially attractive from the perspective of domestic residents and may be optimal even when efficient taxes are available (e.g., head taxes). Huizinga and Nielson (1997) further extend this intuition to the case where foreign firms earn above-normal returns on investment. The case for taxing immobile investments is strengthened if relatively mobile capital has easier access to income sheltering opportunities. In this case, income sheltering increases the portion of the burden born by immobile factors and reduces the marginal distortion associated with source-based taxation (Gugl and Zodrow, 2006; Hong and Smart, 2010). Even when all capital is perfectly mobile, some source-based capital income taxation may be justified. Notably, source-based capital income taxation may act as a tax on labor income that is disguised as small-business capital income, both generating revenue and deterring costly sheltering behavior (Gordon and Mackie-Mason, 1995). Consequently, neither form of capital income taxation is universally inefficient, even though special economic characteristics may be necessary to justify a non-zero rate.

Rather than justifying either form of taxation, this paper is intended to illuminate the choice between the two forms of capital income taxation with increasingly open markets. To achieve this, I include a fixed capital income revenue requirement and study the optimal balance between residence-based and source-based capital income taxation. By incorporating inter-temporal consumption decisions, imperfectly mobile capital investment, and income shifting behavior, I am able to capture the primary costs and benefits associated with both approaches.

In the following section I describe the basic analytical model used throughout the paper, a model that does not assign functional forms but does assume constant returns to scale in production and perfect substitutability between domestic and foreign goods. Section III derives the equilibrium marginal responses to capital income taxation. Section IV uses these responses to evaluate the optimal balance between source-based and residence-based capital income taxation in a small open economy. Section V performs similar derivations for the partially open economy, comparing the results to Section IV and highlighting how globalization amplifies the distinction between the two forms of capital income taxation. Section VI concludes.

2.1 An Overlapping Generations Model of Capital Income Taxation

2.1.1 The Individual's Problem

In this economy a new individual is born every period and lives for two periods, making labor supply and consumption decisions in each period. In every period t, the labor supply of the age s individual, h_t^s, is limited by a time constraint $T_t^s = h_t^s + l_t^s$, where T_t^s is the total time endowment of an age s individual in period t and l_t^s is the corresponding hours of leisure. The return to labor finances purchases of the consumption good in each period, c_t^s. The individual born in period t chooses labor supply and consumption in each period to maximize lifetime utility

$$u\left(c_t^1, l_t^1, c_{t+1}^2, l_{t+1}^2\right), \tag{2.1}$$

where utility is continuous, increasing, and concave. In period t all labor earns the same market wage w_t, which finances consumption at price p_t. The individual can also save some labor income, b_t, by purchasing the commodity good and leasing it out to firms for production.[2] These purchases are denoted with k_t, so that savings can be written as $b_t = p_t k_t = w_t h_t^1 - p_t c_t^1$. In the following period these leases earn a gross rate of return $\rho_{t+1} > 0$, which, in the absence of income sheltering behavior, is subject to the residence-based tax rate τ_I. However, if the individual is saving ($b_t > 0$) and the residence-based tax rate is positive ($\tau_I > 0$), the individual can shelter a share ϕ_{t+1}^I of the return at a cost $z^I\left(\phi_{t+1}^I\right)\rho_{t+1} b_t$, where $z^I(\cdot)$ is an increasing, convex function of ϕ_{t+1}^I such that $z^I(0) = 0$.[3,4] The optimizing individual chooses the fraction sheltered to maximize the after-sheltering cost, after-tax return to savings

$$\rho_{t+1}^N = \rho_{t+1}\left[\phi_{t+1}^I + (1-\tau_I)\left(1-\phi_{t+1}^I\right) - z^I\left(\phi_{t+1}^I\right)\right], \tag{2.2}$$

which implies

$$\frac{\partial z^I}{\partial \phi_{t+1}^I} = \tau_I. \tag{2.3}$$

That is, the individual will shelter income until the marginal sheltering cost equals the statutory tax rate. Under this formulation, the cost of income sheltering is stated generally enough to account for any foreign tax payments if income is sheltered abroad. For example, suppose the cost of sheltering can be decomposed as $z^I\left(\phi_t^I\right) = z^{I1}\left(\phi_t^I\right) + \tau_I^F \phi_t^I$, where τ_I^F is the foreign tax rate and $z^{I1}\left(\phi_t^I\right)$ is the direct cost of sheltering income. In this case, (2.3) can be written as $\partial z^{I1}/\partial \phi_t^I = \tau_I - \tau_I^F$ and the firm shelters income until the marginal direct sheltering cost equals the international tax rate differential.

---

[2] These firms may be foreign or domestic, depending on the specification of the model.

[3] I do not model the recipient of these costs. Implicitly, this suggests that the cost of sheltering is paid to an agent outside of the domestic economy.

[4] I assume that the cost of income sheltering is linear with respect to the value of the representative individual's capital income, $\rho_{t+1} b_t$, because the value generated by sheltering is also linear with respect to the individual's return. That is, the value of sheltering is $\phi_{t+1}^I \tau_I \rho_{t+1} b_t$. By assuming that both terms have a linear relationship, I ensure that the optimal level of sheltering is not affected by the aggregate level of saving in the economy. A similar assumption is imposed for firm-level income sheltering.

Accounting for optimal individual sheltering behavior, the individual born in period t is subject to the lifetime budget constraint

$$w_t h_t^1 - p_t c_t^1 + \frac{w_{t+1} h_{t+1}^2 - p_{t+1} c_{t+1}^2}{1 + \rho_{t+1}^N} \geq 0. \tag{2.4}$$

Defining discounted prices and wages as $p_{t+1}^D = p_{t+1} / \left(1 + \rho_{t+1}^N\right)$ and $w_{t+1}^D = w_{t+1} / \left(1 + \rho_{t+1}^N\right)$, the utility-maximizing individual born in period t chooses consumption and leisure such that the first-order conditions

$$u_{c_1} - \alpha_t p_t = 0 \tag{2.5}$$

$$u_{c_2} - \alpha_t p_{t+1}^D = 0 \tag{2.6}$$

$$u_{l_1} - \alpha_t w_t = 0 \tag{2.7}$$

$$u_{l_2} - \alpha_t w_{t+1}^D = 0 \tag{2.8}$$

$$w_t h_t^1 - p_t c_t^1 + w_{t+1}^D h_{t+1}^2 - p_{t+1}^D c_{t+1}^2 = 0 \tag{2.9}$$

hold, where α_t indicates the marginal utility of income for the individual born in period t. Letting $\{c_t^{1^*}, l_t^{1^*}, c_{t+1}^{2^*}, l_{t+1}^{2^*}\}$ denote the optimal choices of consumption and leisure for the individual given prices and taxes, the indirect utility function for the individual born in year t is

$$V^t \left(w_t, w_{t+1}^D, p_t, p_{t+1}^D\right) = u \left(c_t^{1^*}, l_t^{1^*}, c_{t+1}^{2^*}, l_{t+1}^{2^*}\right). \tag{2.10}$$

2.1.2 The Firm's Problem

At time t the domestic firm produces a quantity of the consumption good, X_t, using capital, K_t, and domestically supplied labor, L_t. The firm's production function $F(K_t, L_t)$ is increasing with respect to both inputs and exhibits constant returns to scale. Inputs are chosen to maximize profits given each factor's cost: the wage rate,

w_t, and the product of domestically required rate of return to capital, r_t^d, and the capital price in the period of purchase p_{t-1}. The source-based capital income tax τ_F is levied on all equity-financed capital, where an initial portion ϕ_t^{F1} of capital is debt-financed and effectively exempt from the source-based capital income tax. The firm can debt finance or otherwise shelter an additional portion of capital, ϕ_t^{F2}, at a cost $z^F\left(\phi_t^{F2}\right) r_t^d p_{t-1} K_t$. Similar to the individual sheltering cost function, this sheltering cost formulation is general enough to incorporate any foreign tax payments. The firm chooses the level of sheltering to minimize the cost of capital

$$r_t^G = r_t^d\left[1 + \tau_F - \tau_F\left(\phi_t^{F1} + \phi_t^{F2}\right) + z^F\left(\phi_t^{F2}\right)\right], \tag{2.11}$$

so that

$$\frac{\partial z^F}{\partial \phi_t^{F2}} = \tau_F. \tag{2.12}$$

That is, the firm will increase its rate of equity finance until the marginal cost of equity finance (or income sheltering) is as great as the statutory source-based capital income tax rate. Note that without changing the specification of the model, increased equity finance could be alternatively be interpreted as income sheltering activity, where the firm spends on $z^F\left(\phi_t^{F2}\right)$ to shelter income from the source-based tax. Accounting for the optimal level of debt finance and income sheltering, the firm's profit maximization problem can be written as

$$\max_{K_t, L_t}\left\{p_t F(K_t, L_t) - w_t L_t - r_t^G p_{t-1} K_t\right\}, \tag{2.13}$$

which implies the profit-maximizing firm chooses capital and labor such that

$$p_t F_{K_t} - r_t^G p_{t-1} = 0 \tag{2.14}$$

$$p_t F_{L_t} - w_t = 0. \tag{2.15}$$

2.1.3 Market Clearing Conditions

While firm and individual responses to prices are unaffected by the "openness" of the economy, the market clearing conditions can vary significantly between small open and partially open economies. However, a few market clearing conditions are unaffected by the degree of capital mobility. First, throughout this paper all labor used in domestic production must be supplied domestically. Assuming that the population of the domestic economy is constant, this means the labor supply at time t is given by

$$L_t = h_t^1 + h_t^2. \tag{2.16}$$

This assumption was made to reflect the relative immobility of labor in comparison to capital. Relaxing 2.16 to allow for imperfectly mobile labor can mitigate some of the capital flight associated with source-based capital income taxation, but introduces new margins of distortion (Burbidge and Myers 1994). Indeed, with mobile labor, either tax could affect migration decisions for individuals — individuals could leave the country to avoid residence-based taxes or the wage reductions generated by source-based taxes. Due to the complication introduced by these additional distortions, I leave this consideration for future research.

Second, I assume that there is an internationally-produced perfect substitute for the domestic good, so that the market clearing price for the consumption good is fixed,

$$\frac{\partial p_t}{\partial \tau_I} = \frac{\partial p_t}{\partial \tau_F} = 0. \tag{2.17}$$

This assumption is likely extreme, particularly in the case of a partially open economy and in the presence of non-traded goods, but allows me to focus on the role of increasingly mobile capital investment.[5]

Since the consumption price is set by international markets, the evolution of prices

[5] Gravelle and Smetters (2006) provide an extensive discussion of the incidence implications of internationally substitutable goods.

in this economy is also set internationally,

$$\frac{p_{t+1}}{p_t} = q_t. \tag{2.18}$$

Of course, if the consumption good is storable and $q_t > 1 + \rho_t^N$, this generates a natural income sheltering mechanism. If prices increase at a rate exceeding the net return to saving, an individual could simply purchase and store a good for future resale, avoiding taxes on interest income and earning a greater return. For simplicity, I assume that the residence-based tax applies to any asset appreciation on an accrual basis, so that the rate of return to saving provided in (2.2) characterizes the marginal return to all savings mechanisms, including storable goods.

Finally, since this model does not consider barriers to entry, the firm always earns zero profits in equilibrium,

$$p_t F(K_t, L_t) = w_t L_t + r_t^G p_{t-1} K_t. \tag{2.19}$$

The remaining capital market clearing conditions vary significantly with the modeling assumptions, and are presented along with the derivation and discussion of the optimal tax results.

2.1.4 The Steady State

In the derivations below, tax choices are optimized in the steady state. For simplicity, I ignore growth and characterize the steady state by a constant population coupled with constant levels of consumption and leisure. The individual's optimality conditions (2.5)-(2.9) imply, in the steady state,

$$\frac{p_{t+1}}{p_t} = \frac{w_{t+1}}{w_t} = \frac{\alpha_t}{\alpha_{t+1}} = q_t \tag{2.20}$$

and

$$\rho_{t+1}^N = \rho_t^N. \tag{2.21}$$

While I do not require that the marginal revenue product of capital (r_t^d) equals the market-clearing interest rate (ρ_t), I do assume that as long as ρ_t is constant, then r_t^d is as well.[6] This leaves the growth rate for only two variables undefined: X_t and K_t. If firm production is also constant — an assumption consistent with applying similar steady state restrictions to the rest of the world — then the size of capital stock (K_t) will also be constant, although the value ($p_{t-1}K_t$) is increasing with all other prices.

2.2 Optimal Tax Conditions and Market Responses

To understand the trade-offs generated by the choice between residence-based and source-based capital income taxation, I assume the government must raise an exogenous amount of revenue R_t, which is rising with prices, using only the two capital income tax instruments: a residence-based tax on individual capital income (τ_I) and a source-based tax on the return to business capital (τ_F). Effectively, this means the government's selection of each tax is constrained by

$$\tau_F \left(1 - \phi_t^{F1} - \phi_t^{F2}\right) r_t^d p_{t-1} K_t + \tau_I \left(1 - \phi_t^I\right) \rho_t b_{t-1} \geq R_t. \tag{2.22}$$

Using the individual's indirect utility function as defined in (2.10) and denoting $\phi^{F1} + \phi^{F2} = \phi^F$, welfare maximization in the steady state satisfies

$$\max_{\tau_I, \tau_F} \left\{ V\left(w, w^D, p, p^D\right) \middle| \tau_F \left(1 - \phi^F\right) \left(\frac{r^d pK}{q}\right) + \tau_I \left(1 - \phi^I\right) \left(\frac{\rho b}{q}\right) \geq R \right\}. \tag{2.23}$$

Since the individual's utility is strictly increasing in both consumption and leisure, the optimal mix of residence-based and source-based capital income taxes, using Roy's

[6] In this model $r_t^d = \rho_t$ only if the economy is completely closed. Sections 2.3 and 2.4 address the relationship between r_t^d and ρ_t in the perfectly open and partially open economies, respectively.

Identity and the fixed-price condition (2.17), is characterized by three first-order conditions

$$\alpha w h^1 \left(\frac{1}{w}\frac{\partial w}{\partial \tau_F}\right) + \alpha w^D h^2 \left(\frac{1}{w^D}\frac{\partial w^D}{\partial \tau_F}\right) - \alpha p^D c^2 \left(\frac{1}{p^D}\frac{\partial p^D}{\partial \tau_F}\right) \tag{2.24}$$
$$+\lambda \tau_F \left[\frac{r^d\left(1-\phi^F\right)pK}{q}\right]\left(\frac{1}{\tau_F} + \frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} + \frac{1}{K}\frac{\partial K}{\partial \tau_F} + \frac{1}{1-\phi^F}\frac{\partial \phi^{F2}}{\partial \tau_F}\right)$$
$$+\lambda \tau_I \left[\frac{\rho\left(1-\phi^I\right)b}{q}\right]\left(\frac{1}{\rho}\frac{\partial \rho}{\partial \tau_F} + \frac{1}{b}\frac{\partial b}{\partial \tau_F} + \frac{1}{1-\phi^I}\frac{\partial \phi^I}{\partial \tau_F}\right) = 0$$

$$\alpha w h^1 \left(\frac{1}{w}\frac{\partial w}{\partial \tau_I}\right) + \alpha w^D h^2 \left(\frac{1}{w^D}\frac{\partial w^D}{\partial \tau_I}\right) - \alpha p^D c^2 \left(\frac{1}{p^D}\frac{\partial p^D}{\partial \tau_I}\right) \tag{2.25}$$
$$+\lambda \tau_F \left[\frac{r^d\left(1-\phi^F\right)pK}{q}\right]\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I} + \frac{1}{K}\frac{\partial K}{\partial \tau_I} + \frac{1}{1-\phi^F}\frac{\partial \phi^{F2}}{\partial \tau_I}\right)$$
$$+\lambda \tau_I \left[\frac{\rho\left(1-\phi^I\right)b}{q}\right]\left(\frac{1}{\tau_I} + \frac{1}{\rho}\frac{\partial \rho}{\partial \tau_I} + \frac{1}{b}\frac{\partial b}{\partial \tau_I} + \frac{1}{1-\phi^I}\frac{\partial \phi^I}{\partial \tau_I}\right) = 0$$

$$\tau_F r^d\left(1-\phi^F\right)pK + \tau_I \rho\left(1-\phi^I\right)b = qR, \tag{2.26}$$

where λ is the marginal value of relaxing the government budget constraint. Generally, these conditions balance the cost of distorting individual and firm behavior with the amount of revenue raised by each tax. The implications of these conditions vary considerably with the degree of "openess" in the economy. To highlight these differences, I start by deriving the general expressions for the market responses to each form of taxation. Then, using the capital market clearing assumptions associated with either a small open economy or a partially open economy, I refine these optimality conditions for more detailed interpretation.

2.2.1 Market Responses to Taxation

To solve for the market responses to the either tax, I start by differentiating the production function and applying the first-order conditions (2.14) and (2.15)

$$\frac{1}{X_t}\frac{\partial X_t}{\partial \tau} = \theta_{K_t}\left(\frac{1}{K_t}\frac{\partial K_t}{\partial \tau}\right) + \theta_{L_t}\left(\frac{1}{L_t}\frac{\partial L_t}{\partial \tau}\right), \tag{2.27}$$

where θ_{L_t} is the production cost share of labor, θ_{K_t} is the production cost share of capital, and τ can indicate either τ_F or τ_I. Similarly, differentiating the zero-profit condition (2.19) and applying the fixed price condition (2.17) gives

$$\frac{1}{X_t}\frac{\partial X_t}{\partial \tau} = \theta_{L_t}\left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau} + \frac{1}{L_t}\frac{\partial L_t}{\partial \tau}\right) + \theta_{K_t}\left(\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau} + \frac{1}{K_t}\frac{\partial K_t}{\partial \tau}\right). \tag{2.28}$$

Combining the two equilibrium response functions (2.27) and (2.28) suggests the tax semi-elasticity of the wage rate with respect to the either capital income tax is

$$\frac{1}{w_t}\frac{\partial w_t}{\partial \tau} = -\frac{\theta_{K_t}}{\theta_{L_t}}\left(\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau}\right). \tag{2.29}$$

Since the individual discounts second-period prices by $1 + \rho_{t+1}^N$, (2.29) implies the change in the perceived second-period wage is

$$\frac{1}{w_{t+1}^D}\frac{\partial w_{t+1}^D}{\partial \tau} = -\frac{\theta_{K_{t+1}}}{\theta_{L_{t+1}}}\left(\frac{1}{r_{t+1}^G}\frac{\partial r_{t+1}^G}{\partial \tau}\right) - \frac{1}{1+\rho_{t+1}^N}\frac{\partial \rho_{t+1}^N}{\partial \tau}. \tag{2.30}$$

Similarly, the perceived response of the second-period consumption price is

$$\frac{1}{p_{t+1}^D}\frac{\partial p_{t+1}^D}{\partial \tau} = -\frac{1}{1+\rho_{t+1}^N}\frac{\partial \rho_{t+1}^N}{\partial \tau}. \tag{2.31}$$

With these price responses determined, we can turn to the response of domestic capital investment. To derive the change in investment start with the per-unit cost function $C_t = w_t(L_t/X_t) + r_t^G p_{t-1}(K_t/X_t)$, which is defined so that

$$C_{K_t} = \frac{\partial C_t}{\partial r_t^N p_{t-1}} = \frac{K_t}{X_t}. \tag{2.32}$$

Since production is assumed to follow constant returns to scale, application of Euler's homogeneous function theorem implies the response of per-unit capital demand is

$$\frac{1}{C_{K_t}}\frac{\partial C_{K_t}}{\partial \tau} = \sigma\theta_{L_t}\left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau} - \frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau}\right), \tag{2.33}$$

where σ is the Allen-Uzawa elasticity of substitution in production. Applying the wage response (2.29) and the definition in (2.32), (2.33) becomes

$$\frac{1}{K_t}\frac{\partial K_t}{\partial \tau} - \frac{1}{X_t}\frac{\partial X_t}{\partial \tau} = -\sigma\left(\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau}\right). \tag{2.34}$$

Combining this with the differentiated production function (2.27) gives

$$\frac{1}{K_t}\frac{\partial K_t}{\partial \tau} = -\frac{\sigma}{\theta_{L_t}}\left(\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau}\right) + \frac{1}{L_t}\frac{\partial L_t}{\partial \tau}. \tag{2.35}$$

The first term in this expression is the factor substitution effect. If a tax raises the cost of capital in production, the firm's capital/labor ratio will fall, where the magnitude of this effect is driven by the elasticity of substitution in production, σ, and the cost share of capital in production, $\theta_{K_t} = 1 - \theta_{L_t}$. The second term reflects the fact that the individual's labor supply response also affects domestic capital investment in equilibrium. While not written directly here for brevity, note that the labor response to the wage rate is theoretically ambiguous and the labor impact on the capital response is also ambiguous. Consequently, it is possible that the labor supply response will either reinforce or offset the factor substitution effect in equilibrium.

Finally, the conditions characterizing the optimal level of income sheltering at the individual level (2.3) imply

$$\frac{\partial \phi_t^I}{\partial \tau_F} = 0. \tag{2.36}$$

That is, individual income sheltering behavior does not respond to the source-based capital income tax. Similarly, relying on the definition of income sheltering at the firm level (2.12),

$$\frac{\partial \phi_t^F}{\partial \tau_I} = 0. \tag{2.37}$$

That is, firm income sheltering behavior does not respond to the residence-based capital income tax.

2.3 Capital Income Taxation in a Small Open Economy

In a small open economy, the pre-tax domestic cost of capital is set by the internationally required rate of return, r_t, which is unaffected by domestic behavior. That is, in a small open economy

$$\frac{\partial r_t^d}{\partial \tau_F} = \frac{\partial r_t}{\partial \tau_F} = \frac{\partial r_t^d}{\partial \tau_I} = \frac{\partial r_t}{\partial \tau_I} = 0. \tag{2.38}$$

Since the pre-tax cost of capital is fixed, the gross cost of capital expression (2.11) gives

$$\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau_F} = \frac{r_t^d\left(1-\phi_t^F\right)}{r_t^G} \tag{2.39}$$

and

$$\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau_I} = 0. \tag{2.40}$$

That is, only the source-based tax affects the gross cost of capital in a small open economy. This offers considerable simplification to the market responses above. Notably, in a small open economy the wage rate w_t is unaffected by the residence-based tax.[7] Further, combining (2.40) with the capital response given in (2.35), the capital

[7] This is plainly evident by combining (2.29) and (2.40).

response to the residence-based tax is proportional to the labor supply response,

$$\frac{1}{K_t}\frac{\partial K_t}{\partial \tau_I} = \frac{1}{L_t}\frac{\partial L_t}{\partial \tau_I}. \tag{2.41}$$

Because a residence-based tax does not distort any of the firm's prices in a small open economy, the factor substitution effect is eliminated and the capital-labor ratio in production is unchanged. However, if the residence-based tax increases (decreases) labor supply, domestic production increases (decreases) in a corresponding manner.

A second implication of the small open economy assumption of perfectly mobile capital is that the interest rate for domestic savers (or borrowers) is also unaffected by domestic behavior,

$$\frac{\partial \rho_t}{\partial \tau_F} = \frac{\partial \rho_t}{\partial \tau_I} = 0. \tag{2.42}$$

Consequently, the net return to saving is unaffected by the source-based tax

$$\frac{1}{1+\rho_t^N}\frac{\partial \rho_t^N}{\partial \tau_F} = 0, \tag{2.43}$$

as well as the individual's perception of discounted future prices. However, the residence-based tax rate does affect the net return to saving

$$\frac{1}{1+\rho_{t+1}^N}\frac{\partial \rho_{t+1}^N}{\partial \tau_I} = -\frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{1+\rho_{t+1}^N}, \tag{2.44}$$

and, as a consequence, the discounting of second period prices.

2.3.1 Optimal Taxation in Small Open Economy

With the full set of prices derived, the optimality conditions in (2.24)-(2.26) can be revised to reflect the assumptions of a small open economy

$$\alpha\left(wh^{1}+wh^{2}\right)\frac{\theta_K}{\theta_L}\left[\frac{r^{d}\left(1-\phi^{F}\right)}{r^{G}}\right]+\lambda\tau_I\left[\frac{\rho\left(1-\phi^{I}\right)b}{q}\right]\left(\frac{1}{b}\frac{\partial b}{\partial\tau_F}\right) \tag{2.45}$$

$$=\lambda\tau_F\left[\frac{r^{d}\left(1-\phi^{F}\right)pK}{q}\right]\left\{\frac{1}{\tau_F}-\frac{\sigma}{\theta_L}\left[\frac{r^{d}\left(1-\phi^{F}\right)}{r^{G}}\right]+\frac{1}{L}\frac{\partial L}{\partial\tau_F}-\frac{1}{1-\phi^{F}}\frac{\partial\phi^{F2}}{\partial\tau_F}\right\}$$

$$\alpha b\left[\frac{\rho\left(1-\phi^{I}\right)}{1+\rho^{N}}\right]+\lambda\tau_F\left[\frac{r^{d}\left(1-\phi^{F}\right)pK}{q}\right]\left(\frac{1}{L}\frac{\partial L}{\partial\tau_I}\right) \tag{2.46}$$

$$=\lambda\tau_I\left[\frac{\left(1-\phi^{I}\right)\rho b}{q}\right]\left(\frac{1}{\tau_I}+\frac{1}{b}\frac{\partial b}{\partial\tau_I}-\frac{1}{1-\phi^{I}}\frac{\partial\phi^{I}}{\partial\tau_I}\right)$$

$$\tau_F\left(1-\phi^{F}\right)r^{d}pK+\tau_I\rho\left(1-\phi^{I}\right)b=qR. \tag{2.47}$$

Despite the simplifications generated by the small open economy assumptions, these conditions remain quite complex. Nevertheless, two clear lessons emerge from this formulation. First, assuming prices rise according to the zero-arbitrage condition ($q=1+\rho$), if the government does not have to raise revenue from capital income taxation ($R=0$) both taxes are optimally zero. That is, at the optimum, neither tax should be used to subsidize the other.[8] The fact that this observation rests on the assumption of zero arbitrage is a consequence of combining overlapping generations with a perfectly substitutable foreign good. For example, suppose that the rate of price increases falls below the interest rate, $q<1+\rho$. In this case the individual views future wages as relatively low, $w_{t+1}^{D}<w_t$, even in the absence of a residence-based

[8]This result rests on the exclusion of two potential considerations: immobile, location-specific capital and residual taxation of foreign countries. Each of these factors may motivate a positive source-based tax rate, as emphasized by Mintz (1995) and demonstrated in McKeehan and Zodrow (2017).

capital income tax. Consequently, any future wage distortions generated by τ_F are also discounted, so that the individual's welfare is maximized by some source-based taxation as an instrument to finance a negative residence-based tax. Second, the optimality conditions (2.45)-(2.47) suggest that neither tax is generally preferred in small open economy. Under most economic conditions and a positive revenue requirement, the small open economy will optimally use both source-based and residence-based taxation to finance government expenditures.

Welfare and Revenue Effects of the Source-Based Tax

Since the complexity of (2.45)-(2.47) prevents easily expressing either tax as purely a function of model parameters, I also derive the marginal welfare and revenue effects associated with each tax, holding the opposing tax constant. First, using the individual's indirect utility function, the welfare effect of the source-based capital income tax is

$$\frac{1}{\alpha}\frac{\partial V}{\partial \tau_F} = -\left(wh^1 + w^D h^2\right)\frac{\theta_K}{\theta_L}\left[\frac{r^d\left(1-\phi^F\right)}{r^G}\right]. \tag{2.48}$$

This shows that the direct welfare effect of the source-based capital income tax in a small open economy is driven by changes in the wage rate. The welfare effect of this tax is necessarily negative, and increasing in magnitude with respect to cost share of capital in production. Additionally, as firm-level income sheltering (ϕ^F) increases, both the wage distortion generated by the source-based tax and the direct welfare effect of the tax become smaller.

Second, differentiating the government's budget constraint with respect to the source-based tax gives

$$\begin{aligned}\frac{\partial R}{\partial \tau_F} &= \tau_I\left(1-\phi^I\right)\frac{\rho b}{q}\left(\frac{1}{b}\frac{\partial b}{\partial \tau_F}\right) + \tau_F\left[\frac{r^d\left(1-\phi^F\right)K}{q}\right]\left(\frac{1}{L}\frac{\partial L}{\partial \tau_F}\right) \\ &+ \tau_F\left[\frac{r^d\left(1-\phi^F\right)K}{q}\right]\left\{\frac{1}{\tau_F} - \frac{1}{1-\phi^F}\frac{\partial \phi^{F2}}{\partial \tau_F} - \frac{\sigma}{\theta_L}\left[\frac{r^d\left(1-\phi^F\right)}{r^G}\right]\right\}.\end{aligned} \tag{2.49}$$

This highlights the primary revenue effects of the source-based capital tax. There are three ways the source-based tax may lead to deterioration of the capital tax base: (1) reducing domestic capital investment, (2) increasing firm-level income sheltering, and (3) reducing savings.

A comparison of (2.48) and (2.49) demonstrates the complex interaction between firm-level income sheltering and the source-based tax. On the one hand, increases in the elasticity of firm-level income sheltering, which only affect (2.49), lower the revenue gain from increasing the source-based tax. This implies that an increase in the elasticity of firm income sheltering activity unambiguously raises the efficiency cost of source-based capital income taxation. On the other hand, an increase in the *level* of firm income sheltering (ϕ^F) reduces the tax wedge generated by source-based taxation and the associated wage distortion. Further, an increase in ϕ^F reduces the size of the capital tax base, putting upward pressure on both the source-based and residence-based capital income tax. On the whole, it is not obvious whether firm income sheltering increases or decreases reliance on the source-based tax at the optimum.

Welfare and Revenue Effects of the Residence-Based Tax

The direct welfare effect of the residence-based tax is

$$\frac{1}{\alpha}\frac{\partial V}{\partial \tau_I} = \left(w^D h^2 - p^D c^2\right)\left[\frac{\rho\left(1-\phi^I\right)}{1+\rho^N}\right]. \tag{2.50}$$

Note that the savings rate can alternatively be written as $b = p^d c^2 - w^D h^2$. Applying this definition, it is clear there is no first-order welfare effect from the residence-based tax if the individual neither saves nor borrows. Further, if $b \neq 0$ and there is a first-order welfare effect, the magnitude of this effect is limited by the individual's income sheltering; income sheltering again reduces the effective tax wedge.

The revenue effect of the residence-based tax is

$$\begin{aligned} \frac{\partial R}{\partial \tau_I} &= \tau_F \left[\frac{r^d \left(1-\phi^F\right) K}{q} \right] \left(\frac{1}{L} \frac{\partial L}{\partial \tau_I} \right) \\ &+ \tau_I \left[\frac{\rho \left(1-\phi^I\right) b}{q} \right] \left(\frac{1}{\tau_I} - \frac{1}{1-\phi^I} \frac{\partial \phi^I}{\partial \tau_I} + \frac{1}{b} \frac{\partial b}{\partial \tau_I} \right). \end{aligned} \tag{2.51}$$

The first term in (2.51) captures the revenue effects of any production distortion generated by the residence-based tax. As implied by (2.41), if the tax leads to an increase in labor supply ($\partial L/\partial \tau_I > 0$), domestic capital investment (and production) increase proportionately — the capital tax base expands. Conversely, if the residence-based capital income tax leads to a reduction in the domestic labor supply, this causes a corresponding decrease in domestic capital investment and production.

The second term in (2.51) captures the effects on the base for τ_I. As in (2.49), increases in the corresponding sheltering elasticity imply increases in the residence-based tax generate smaller revenue gains. The second part of (2.51) also includes the savings effect, $\frac{1}{b}\frac{\partial b}{\partial \tau_I}$, which incorporates two important prior observations about the efficiency of residence-based capital income taxation.

First, using the individual's consumption and leisure responses to taxation (presented in Appendix A.1.1), it is easy to show that the savings effect becomes more negative as consumption becomes increasingly substitutable across periods (this is derived in Appendix A.1.2). That is, as the inter-temporal consumption elasticity increases, increases in the residence-based tax rate generate less revenue. This observation reflects the insight included in Atkinson and Stiglitz (1976) and emphasized by Feldstein (1978): Residence-based capital income taxation distorts the timing of consumption, so that as the inter-temporal elasticity of substitution in consumption increases, so does the distortionary cost of residence-based taxation.

Second, as demonstrated in Appendix A.1.3, the savings effect becomes more positive as the complementarity of consumption and leisure increases in the second period. This reflects the observation of Erosa and Gervais (2002): As the relative complementarity of consumption and leisure rises later in the life-cycle, the efficiency cost of residence-based capital income taxation falls. Since a residence-based capital income tax raises the cost of consumption in later periods, if consumption and leisure are complements in the second period the residence-based capital income tax can actually encourage labor force-participation and counteract the labor-discouraging effects of the source-based tax rate.

2.4 Capital Income Taxation in a Partially Open Economy

The partially open economy primarily differs from the small open economy described above by allowing for immobile capital. Under imperfect capital mobility, it is possible that the domestic rate of return on investment differs from the return earned in international markets. Further, in a partially open economy domestic capital investment may vary according to changes in domestic saving. To incorporate both of these considerations, I expand the resident individual's problem so that the individual not only chooses how much to save, but also where to invest any savings. This investment decision is driven not only by the rates of return available, but also by an exogenous cost of investing abroad. Consequently, the individual may choose to make some domestic investments even if the domestic rate of return falls below the international rate. These modeling expansions are characterized below.

For a given level of savings b_t, the individual chooses how much to invest domestically (b_t^d) and how much to invest abroad ($b_t - b_t^d$). Letting $\phi_t^B = b_t^d / b_t$ indicate the share of savings invested domestically, the cost of foreign investment is $z^B \left(1 - \phi_t^B\right) \rho_{t+1} b_t$. By assumption, $z^B(0) = 0$ and z^B is a convex, increasing function of $1 - \phi_t^B$. Accounting for this cost, the individual allocates investment domestically and internationally to maximize the after-cost, pre-tax rate of return

$$\rho_{t+1} = \phi_t^B r_{t+1}^d + \left(1 - \phi_t^B\right) r_{t+1} - z^B \left(1 - \phi_t^B\right). \tag{2.52}$$

This implies the individual will choose to shift income such that $z^{B\prime} = r_{t+1} - r^d_{t+1}$.[9] This pre-tax rate of return, which now may vary with government policy, corresponds to that referenced in (2.2), so the individual's problem is otherwise unchanged from the problem presented in Section 2.1.1.

In addition to the modifications to the individual's problem defined above, the capital market clearing conditions in the partially open economy differ considerably from those in the small open economy. Primarily, the level of domestic capital investment may vary with domestic savings. To capture this consideration, I assume that the domestic individual is the marginal investor in the domestic economy,

$$\frac{\partial K_t}{\partial \tau_F} = \frac{1}{p_{t-1}} \frac{\partial b^d_{t-1}}{\partial \tau_F} \qquad \frac{\partial K_t}{\partial \tau_I} = \frac{1}{p_{t-1}} \frac{\partial b^d_{t-1}}{\partial \tau_I}. \tag{2.53}$$

Under this assumption, capital and domestic saving are related by

$$\frac{1}{K_t} \frac{\partial K_t}{\partial \tau} = \frac{b^d_{t-1}}{p_{t-1} K_t} \left[\frac{r^d_t}{z^{B\prime\prime} \phi^B_{t-1}} \left(\frac{1}{r^d_t} \frac{\partial r^d_t}{\partial \tau} \right) + \frac{1}{b_{t-1}} \frac{\partial b_{t-1}}{\partial \tau} \right], \quad \tau = \tau_I, \tau_F. \tag{2.54}$$

The savings-investment relationship defined in (2.54) combined with the capital-labor relationship (2.35) implicitly determines how the domestic cost of capital responds to each tax rate in equilibrium. While the associated derivations are algebraically complex (and thus are included in Appendix A.1.4), the steady state responses are related through

$$\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_F} = \left[\frac{r^d \left(1 - \phi^F\right)}{r^G} \frac{\rho^N}{\rho \left(1 - \phi^I\right)} \right] \left(\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_I} \right) Q_A - \frac{r^d \left(1 - \phi^F\right)}{r^G}, \tag{2.55}$$

where $Q_A \to 1$ in a completely closed economy.

Since it is possible that the domestic cost of capital (r^d_t) will respond to changes

[9] I further assume that $z^{B\prime}(1) \geq r_{t+1} - r^d_{t+1}$ and $r_{t+1} \geq r^d_{t+1}$ so that $0 \leq \phi^B_t \leq 1$.

in domestic tax policy, the gross cost of capital responses are

$$\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau_F} = \frac{1}{r_t^d}\frac{\partial r_t^d}{\partial \tau_F} + \frac{r_t^d\left(1-\phi_t^F\right)}{r_t^G} \tag{2.56}$$

and

$$\frac{1}{r_t^G}\frac{\partial r_t^G}{\partial \tau_I} = \frac{1}{r_t^d}\frac{\partial r_t^d}{\partial \tau_I}. \tag{2.57}$$

As (2.57) suggests, the domestic wage rate may be affected by the residence-based tax in the partially open economy.

Equations (2.56) and (2.57) additionally imply that the individual's pre-tax rate of return to saving may be affected by either tax, since this return is a function of the domestic cost of capital. As long as the domestic investor chooses the share of savings invested domestically to maximize the pre-tax rate of return (2.52), the gross rate of return to saving responds to domestic taxes according to

$$\frac{1}{\rho_t}\frac{\partial \rho_t}{\partial \tau} = \frac{r_t^d b_{t-1}^d}{\rho_t b_{t-1}}\left(\frac{1}{r_t^d}\frac{\partial r_t^d}{\partial \tau}\right), \quad \tau = \tau_I, \tau_F. \tag{2.58}$$

Accounting for the gross-return responses given in (2.58), the net return to saving responds to the source-based and residence-based tax rates such that

$$\frac{1}{1+\rho_{t+1}^N}\frac{\partial \rho_{t+1}^N}{\partial \tau_F} = \frac{\rho_{t+1}^N}{1+\rho_{t+1}^N}\left(\frac{r_{t+1}^d b_t^d}{\rho_{t+1} b_t}\right)\left(\frac{1}{r_{t+1}^d}\frac{\partial r_{t+1}^d}{\partial \tau_F}\right) \tag{2.59}$$

and

$$\frac{1}{1+\rho_{t+1}^N}\frac{\partial \rho_{t+1}^N}{\partial \tau_I} = \frac{\rho_{t+1}^N}{1+\rho_{t+1}^N}\left[\left(\frac{r_{t+1}^d b_t^d}{\rho_{t+1} b_t}\right)\left(\frac{1}{r_{t+1}^d}\frac{\partial r_{t+1}^d}{\partial \tau_I}\right) - \frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{\rho_{t+1}^N}\right], \tag{2.60}$$

respectively.

Generally, the price responses in (2.56)-(2.60) suggest the difference between source-based and residence-based taxation is considerably more nuanced in a partially open economy. Both taxes have the ability to adjust all endogenous prices, and thus may affect the behavior of both firms and individuals, regardless of who pays the tax.

2.4.1 Optimal Taxation in a Partially Open Economy

Using the price responses derived above, the steady-state optimality conditions in the partially open economy become

$$\begin{aligned}
&- \alpha\left(wh^1 + w^D h^2\right)\frac{\theta_K}{\theta_L}\left[\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} + \frac{r^d\left(1-\phi^F\right)}{r^G}\right] \\
&+ \alpha b\frac{\rho^N}{1+\rho^N}\left(\frac{r^d b^d}{\rho b}\right)\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}\right) - \lambda\tau_I\left[\frac{\rho\left(1-\phi^I\right)b}{q}\right]\left[\frac{r^d b^d}{\rho b}\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}\right) + \frac{1}{b}\frac{\partial b}{\partial \tau_F}\right] \\
&+ \lambda\tau_F\left[\frac{r^d\left(1-\phi^F\right)K}{q}\right]\left(\frac{1}{\tau_F} + \frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} - \frac{1}{1-\phi^F}\frac{\partial \phi^{F2}}{\partial \tau_F}\right) \\
&+ \lambda\tau_F\left[\frac{r^d\left(1-\phi^F\right)K}{q}\right]\left\{-\frac{\sigma}{\theta_L}\left[\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} + \frac{r^d\left(1-\phi^F\right)}{r^N}\right] + \frac{1}{L}\frac{\partial L}{\partial \tau_F}\right\} = 0
\end{aligned} \tag{2.61}$$

$$\begin{aligned}
&- \alpha\left(wh^1 + w^D h^2\right)\frac{\theta_L}{\theta_K}\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) \\
&+ \alpha b\frac{\rho^N}{1+\rho^N}\left[\frac{r^d b^d}{\rho b}\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) - \frac{\rho\left(1-\phi^I\right)}{\rho^N}\right] \\
&+ \lambda\tau_F\left[\frac{r^d\left(1-\phi^F\right)K}{q}\right]\left[\left(1-\frac{\sigma}{\theta_K}\right)\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) + \frac{1}{L}\frac{\partial L}{\partial \tau_I}\right] \\
&+ \lambda\tau_I\left[\frac{\rho\left(1-\phi^I\right)b}{q}\right]\left[\frac{1}{\tau_I} + \frac{r^d b^d}{\rho b}\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) + \frac{1}{b}\frac{\partial b}{\partial \tau_I} - \frac{1}{1-\phi^I}\frac{\partial \phi^I}{\partial \tau_I}\right] = 0
\end{aligned} \tag{2.62}$$

$$\tau_F\left(1-\phi^F\right)r^d K + \tau_I\rho\left(1-\phi^I\right)b = qR. \tag{2.63}$$

Unlike in the small open economy, the optimality conditions (2.61)-(2.63) suggest some non-zero capital income taxation can be optimal in the absence of a revenue requirement, even when prices increase according to a zero-arbitrage condition. To illustrate this, at $\tau_I = \tau_F = R = 0$ and $q_t = 1 + \rho_t$, these conditions simplify to

$$\left(1 - \frac{b^d}{qK}\right)\left[\frac{r^d pK}{\rho b}\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) - \frac{1}{1-\phi^{F1}}\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}\right)\right] = 0. \tag{2.64}$$

That is, the welfare-maximizing government will only abstain from either form of capital income taxation in the absence of a revenue requirement if all domestic capital investment is made by local investors $\left(b^d/q = K\right)$. This condition results from assumption (2.53), that domestic investment is determined by the domestic investor at the margin. As long as there is inelastic investment from foreign agents, source-based capital income taxation offers an opportunity for capital tax burden exporting.

Welfare and Revenue Effects of the Source-Based Tax

The optimality conditions (2.61)-(2.63) are again complex enough to prevent presenting either tax as purely a function of model parameters, so I again derive the marginal revenue and welfare effects associated with each tax, holding the opposing tax constant. In the partially open economy, the direct welfare effect of the source-based tax is

$$\begin{aligned}\frac{1}{\alpha}\frac{\partial V}{\partial \tau_F} = &-\left(wh^1 + w^D h^2\right)\frac{\theta_K}{\theta_L}\left[\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} + \frac{r^d\left(1-\phi^F\right)}{r^G}\right] \\ &+ b\left(\frac{\rho^N}{1+\rho^N}\right)\left(\frac{r^d b^d}{\rho b}\right)\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}\right).\end{aligned} \tag{2.65}$$

This highlights how the source-based tax not only distorts the individual's wage, but also the domestic cost of capital in a partially open economy. Depending on whether the source-based tax decreases or increases the domestic return to capital, this may act to attenuate or compound the wage distortion. This also suggests that source-based taxation may affect individuals who borrow or save, and this effect which cannot be mitigated through income sheltering activity. However, as the residence-based tax decreases the net return to saving (ρ_t^N), the welfare consequences of this distortion diminish.

The direct revenue effect of the source-based tax in the partially open economy is

$$\frac{\partial R}{\partial \tau_F} = \tau_F \left[\frac{r^d \left(1-\phi^F\right) K}{q} \right] \left(\frac{1}{\tau_F} - \frac{1}{1-\phi^F} \frac{\partial \phi^{F2}}{\partial \tau_F} + \frac{1}{r^d} \frac{\partial r^d}{\partial \tau_F} \right) \tag{2.66}$$

$$+\tau_F \left[\frac{r^d \left(1-\phi^F\right) K}{q} \right] \left\{ \frac{1}{L} \frac{\partial L}{\partial \tau_F} - \frac{\sigma}{\theta_L} \left[\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_F} + \frac{r^d \left(1-\phi^F\right)}{r^G} \right] \right\}$$

$$+\tau_I \left[\frac{\rho \left(1-\phi^I\right) b}{q} \right] \left[\frac{r^d b^d}{\rho b} \left(\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_F} \right) + \frac{1}{b} \frac{\partial b}{\partial \tau_F} \right].$$

Comparison to (2.49) reveals how the impact of the source-based tax changes in a partially open economy: the equations are identical except that in a partially open economy the source-based tax may affect the domestic return to capital. Any decrease (increase) in the domestic return decreases (increases) both tax bases and increases (decreases) the efficiency cost associated with source-based taxation. However, in combination with the direct welfare effects (2.65), it is not clear that the efficiency cost of the source-based tax rises in the partially open economy even when the sign of $\partial r^d / \partial \tau_F$ is known. Any decrease in the domestic rate of return, corresponding to an increase in capital investment, puts upward pressure on the individual's wage rate — the revenue and welfare effects work in opposition.

Welfare and Revenue Effects of the Residence-Based Tax

The direct welfare effect of the residence-based tax in the partially open economy is

$$\frac{1}{\alpha} \frac{\partial V}{\partial \tau_I} = -\left(wh^1 + w^D h^2\right) \frac{\theta_K}{\theta_L} \left(\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_I} \right) \tag{2.67}$$

$$+ \frac{\rho^N b}{1+\rho^N} \left[\frac{r^d b^d}{\rho b} \left(\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_I} \right) - \frac{\rho \left(1-\phi^I\right)}{\rho^N} \right].$$

This expression is remarkably similar to (2.65), only replacing the direct effect of the source-based tax on the wage rate with the direct effect of the residence-based tax on the return to saving. Further, as the economy becomes increasingly closed, the direct welfare effects presented in (2.65) and (2.67) become increasingly similar. In fact, in a completely closed economy with no income sheltering the two welfare effects are identical after scaling for gross tax rates.[10]

In the partially open economy, the direct revenue effect of the residence-based tax is

$$\begin{aligned} \frac{\partial R}{\partial \tau_I} &= \tau_F \left[\frac{r^d \left(1-\phi^F\right) K}{q} \right] \left[\left(1 - \frac{\sigma}{\theta_K}\right) \frac{1}{r^d} \frac{\partial r^d}{\partial \tau_I} + \frac{1}{L} \frac{\partial L}{\partial \tau_I} \right] \\ &+ \tau_I \left[\frac{\rho \left(1-\phi^I\right) b}{q} \right] \left[\frac{1}{\tau_I} - \frac{1}{1-\phi^I} \frac{\partial \phi^I}{\partial \tau_I} + \frac{r^d b^d}{\rho b} \left(\frac{1}{r^d} \frac{\partial r^d}{\partial \tau_I} \right) + \frac{1}{b} \frac{\partial b}{\partial \tau_I} \right]. \end{aligned} \tag{2.68}$$

As demonstrated in the Appendix A.1.2, this formulation suggests the importance of the inter-temporal consumption elasticity emphasized by Feldstein (1978), which was noted in the small open economy, persists even in a partially open economy. However, it is complicated because the inter-temporal elasticity of substitution in consumption also interacts with the rate-of-return response $\left(\frac{1}{r_t^d} \frac{\partial r_t^d}{\partial \tau_I}\right)$, which is itself affected by the inter-temporal elasticity of substitution in consumption.[11] Similarly, the effect aligning with Erosa and Gervais' (2002) insight that an increase in second-period consumption-labor complementarity supports residence-based taxation persists in the partially open economy. However, the effect is again complicated by interactions with changes in the rate of return to capital. As with the direct welfare effect, in the extreme case of a completely closed economy the direct revenue effect of the

---

[10] To show this, apply the relationship (2.55) to (2.67). Under the assumptions of a closed economy with no income sheltering this gives $\frac{1}{\alpha} \frac{\partial V}{\partial \tau_I} = \left(\frac{1+\tau_F}{1-\tau_I}\right) \frac{1}{\alpha} \frac{\partial V}{\partial \tau_F}$.

[11] This relationship can again be shown by first applying (2.55) to the labor and savings responses giving $\frac{1}{L} \frac{\partial L}{\partial \tau_I} = \left(\frac{1+\tau_F}{1-\tau_I}\right) \frac{1}{L} \frac{\partial L}{\partial \tau_F}$ and $\frac{1}{b} \frac{\partial b}{\partial \tau_I} = \left(\frac{1+\tau_F}{1-\tau_I}\right) \frac{1}{b} \frac{\partial b}{\partial \tau_F}$. Since these relationships hold, applying (2.55) to (2.68) gives $\frac{\partial R}{\partial \tau_I} = \left(\frac{1+\tau_F}{1-\tau_I}\right) \frac{\partial R}{\partial \tau_F}$ (assuming a completely closed economy with no sheltered income).

residence-based tax and the source-based tax are equivalent after scaling for gross tax rates. Consequently, while an increasing inter-temporal elasticity of substitution or a decreasing second-period consumption-leisure complementarity favors source-based taxation in the small open economy, the importance of these considerations is diminished in a partially open economy. Instead, considerations such as asymmetric income sheltering opportunities become increasingly important.

2.5 Conclusion

This paper uses an analytical equilibrium model to study the impact of globalization on the optimal choice between source-based and residence-based capital income taxation. In this model globalization is represented through two changes in the economy: increasingly mobile capital investment and increased opportunities for international income sheltering. The interactions of these two considerations are shown to be complex. In a relatively closed economy with immobile capital investments, source-based and residence-based taxes have similar effects, suggesting that asymmetry in income sheltering opportunities is likely to drive the choice between the two forms of capital income taxation. However, as capital becomes more mobile, the capital distortions generated by these two taxes become more distinct. Consequently, holding income sheltering opportunities constant, the role of income sheltering in determining the optimal form of capital income taxation is expected to diminish as an economy becomes increasingly global. This is compounded by the observation that, even when income sheltering opportunities are increasing, it is not clear that these increases will affect the relative optimality of these two tax systems since sheltering activity has conflicting efficiency implications. On the one hand, income sheltering is a costly, non-productive activity that only arises in response to taxation, decreasing the efficiency of the associated tax. On the other hand, income sheltering also reduces the real economic distortions generated by taxation. In sum, these factors suggest that when choosing between source-based and residence-based taxation in increasingly global markets, policy makers should focus on mitigating capital distortions, not income sheltering.

Focusing on capital distortions, the classic efficiency considerations associated with each form of taxation drive the choice between source-based and residence-based taxation in a partially (or fully) open economy. When the production cost share of capital or the elasticity of substitution between capital and labor is high, source-based taxation becomes less desirable. When the domestic inter-temporal elasticity of substitution is high or the complementarity of consumption and leisure is falling with age, residence-based taxation becomes less desirable. On the whole, whether globalization favors source-based or residence-based capital income taxation depends more on the preferences of domestic residents and opportunities for attracting foreign investment than on income sheltering behavior.

Chapter 3

Balancing Act: Weighing the Factors Affecting the Taxation of Capital Income in a Small Open Economy

Written in collaboration with George R. Zodrow.

Published in *International Tax and Public Finance*, Volume 24, Issue 1, pp. 1–35.

3.1 Introduction

Under the appropriate assumptions, optimal tax theory provides a striking result on the use of source-based taxes on capital income such as the typical corporate income tax: in a small open economy that cannot affect the after-tax return to internationally mobile capital or the prices of tradable goods, the optimal capital income tax rate is zero (Gordon 1986; Razin and Sadka 1991; Zodrow and Mieszkowski 1983).[1] This result does not rely on — although it is reinforced by — concerns about the negative effects of capital income taxation on domestic saving or the distortions of many types of investment decisions under the typical corporate income tax (Nicodme 2008), or the tendency toward under-provision of public services financed with capital income taxes in the presence of international tax competition (Zodrow and Mieszkowski 1986; Wilson 1986). Instead, the argument follows from the assumption that the small open economy faces a perfectly elastic supply of highly mobile international capital. In this case, the imposition of a source-based tax on capital income will simply cause internationally mobile capital to migrate to other countries until its after-tax return in the taxing country increases to the internationally determined rate of return. This

[1] For further discussion, see Zodrow (2010a, b).

emigration of capital lowers the productivity of the fixed factors in the taxing country — land, labor (or at least relatively immobile labor), and any immobile capital — so that local factors of production ultimately bear the entire burden of the capital income tax, including both the revenue raised and the efficiency costs of the tax due to capital emigration (as well as the other distortionary costs noted above). Indeed, Harberger (1995, 2008) argues that immobile labor and land may bear more than one hundred percent of a corporate income tax in a small open economy, once general equilibrium effects across business sectors are considered.

This argument is reinforced by two additional considerations in the modern global economy. The first is a straightforward extension of the basic argument, applied to investments by multinational corporations (MNCs) that generate significant firm-specific economic rents; such rents are attributable to factors unique to the firm such as specialized and patented technological knowledge, superior managerial skills or production techniques, or valuable product brands, trademarks, reputations, and other intangible assets (Dunning 1981). Moreover, there is some empirical evidence that the relative importance of such rents is increasing over time, as Auerbach (2006) shows that the dispersion of relative profitability for US corporations has increased significantly in recent years, suggesting an increase in the importance of investments that generate above-normal returns made by a relatively small number of highly profitable firms. Because such firm-specific capital is likely to be especially mobile and also may have the potential for significant increases in the productivity of local factors (e.g., it is most likely to be associated with high levels of technology transfer, access to skilled labor including highly effective management, and the generation of other external benefits including the creation of a competitive environment that fosters invention and innovation), concerns about tax-induced emigration of mobile capital may be especially pronounced for such investments, reinforcing the standard zero-tax argument (Gordon and Hines 2002).

The second issue has been the focus of many recent policy discussions, most recently in the Base Erosion and Profit Shifting project of the Organisation for Economic Co-operation and Development (OECD) (2013). Specifically, the application of a relatively high corporate tax rate to the income of MNCs encourages them to engage in profit shifting, that is, to use various financial manipulations, including transfer pricing, the relocation of the ownership of intangibles, and the use of loan reallocations that facilitate interest stripping, to shift revenues to relatively low tax countries and deductions to relatively high-tax countries. There is considerable empirical evidence of income shifting (Clausing 2011, 2016; Dowd 2016), in particular that a relatively high statutory corporate tax rate encourages income shifting, since it is the statutory tax rate that determines the value to the firm of shifted revenues and deductions. Thus a desire to avoid creating incentives for income shifting also puts downward pressure on capital income tax rates.[2]

Despite these arguments, as well as empirical evidence of the importance of international tax competition (Devereux and Loretz 2013), corporate income tax rates in small open economies have not in practice converged to zero (although they have declined on average over time). A wide variety of arguments have been offered in support of corporate taxation, all of which qualify the argument that a small open economy should exempt capital income from tax. Although it is difficult to judge the relative importance of each of these qualifications, the pervasiveness of corporate income taxation around the world suggests that together these arguments have been taken seriously by policymakers.

Perhaps the most important argument in support of a relatively high level of source-based capital income taxation is that it allows the government to obtain significant revenues from the taxation of location-specific economic rents. Such rents, which may accrue to both domestically-owned firms and firms that are partially or fully owned by foreigners, can reflect resource rents as well as economic rents that

[2]Furthermore, a low statutory rate may make a country attractive for investment by MNCs simply because it creates the potential for additional income shifting (Slemrod 1997).

arise because of factors such as local economies of agglomeration, productive government infrastructure, easier access to consumer markets (including those for financial services), lower transport costs, and inexpensive but relatively productive local factors of production including skilled labor — in addition to the ability to avoid trade barriers such as tariffs and quotas.

The taxation of location-specific economic rents provides an efficient and thus highly desirable source of revenue. Moreover, if these rents accrue to foreigners, such taxes are especially attractive from the perspective of the taxing country, as the burden of the tax on rents is borne by foreigners, while marginal domestic investment decisions are not distorted (Mintz 1995). Indeed, empirical evidence suggests that a higher share of foreign ownership in a country tends to result in a higher average corporate income tax rate (Huizinga and Nicodme 2006).

A second argument is related to the prevalence of income shifting noted above. Specifically, although a high domestic corporate tax rate tends to encourage more income shifting, the existence of income shifting to some extent mitigates the negative effect of a high statutory tax rate on foreign direct investment by MNCs, since firms know they will be able to avoid some of the costs of a high tax rate in a host country by shifting income to lower tax countries. Indeed, to the extent that such tax avoidance opportunities are available primarily to MNCs and such firms are more mobile than domestic companies, a relatively high statutory rate may be desirable as part of a strategy that attracts FDI at minimal revenue cost by imposing a high tax burden on relatively immobile domestic capital but a low effective tax burden, taking into account tax avoidance activities, on relatively mobile international capital (Hong and Smart 2010; Gugl and Zodrow 2006). An aggressive version of this strategy would include lax enforcement of the many rules currently used to limit tax avoidance by MNCs or even explicit regulations that facilitate such tax avoidance — the new variation of international tax competition stressed by Altshuler and Grubert (2006), which they note is exemplified by the long-time existence of the "check-the-box" rules in the United States.

A third argument for a relatively high corporate tax rate in a small open economy was once believed to be compelling, but has been declining in importance over time. Specifically, the "treasury transfer" argument suggests that a host country that imports capital primarily from countries that use residence-based corporate income tax systems and grant foreign tax credits (FTCs) should raise its tax rate approximately to the rate utilized by those countries, since such a rate increase will essentially transfer revenues from the treasury of the home countries to the treasury of the host country without having any deleterious effects on FDI (since the combined host and home countries tax burden borne by the MNC is always determined solely by the statutory tax rate of the home country).

The prospect of such a "free" source of tax revenue is naturally appealing and has been stressed in many tax policy discussions. However, there are at least three reasons the treasury transfer effect is often argued to be of limited relevance in the modern economy. First, because both Japan and the United Kingdom have recently switched to "territorial" tax systems under which foreign-source income is largely tax exempt, the United States is now the only major industrialized country that utilizes a residence-based tax system with an FTC. Thus, the treasury transfer argument is potentially relevant only for countries that import significant amounts of capital from the United States.[3] Second, because of various limitations placed on the use of foreign tax credits, many US multinationals are in an "excess foreign tax credit" position — that is, they already have more credits than they can use currently, so that additional credits are of limited value and a lower host country tax rate should attract additional FDI. Third, the importance of the treasury transfer effect is limited by the fact that host country taxes are assessed currently but foreign tax credits in

[3] Although the relative importance of FDI from the United States has of course declined in recent years, it is still significant in many countries. For example, the Economic Commission for Latin America and the Caribbean (2012) reports that the U.S. accounts for roughly a quarter of foreign direct investment in Latin America and the Caribbean.

the home country are not granted until the funds are repatriated to the parent firm. Indeed, under certain circumstances, a home country repatriation tax has no effect on investment financed with the retained earnings of the subsidiary (Hartman 1985; Sinn 1987) — although the relevance in practice of this proposition has been the subject of debate; in particular, Grubert and Altshuler (2013, Appendix A) argue that the Hartman-Sinn model is based on very restrictive assumptions and its predictions are inconsistent with the empirical data on repatriations.

It is also interesting to note, however, that the importance of the treasury transfer effect may be increasing — currently and perhaps to a significantly greater extent in the near future — for host countries with relatively low tax rates. Specifically, many capital-exporting countries have become increasingly concerned about revenue losses due to income shifting by multinationals, especially to very low rate tax haven countries, and are enacting, or considering the enactment of, what are broadly referred to as "anti-base-erosion" provisions (OECD 2013). Although such provisions may take many forms, one common approach is to impose current home country taxes on income that is earned in relatively low-rate jurisdictions. For example, the new territorial tax system in Japan includes Controlled Foreign Company (CFC) provisions under which Japanese companies are required to report as domestic income taxable profits earned in any country with an effective tax rate of 20 percent or less (Deloitte 2014).

Similar provisions have been proposed in the context of reform of the system of international taxation in the United States. For example, the discussion draft put forward by Representative Dave Camp includes an anti-base-erosion provision under which foreign-source income from intangibles derived from sales to foreign markets would be taxed in the United States in the year earned at a 15 percent rate, subject to credits for foreign taxes paid, while foreign-source income from intangibles derived from sales to the US market would be taxed in the year earned at a 25 percent rate all relative to a proposed general corporate statutory tax rate of 25 percent.[4] The discussion draft released by Senator Max Baucus would tax all passive and highly mobile foreign-source income, as well as foreign-source income earned from selling goods and services back to the U.S., in the year earned at the statutory corporate tax rate, subject to credits for foreign taxes paid. Foreign-source income from products and services sold abroad would similarly be taxed currently, although at reduced rates.[5] Both of these proposals could significantly increase the relevance of the treasury transfer effect, although within the context of a lower US corporate tax rate.

Numerous other arguments support some source-based capital income taxation, often in the form of a corporate income tax. From a domestic perspective, a corporate income tax is often deemed to be desirable as a "backstop" to the personal income tax; that is, depending on relative personal and corporate tax rates, a corporate income tax may be desirable to prevent individuals from incorporating and deferring personal income tax on labor income by retaining the earnings in corporate form while financing any desired consumption with loans from their companies. In addition, the small open economy assumptions may be too extreme for some countries; Gravelle and Smetters (2006) stress that the economic effects of corporate income taxes differ significantly if capital is imperfectly mobile or if traded and domestically-produced goods are imperfect substitutes. Finally, a corporate income tax may be politically indispensable in many countries.

Relatively few papers have examined the interactions of these competing effects on capital income taxation from the perspective of an open economy. Four papers are particularly relevant to our analysis.

Gordon and Mackie-Mason (1995) consider the interaction of domestic income shifting and international income shifting. In their model, an optimal tax system

---

[4] Details of the Camp discussion draft are available at `http://waysandmeans.house.gov/UploadedFiles/Statutory_Text_Tax_Reform_Act_of_2014_Discussion_Draft__022614.pdf`.

[5] Details of the Baucus discussion draft are available at `http://www.finance.senate.gov/imo/media/doc/Chairman'sStaffInternationalDiscussionDraftSummary.pdf`.

balances the cost from individuals disguising labor income as capital income when the capital income tax rate is lowered against the benefit of an increase in the tax base due to reduced international income shifting.[6]

Huizinga and Nielsen (1997) examine optimal rules for separate taxes on all capital income and on above-normal profits in a small open economy model where foreigners own some of the domestic capital stock. They show that, as long as above-normal profits are taxed at rates less than one hundred percent, some source-based taxation of capital income is desirable to extract rents from foreign owners of domestic capital.

Becker and Fuest (2011) examine how differences in capital mobility and profitability affect the desirability of base broadening, rate reducing (BBRR) corporate reforms relative to introducing investment incentives. Specifically, they show that under certain circumstances a BBRR reform that involves a corporate rate reduction financed by less generous deductions for depreciation is preferable to increasing investment incentives if relatively more mobile firms are also more profitable than their relatively immobile competitors. The intuition is that a lower statutory rate is desirable to attract/retain the more mobile firms which are highly responsive to the statutory rate since that is the rate applied to its above-normal profits, even at the cost of reducing investment incentives (accelerated depreciation), which are relatively more important in determining the tax burden of the comparatively immobile less profitable firms.

Finally, Haufler and Schjelderup (2000) construct a model that includes foreign direct investment and the possibility of income shifting. Like Becker and Fuest (2011), they show that under certain circumstances a BBRR reform that involves a corporate rate reduction financed by less generous deductions for depreciation is desirable, as the gains from reducing income shifting are unambiguously larger than the costs of

[6]See also Gordon and Slemrod (2000), who estimate the extent of income shifting between the personal and corporate income tax bases following the enactment of the Tax Reform Act of 1986, and Slemrod and Wilson (2009) who investigate the effects of such shifting in the presence of low-rate tax havens.

reducing investment incentives.

In a similar vein, we construct a simple theoretical model that illustrates how the government of a small open economy might balance some of the trade-offs involved in taxing capital income described above, and then simulate a more complicated version of the model to see how much optimal capital income tax rates might vary from zero under scenarios that take into account the interactions between the various factors analyzed.[7] We maintain the standard small open economy assumptions of perfect mobility (of certain forms of) capital and perfect substitutability of domestic and foreign tradable goods in our model. In addition, we assume the economy is small enough that changes in domestic tax policy do not affect the determination of tax rates in other countries; that is, foreign countries do not respond strategically to the increase in the domestic tax rate, as foreign tax rates are treated as exogenous. In our base analytical model, we focus on the trade-offs involved in balancing (1) the costs of taxing highly mobile capital, including firm-specific capital earning above-normal returns, and (2) the costs of encouraging income shifting to lower-tax jurisdictions, against (3) the gains from taxing location-specific capital, some of which is foreign-owned, (4) the mitigating effects on tax-induced reductions of FDI of the presence income shifting possibilities, and (5) the potential for a treasury transfer effect. Our base model does not include explicit costs of income shifting or the potential for disguising labor income as capital income. However, we include these features in our computational model, which also includes ordinary capital in both production sectors,

[7]To simplify the analysis, we model a single "capital income tax rate" (τ), which serves as a proxy for a combination of the various relevant tax rates. For example, the relevant capital income tax rate would be the statutory rate for equity-financed domestic investment under a system that measured real economic income accurately (e.g., with tax depreciation equal to inflation-adjusted economic depreciation and no other investment allowances). In practice, tax systems are far more complicated, with lower effective tax rates due to interest deductions for debt-financed investment and accelerated depreciation deductions, investment tax credits, etc. In addition, different tax rates are relevant at different margins — the statutory rate is most relevant for income shifting, some combination of the statutory rate and the effective tax rate is most relevant for investment of firm-specific capital, and the effective tax rate is most relevant for investment of ordinary capital. Note, however, that we do model explicitly the reduction in the effective capital income tax rate due to income shifting.

endogenous labor supply, a proportional labor income tax, and the possibility of direct taxation of location-specific capital.

The base analytical model confirms several general results, showing that some capital income taxation may be efficient in the presence of residual taxation or foreign ownership of location-specific capital. The computational model confirms and extends these observations, showing that foreign ownership and residual taxation can both generate large increases in the optimal capital income tax rate. However, these results are subject to various qualifications. If separate taxation of location-specific capital is feasible, foreign ownership does not notably increase the optimal general capital income tax rate. While residual taxation is shown to be an important consideration, changes in the foreign tax rate have minimal effects on the optimal domestic rate unless the two rates are very close to each other. The computational model also highlights the varying importance of income shifting activity. If individuals are able to easily disguise labor income as capital income, increasing capital income taxation becomes more desirable. However, greater international income shifting opportunities have only modest effects on the optimal capital income tax rate due to offsetting effects. While increases in income shifting imply the size of the tax base is more sensitive to capital income taxation, income shifting opportunities also lower the tax sensitivity of real investment (since firms know they will be able to lower their effective tax burden through income shifting) and increase the proportion of relatively immobile factors in the tax base.

We describe the structure of our base analytical model in the following section, and the characteristics of the solution for the optimal capital income tax rate in Section 3. The details of the expanded computational model are presented in Section 4, which also provides the results of simulating that model for the optimal capital income tax rate for a wide variety of parameter values. Conclusions and directions for future research are discussed in the final section.

3.2 The Base Model

Our base analytical model is designed to capture four of the primary factors that influence the optimal capital income tax rate in a small open economy: (1) immobile capital that earns location-specific rents, some of which may be owned by foreigners; (2) perfectly mobile foreign-owned capital that earns firm-specific rents; (3) the possibility of capital income shifting; and (4) the possibility of residual home country taxation of foreign-source income by countries that operate a residence-based system of taxation, such as the United States, or countries like Japan that have base erosion provisions that apply domestic tax on an accrual basis to income earned in host countries with sufficiently low tax rates, subject to foreign tax credits.

To capture these effects we construct a simple two-sector model. Sector one is a "domestic" sector that produces a non-traded good (X_1) using labor (L_1) and location-specific capital (LSK) that is fixed, immobile, and earns economic rents (ρ_{LSK}) that may be partially or completely foreign-owned. Sector two is a "multinational" sector that produces a traded good (X_2) using labor (L_2) and firm-specific capital (FSK) that is perfectly mobile, foreign-owned, and earns economic rents at an internationally determined rate of return (ρ_F). The price of the traded good (p_2) is also determined internationally, and it is possible that the small open economy may be either a net importer or a net exporter. The domestic good is produced using a constant returns to scale technology, $X_1 = F_1(L_1; LSK)$. The earnings of capital in the domestic sector are subject to capital income taxation at a statutory tax rate τ, so the profit-maximizing labor demand in sector one is the solution to $\max_{L_1} \{p_1 X_1 - wL_1\}$, where p_1 is the market price of good one and w is the market wage. In equilibrium, the before-tax economic rents earned by LSK are $(1+\tau)\,\rho_L LSK = p_1 X_1 - wL_1$. Note that in order to simplify the model, we treat the corporate tax simply as applying to all capital income, and thus do not consider many complicating and distortionary features of actual corporate income taxes, including deductions for economic depreciation, accelerated depreciation deductions, investment tax credits and other investment preferences, the treatment of inflation, as well as differential treatment of equity and debt finance, especially deductions for interest expense.

Production in the multinational or traded goods sector is a function of the amounts of labor (L_2) and FSK utilized, $X_2 = F_2(L_2, FSK)$.[8] The earnings of the firm-specific capital in the multinational sector are in principle also subject to the statutory capital income tax rate. However, a fraction (ϕ_S) of capital income in this multinational sector is shifted to a tax haven country with a relatively low tax rate τ_H; the fraction shifted is a function of the tax differential $\tau - \tau_H$. Only the unshifted share of capital income $(1-\phi_S)$ is subject to the domestic tax. In addition, a fraction ϕ_F of the unshifted income is also subject to a current residual tax imposed by the foreign (home) country at tax rate τ_F. We assume that none of the capital income shifted to the tax haven is subject to a residual tax.

Consequently, the effective capital income tax rate in the multinational sector, taking into account income shifting to tax havens and residual home country current taxation, is $T_K = (1-\phi_S)[\tau + \phi_F \max(\tau_F - \tau, 0)] + \phi_S \tau_H$. Given any level of FSK, the multinational firms in sector two choose labor to maximize profit. The amount of firm-specific capital invested is the amount consistent with after-tax earnings equal to the internationally-determined rate of return ρ_F, taking into account the demand for labor as a function of FSK. That is, the amount of firm-specific capital invested in the country is such that $\rho_F = (p_2 X_2 - wL_2)/[(1+T_K)\,FSK]$, where both X_2 and L_2 are functions of the firm-specific capital invested.

In the base model, we assume a single representative resident with inelastic labor

[8] Following the approach used in the CORTAX computable general equilbrium model constructed by Bettendorf et al. (2009) and de Mooij and Devereux (2011), we model the factor generating firm-specific rents as an explicit production input characterized by "fixed management capacity." That is, we assume a fixed amount of firm-specific capital (which includes a combination of factors such as unique managerial skills, production processes, and intangible capital) that must be allocated among different locations around the world. A similar approach is used by Becker and Fuest (2011), who consider "ownership skill" that creates above-normal returns, assuming first that the amount of this skill is fixed and must be allocated across countries, and then extending the analysis to the case in which ownership skill is unlimited. Devereux, Fuest, and Lockwood (2014) consider both cases as well as intermediate possibilities.

supply. Consequently, the individual allocates income across consumption goods to maximize utility, producing the indirect utility function

$$v\left(p_1, I\right) = \max_{C_1, C_2} \left\{ U\left(C_1,\, C_2\right) \mid\ I \geq p_1 C_1 + p_2 C_2 \right\}, \tag{3.1}$$

where C_i is the consumption of good i, p_i is the market price of good i, and I is the individual's after-tax income. We hold government services (G) constant throughout the analysis and assume they are separable from consumption in the individual's welfare function. Income is composed of labor income and capital income, less any lump-sum taxes levied by the government, so that net income is

$$I = wL + \theta \rho_L LSK - t \tag{3.2}$$

where t is the lump-sum tax, L is the fixed level of total labor supply, and θ is the share of location-specific capital that is owned domestically.

Government services are modeled as purchases of the tradable good, and government revenues are raised from capital income taxation of the returns to LSK and FSK and the lump-sum tax (which is a proxy for labor income taxation in the base model, given the assumption of an inelastic supply of labor). The government budget constraint is thus

$$p_2 G \leq \tau \rho_L LSK + \left(1 - \phi_S\right) \tau \rho_F FSK + t. \tag{3.3}$$

Finally, since total labor supply (L) is fixed, equilibrium in the labor market requires $L_1 + L_2 = L$, and equilibrium in the domestic good market requires $C_1 = X_1$. Combining these two conditions with the first-order conditions for the consumer and producer optimization problems fully specifies the equilibrium in the model.

3.3 Properties of the Optimal Capital Income Tax Rate

3.3.1 Characterizing the Optimal Capital Income Tax Rate

The government chooses its tax rates to maximize the utility of the representative resident while ensuring that revenues are sufficient to finance a fixed level of the separable public good (G), which is modeled as purchases of the output of the multinational sector. The government thus solves

$$\max_{\tau,t} \left\{ v\left(p_1, I\right) + \lambda \left[p_2 G - \tau \rho_L LSK - \tau \left(1-\phi_S\right) \rho_F FSK - t\right]\right\},$$

where $v\left(p_1, I\right)$ is the individual indirect utility function, the government budget constraint is $p_2 G = \tau \left[\rho_L LSK + \left(1-\phi_S\right) \rho_F FSK\right] + t = R + t$, and R is capital income tax revenue. Since the lump-sum tax is always available to the government, the capital income tax will be used only if it can successfully extract resources from foreign investors, that is, if some of the tax burden can successfully be "exported" abroad. Note that the capital tax is applied to all unshifted capital income earned in the country. Substituting from the government budget constraint, the government's problem becomes

$$\begin{aligned} &\max_{\tau} v\left(p_1, I\right); \\ &I = \left(wL + \theta \rho_L LSK\right) - \left\{p_2 G - \tau \left[\rho_L LSK + \left(1-\phi_S\right) \rho_F FSK\right]\right\}. \end{aligned} \tag{3.4}$$

Thus, since income is defined to include the head tax, any revenue shortfalls that arise due to outmigration of FSK or any declines in the return to LSK associated with increases in the capital income tax rate must be offset with head tax increases.

The first-order condition for the optimal capital income tax rate is

$$\frac{\partial v(p_1, I)}{\partial \tau} = \frac{\partial v}{\partial p_1}\frac{\partial p_1}{\partial \tau} + \frac{\partial v}{\partial I}\frac{\partial I}{\partial \tau} = -C_1 \alpha \frac{\partial p_1}{\partial \tau} + \alpha \frac{\partial I}{\partial \tau} = \alpha \left[\frac{1}{I}\frac{\partial I}{\partial \tau} - \left(\frac{p_1 C_1}{I}\right)\frac{1}{p_1}\frac{\partial p_1}{\partial \tau}\right] = 0$$

$$\frac{1}{\alpha}\frac{\partial v(p_1, I)}{\partial \tau} = \pi_I - \psi^I_{C_1}\pi_{p_1} = 0, \tag{3.5}$$

using Roy's Identity, and defining π_I and π_{p_1} as the tax semi-elasticities of the subscripted variables, $\psi^I_{C_1}$ as the expenditure share of good one, and α as the marginal utility of income. This condition reflects the standard result that the optimal capital income tax rate should be set to maximize the dollar value of individual utility at the margin, which requires that the change in real income, or the sum of the "sources" and "uses" effects on utility, equals zero. This expression can be interpreted in terms of several key tax semi-elasticities.

Tax Semi-elasticity of Income

The tax semi-elasticity of income is

$$\pi_I = \psi^I_L\pi_w + \left[\psi^I_{LSK} + \left(\frac{R}{I}\right)\psi^R_{LSK}\right]\pi_{\rho_L} + \left(\frac{R}{I}\right)\psi^R_{FSK}\left(\pi_{FSK} + \pi_{1-\phi_S}\right) + \left(\frac{R}{I}\right)\frac{1}{\tau}, \tag{3.6}$$

where the various ψ's are factor shares in income or total capital income tax revenue (R). The tax semi-elasticity of income is thus determined by the changes in the returns to the two fixed factors in response to an increase in the capital income tax and the change in the head tax, which equals the change in capital tax revenues, taking into account the effects of the tax on FSK and ρ_L.

Tax Semi-elasticity of the Wage

To obtain the tax semi-elasticity of the wage, recall that in the multinational sector the effective tax rate on FSK is $T_K = (1-\phi_S)\left[\tau + \phi_F max\left(\tau_F - \tau, 0\right)\right] + \phi_S\tau_H$. We assume that $\tau_F > \tau$ for this derivation, so that

$$T_K = (1-\phi_S)(1-\phi_F)\tau + (1-\phi_S)\phi_F\tau_F + \phi_S\tau_H$$

which implies that

$$\frac{\partial T_K}{\partial \tau} = (1-\phi_S)(1-\phi_F) + (1-\phi_S)\left[(1-\phi_F)\tau + \phi_F\tau_F - \tau_H\right]\pi_{1-\phi_S} \tag{3.7}$$

is a constant determined by the extent of income shifting and residual taxation. With constant returns to scale in labor and FSK in the multinational sector, differentiating the unit cost function with respect to τ for fixed ρ_F yields $\chi_{L2}\pi_w + \chi_{FSK2}\pi_{\rho_{FG}} = 0$, where the χ terms are gross factor shares in production costs and $\pi_{\rho_{FG}} = (\partial T_K/\partial\tau)/(1+T_K)$ is the tax semi-elasticity of the gross rate of return to FSK. Thus, with a fixed commodity price and a fixed return to FSK in the multinational sector, any increase in the capital income tax burden is fully reflected in a reduction in wages — consistent with the traditional small open economy reasoning described above.

Tax Semi-elasticity of the Price of Good One

Similarly, with constant returns to scale in labor and LSK in the domestic sector,

$$\pi_{p_1} = \chi_{L1}\pi_w + \chi_{LSK1}\pi_{\rho_{LG}} = \chi_{L1}\pi_w + \chi_{LSK1}\left(\pi_{\rho_L} + \frac{1}{1+\tau}\right). \tag{3.8}$$

Thus, the tax semi-elasticity of the price of the domestic good is determined by a weighted average of the tax semi-elasticities of the gross prices of the two inputs, labor and location-specific capital.

Tax Semi-elasticity of the Return to Location-specific Capital

Differentiating the consumer's first-order condition for the domestic good yields $\pi_{C_1} = \left(\varepsilon_{11} - \eta_1\psi_{C_1}^I\right)\pi_{p_1} + \eta_1\pi_I$, where ε_{11} is the compensated elasticity of demand for good one and η_1 is the income elasticity of demand for good one. Substituting from (3.8) yields the price and income effects on the tax semi-elasticity of consumer demand C_1

$$\pi_{C_1} = \left(\varepsilon_{11} - \eta_1 \psi^I_{C_1}\right) \{\chi_{L1}\pi_w + \chi_{LSK1}\left[\pi_{\rho_L} + 1/(1+\tau)\right]\} + \eta_1 \pi_I \tag{3.9}$$

On the production side, differentiating the production function with fixed location-specific capital and solving for the tax semi-elasticity of labor demand yields

$$\pi_{X_1} = -\chi_{L1}\sigma_1 \left(\pi_w - \pi_{\rho_{LG}}\right) \tag{3.10}$$

where σ_1 is the Allen-Uzawa elasticity of substitution in production.[9] Since the consumption and production tax semi-elasticities of the domestic good are equal, equating (3.9) and (3.10) and solving for the tax semi-elasticity of the net return to LSK yields

$$\pi_{\rho_L} = \frac{\left(\varepsilon_{11} - \eta_1 \psi^I_{C_1} + \sigma_1\right) \chi_{L1}\pi_w + \eta_1 \pi_I}{\chi_{L1}\sigma_1 - \chi_{LSK1}\left(\varepsilon_{11} - \eta_1 \psi^I_{C_1}\right)} - \frac{1}{1+\tau} \tag{3.11}$$

Note that in the case of Cobb-Douglas utility and production functions, this expression reduces to $\pi_{\rho_L} = \pi_I - 1/(1+\tau)$ which indicates that — apart from the effects of changes in income — the gross return to LSK is fixed so that the owners of LSK bear the burden of the capital income tax in that sector. Otherwise, the first term in (3.11) reflects the net general equilibrium effects on the return to LSK of changes in relative prices on consumer demands and factor demands. Substituting (3.11) into (3.8) implies that the tax semi-elasticity of the price of the domestic good is

$$\pi_{p_1} = \chi_{L1}\pi_w + \chi_{LSK1}\left[\frac{\left(\varepsilon_{11} - \eta_1 \psi^I_{C_1} + \sigma_1\right) \chi_{L1}\pi_w + \eta_1 \pi_I}{\chi_{L1}\sigma_1 - \chi_{LSK1}\left(\varepsilon_{11} - \eta_1 \psi^I_{C_1}\right)}\right]. \tag{3.12}$$

Note that an income increase thus results in an increase in the relative price of the domestic good (since the price of the multinational good is fixed).

[9]The Allen-Uzawa elasticity of substitution can be written as $[\partial \ln(x_i) / \partial \ln(p_j)]/S_j$, where x_i is the quantity of factor i used in production, p_j is the price of factor j, and S_j is the production cost share of factor j.

Tax Semi-elasticity of Firm-specific Capital

To solve for π_{FSK}, calculate the tax semi-elasticity of the multinational sector good using the labor market equilibrium equation and the tax semi-elasticity of per-unit labor demand, and substitute into the expression for the tax semi-elasticity of demand for FSK to yield

$$\pi_{FSK} = \frac{\lambda_1}{\lambda_2}\sigma_1 \left(\pi_w - \pi_{\rho_L} - \frac{1}{1+\tau}\right) + \sigma_2 \left[\pi_w - \frac{1}{1+T_K}\left(\frac{\partial T_K}{\partial \tau}\right)\right] \tag{3.13}$$

where $\lambda_1 = L_1/L$, $\lambda_2 = L_2/L$, and σ_1, σ_2 are the elasticities of substitution in production in the domestic and multinational sectors, respectively. In the Cobb-Douglas case, this reduces to

$$\pi_{FSK} = \left(1 + \frac{\lambda_1}{\lambda_2}\right)\pi_w - \left(\frac{\lambda_1}{\lambda_2}\right)\pi_I - \frac{1}{1+T_K}\left(\frac{\partial T_K}{\partial \tau}\right). \tag{3.14}$$

The first term indicates that an increase in the wage reduces the relative price of FSK (since the price of the multinational good is fixed) and thus increases demand for FSK. The second term reflects the fact, noted above, that an increase in income results in an increase in the relative price of the domestic good and thus the demands for the factors producing that good, while decreasing relative factor demands for the factors producing the multinational sector good, thus putting downward pressure on the demand for FSK. The more general case reflects the additional net general equilibrium effects on the demand for FSK of changes in relative prices on consumer demands and factor demands.

Solving for the Optimal Tax Rate in the Cobb-Douglas Case

To make these expressions more tractable in solving for the optimal τ, suppose that the production functions are Cobb-Douglas with constant labor shares χ_{L1}, χ_{L2}, and the utility function is also Cobb-Douglas with constant expenditure shares $\psi^I_{C_1},\ \psi^I_{C_2}$.

In this case, the various tax semi-elasticities reduce to

$$\frac{\partial T_K}{\partial \tau} = (1-\phi_S)(1-\phi_F) + (1-\phi_S)\left[(1-\phi_F)\tau + \phi_F\tau_F - \tau_H\right]\pi_{1-\phi_S}$$

$$\pi_w = -\frac{\chi_{FSK2}}{\chi_{L2}(1+T_K)}\left(\frac{\partial T_K}{\partial \tau}\right)$$

$$\pi_{\rho_L} = \pi_I - \frac{1}{1+\tau}$$

$$\pi_{p_1} = \chi_{L1}\pi_w + (1-\chi_{L1})\pi_I$$

$$\pi_{FSK} = \left(1+\frac{\lambda_1}{\lambda_2}\right)\pi_w - \left(\frac{\lambda_1}{\lambda_2}\right)\pi_I - \frac{1}{1+T_K}\left(\frac{\partial T_K}{\partial \tau}\right)$$

$$\pi_I = \psi_L^I\pi_w + \psi_{LSK}^I\pi_{\rho_L} + \left(\frac{R}{I}\right)\left[\psi_{LSK}^R\pi_{\rho_L} + \psi_{FSK}^R(\pi_{FSK} + \pi_{1-\phi_S}) + \frac{1}{\tau}\right].$$

Substituting for π_{ρ_L} and π_{FSK} and solving for the tax semi-elasticity of income yields

$$\begin{aligned} D\tau\pi_I = {} & \frac{R}{I} + \left[\psi_L^I + \left(\frac{R}{I}\right)\psi_{FSK}^R\left(\frac{\lambda_1}{\lambda_2} + \frac{1}{\chi_{FSK2}}\right)\right]\tau\pi_w \\ & - \left[\psi_{LSK}^I + \left(\frac{R}{I}\right)\psi_{LSK}^R\right]\left(\frac{\tau}{1+\tau}\right) + \left(\frac{R}{I}\right)\psi_{FSK}^R\tau\pi_{1-\phi_S}, \end{aligned} \tag{3.15}$$

where $D = 1 - \psi_{LSK}^I - \left(\frac{R}{I}\right)\psi_{LSK}^R + \left(\frac{R}{I}\right)\left(\frac{\lambda_1}{\lambda_2}\right)\psi_{FSK}^R$. Substituting $\pi_{p_1} = \chi_{L1}\pi_w + (1-\chi_{L1})\pi_I$ into the government's first-order condition for τ (3.5) and multiplying by $D\tau$ yields

$$D\tau\,\pi_I - D\left(\frac{\psi_{C_1}^I\chi_{L1}}{1-\psi_{C_1}^I\chi_{LSK1}}\right)\tau\pi_w = 0. \tag{3.16}$$

Substituting from the Cobb-Douglas tax semi-elasticity expressions above yields

$$\frac{R}{I} - \Omega_R \left(\frac{R}{I}\right) = \psi^I_{LSK} \left(\frac{\tau}{1+\tau}\right) + \Omega_{T_K} \left(\frac{\tau}{1+T_K}\right) \left(\frac{\partial T_K}{\partial \tau}\right), \tag{3.17}$$

where

$$\Omega_R = \psi^R_{LSK} \left(\frac{\tau}{1+\tau}\right) + \psi^R_{FSK} \left[\frac{\lambda_1}{\lambda_2} \left(\frac{\chi_{FSK2}}{\chi_{L2}}\right) + \frac{1}{\chi_{L2}} - \tau \pi_{1-\phi_S}\right]$$

$$\Omega_{T_K} = \left[\psi^I_L - \frac{D\psi^I_{C_1}\chi_{L1}}{1-\psi^I_{C_1}\chi_{LSK1}}\right] \left(\frac{\chi_{FSK2}}{\chi_{L2}}\right)$$

$$T_K = (1-\phi_F)(1-\phi_S)\tau + [(1-\phi_S)\phi_F \tau_F + \phi_S \tau_H] .$$

Thus, at the capital income tax rate optimum, the static increase in revenue due to an increase in the tax rate (the first term in (3.17), R/I) is exactly offset by the net effect on real income, including endogenous adjustments in the head tax ($\Omega_R R/I$), and the increase in taxation of capital in the domestic sector (the second-to-last term in (3.17)) and in the multinational sector (the last term in (3.17)).

3.3.2 Properties of the Optimal Capital Income Tax Rate

In this section, we show that our optimality condition is consistent with the basic results discussed in the introduction on (1) zero capital income taxation, and (2) capital income taxation at the residual tax rate. First, divide the optimality condition (3.17) by τ and apply $R = \tau [\rho_L LSK + (1-\phi_S)\rho_F FSK]$ so that the optimality condition is well defined at $\tau = 0$,

$$\frac{\rho_L LSK + (1-\phi_S)\rho_F FSK}{I} - \left[\psi^I_{LSK} + \left(\frac{R}{I}\right)\psi^R_{LSK}\right]\left(\frac{1}{1+\tau}\right) + \left(\frac{R}{I}\right)\psi^R_{FSK}\pi_{1-\phi_S}$$
$$- \left[\frac{D\psi^I_{C_1}\chi_{L1}}{1-\psi^I_{C_1}\chi_{LSK1}} - \psi^I_L - \left(\frac{R}{I}\right)\psi^R_{FSK}\left(\frac{\lambda_1}{\lambda_2} + \frac{1}{\chi_{FSK2}}\right)\right]\pi_w = 0. \tag{3.18}$$

When there is a zero capital income tax rate, $\psi^R_{LSK} = \psi^R_{FSK} = T_K = 0$ and (3.18) simplifies to

$$\frac{\rho_L LSK + (1-\phi_S)\,\rho_F FSK}{I} - \psi^I_{LSK} = \left[\frac{\left(1-\psi^I_{LSK}\right)\psi^I_{C_1}\chi_{L1}}{1-\psi^I_{C_1}\chi_{LSK1}} - \psi^I_L\right]\pi_w. \tag{3.19}$$

Assuming that the tax rate in the tax haven is non-zero, $\tau_H > 0$, firms will not shift income to the tax haven if the change from $\tau = 0$ is small enough, $\pi_{1-\phi_S} = 0|_{\tau=0}$. Additionally, at $\tau = 0$, no income shifting occurs ($\phi_S = 0$), reducing the wage expression to

$$\pi_w = -\frac{\chi_{FSK2}}{\chi_{L2}}\left(1-\phi_F\right). \tag{3.20}$$

Recognizing that $\psi^I_{C_1}\chi_{LSK1} = \psi^I_{LSK}/\theta$, $\psi^I_{C_1}\chi_{L1} = \psi^I_L\lambda_1$, and $\chi_{FSK2}/\chi_{L2} = \rho_F FSK/wL_2$ at $\tau = 0$, we can multiply this entire expression by $IL_2/\rho_F FSK$ to get

$$\frac{\psi^I_{LSK} I}{\rho_F FSK}\left(\frac{1-\theta}{\theta}\right)L_2 + L_2 = \left[L - \left(\frac{1-\psi^I_{LSK}}{1-\psi^I_{LSK}/\theta}\right)L_1\right]\left(1-\phi_F\right), \tag{3.21}$$

which is the condition under which a zero capital tax rate is optimal. If all location-specific capital is owned domestically ($\theta = 1$), the optimality condition becomes

$$L_2 = \left(L - L_1\right)\left(1-\phi_F\right)$$

and a zero capital income tax is optimal only if there is no foreign residual tax.

To consider the case where a portion of location-specific capital is not owned domestically, $\theta < 1$, rewrite the optimality condition to the form

$$\frac{\psi^I_{LSK} I}{\rho_F FSK}\left(\frac{1-\theta}{\theta}\right)L_2 = \left[L - \left(\frac{1-\psi^I_{LSK}}{1-\psi^I_{LSK}/\theta}\right)L_1\right]\left(1-\phi_F\right) - L_2. \tag{3.22}$$

As long as $\theta < 1$, $1-\psi^I_{LSK} > 1-\psi^I_{LSK}/\theta$ so that $L - \left(\frac{I-\theta\rho_L LSK}{I-\rho_L LSK}\right)L_1 < L_2$. Since $(1-\phi_F) \leq 1$, this suggests the right-hand side of (3.22) is strictly negative, while $\theta < 1$ implies the left-hand side of (22) is strictly positive. Consequently, optimality condition (3.22) never holds if $\theta < 1$. This suggests that as long as any location-specific capital is foreign-owned, the optimal capital tax rate is non-zero, as a portion of location-specific capital represents immobile, foreign-owned, above-normal returns (assuming a non-zero tax rate in the tax haven). However, if all location-specific capital is owned domestically, the optimal capital tax rate is zero if there is no residual tax, under the baseline assumption $\tau_H > 0$.

We can also characterize the optimal capital income tax rate under full residual taxation. If all capital income earned in sector two is subject to residual taxation ($\phi_F = 1$) and the domestic tax rate is lower than the residual tax rate ($\tau < \tau_F$), the optimality condition (3.17) reduces to

$$\frac{1+\tau}{\theta+\tau} = \frac{\rho_L LSK}{\rho_L LSK + (1-\phi_S)\,\rho_F FSK}. \tag{3.23}$$

By definition, $0 \leq \theta \leq 1$ and the expression in (2.23) cannot hold as long as some income is unshifted, $\phi_S < 1$. Consequently, if there is full residual taxation, $\tau < \tau_F$ is not optimal as long as any capital income in sector two is unshifted when $\tau = \tau_F$.

3.4 Extended Model, Parameter Values, and Simulation Results

3.4.1 Extended Model

In this section, we simulate an extended version of the model to obtain an idea of the magnitudes of the effects of the various factors on the optimal capital income tax rate. Specifically, we expand the individual's optimization problem to include endogenous labor supply, converting the head tax to a proportional tax on labor, and allow for the possibility of endogenous labor income shifting to the capital income tax base. Further, we add another factor in both production sectors — "ordinary" capital (K) that earns a normal rate of return (r); we assume that this factor is also perfectly mobile so that r is fixed. This implies that domestic production also includes internationally mobile capital, so that both production sectors are affected by the capital tax rate. Both sectors thus now employ three factors in production, which we model using CES production functions. Finally, we consider the effects on the optimal capital income tax rate of adding an explicit tax on location-specific capital as an additional tax instrument available to the government.

In the computational model, we use a utility function that enables calibration of the income elasticity of labor:

$$v(p_1, I) = \max_{C_1,C_2,L} \left\{ \alpha_{C1} \left(\frac{C_1^{1-1/\gamma_1}}{1-1/\gamma_1} \right) + \alpha_{C2} \left(\frac{C_2^{1-1/\gamma_2}}{1-1/\gamma_2} \right) + \alpha_L \left(\frac{(H-L)^{1-1/\gamma_L}}{1-1/\gamma_L} \right) \right\}$$

$$s.t.\ I = wL + \theta\rho_L LSK + rK_d > p_1C_1 + p_2C_2;\ H \geq L. \tag{3.24}$$

All variables correspond to those used in the analytical model above, with the additional terms K_d and H indicating domestic ownership of capital and the labor endowment, respectively, with leisure defined as $H - L$. The wage rate in the individual problem remains net of tax and, as will be discussed below, includes any wages that are shifted to the business income tax base and thus subject to the capital income tax.

Both CES production functions now account for ordinary capital (K_1 and K_2), or

$$X_1 = \left[\alpha_1 {K_1}^{(\xi_1-1)/\xi_1} + \alpha_2 {L_1}^{(\xi_1-1)/\xi_1} + (1-\alpha_1-\alpha_2)\, LSK^{(\xi_1-1)/\xi_1} \right]^{\frac{\xi_1}{\xi_1-1}} \tag{3.25}$$

$$X_2 = \left[\beta_1 {K_2}^{(\xi_2-1)/\xi_2} + \beta_2 {L_2}^{(\xi_2-1)/\xi_2} + (1-\beta_1-\beta_2)\, FSK^{(\xi_2-1)/\xi_2} \right]^{\frac{\xi_2}{\xi_2-1}}, \tag{3.26}$$

where ξ_1 and ξ_2 are the elasticities of substitution in production for sectors one and two.

Turning next to extensions of the modeling of income shifting, Grubert and Altshuler (2013) argue that the costs associated with international income shifting are roughly quadratic.[10] Accordingly, we assume that multinationals engage in income shifting to maximize the increment in after-tax profits attributable to such shifting, subject to quadratic adjustment costs. Thus, the proportion of capital income shifted to a tax haven (ϕ_S) satisfies

$$\phi_S \in \max_{0\leq\phi_S\leq 1} \left\{\left[(\tau + \phi_F \max\{\tau_F - \tau, 0\} - \tau_H)\,\phi_S - \eta{\phi_S}^2\right](rK_2 + \rho_F FSK)\right\}, \quad (3.27)$$

and the total per-unit cost of both types of capital to the multinational sector with income shifting is $1 + (1-\phi_S)\left[\tau + \phi_F \max(\tau_F - \tau, 0)\right] + \phi_S\tau_H + \eta\phi_S^2$.

In the domestic economy, some individuals are assumed to be able to shift labor income to the business tax base when the capital income tax rate is lower than the labor income tax rate. Such shifting maximizes the associated increment in after-tax wage income, again subject to quadratic adjustment costs. Only a limited portion (ω_I) of labor income, corresponding roughly to the share of labor income earned from self-employment or in small closely-held corporations, can potentially be shifted. Consequently, the proportion of labor income shifted to the capital income tax base (ϕ_I) satisfies

$$\phi_I = \omega_I a \,\Big|\, a \in \max_{0\leq a\leq 1} \left\{a\,(\tau_L - \tau)\,wL - \mu a^2 wL\right\}. \quad (3.28)$$

With ϕ_E indicating the share of wage income exempt from labor taxation, the gross wage rate, including shifting costs, is

$$w_G = \phi_E w + (1-\phi_E)\,w\left[(1-\phi_I)(1+\tau_L) + \phi_I(1+\tau) + \mu\phi_I^2\right].$$

Government revenue comes from three tax instruments: a capital income tax, a labor income tax, and (in some cases) a direct tax on location-specific capital. A fixed share (ϕ_{LSK}) of LSK is subject to the direct tax, and any of these taxes paid are deductible from the capital income tax base, so the total tax revenue raised from location-specific

[10]Most of this discussion is included in their online Appendix A, `http://econweb.rutgers.edu/altshule/Fixing-appendices.pdf`.

capital income is $R_{LSK} = \phi_{LSK} [\tau_{LSK} + \tau (1 - \tau_{LSK})] \rho_L LSK + (1 - \phi_{LSK}) \tau \rho_L LSK$. Accounting for income shifting behavior, total revenue raised from the taxation of labor income is $R_L = \tau_L (1 - \phi_I) wL + \tau \phi_I wL$ and total revenue raised from ordinary and firm-specific capital income is $R = \tau \{r [K_1 + (1 - \phi_S) K_2] + (1 - \phi_S) \rho_F FSK\}$. In our simulations, we treat the location-specific capital tax rate as exogenous, effectively assuming there is a maximum feasible level of LSK taxation. The welfare-maximizing government chooses the capital income tax rate and the labor income tax rate according to

$$\max_{\tau_L, \tau} \{ v (p_1, I) | \, p_2 G = R_L + R_{LSK} + R \} . \tag{3.29}$$

3.4.2 Parameter Values

In this section, we describe the parameter values used in our model. In the simulations, we consider a wide range of values for numerous key parameters.

Production Function Parameter Values

The appropriate value for the elasticity of substitution in production is a contentious issue. Many simulation studies (e.g., Altig et al., 2001; Fehr et al., 2013) assume Cobb-Douglas production functions, and a relatively large degree of substitutability seems appropriate for our model given that two of our inputs are different types of capital. Accordingly, in our benchmark case, we assume a Cobb-Douglas production function, that is, a unitary elasticity of substitution in production. However, Chirinko (2002) argues that a much lower elasticity of substitution between capital and labor is appropriate; his preferred estimate is 0.4. Accordingly, we calibrate our simulation model for a wide range of substitution elasticities, varying from the Cobb-Douglas case ($\xi_1 = \xi_2 = 1$) to an elasticity of substitution in production as low as $\xi_1 = \xi_2 = 0.25$ (Table 1).

In a recent paper that documents the decline in the labor share of income since the 1980s, Karabarbounis and Neiman (2014) estimate a global corporate labor share

Table 3.1 : Optimal Capital Taxation Model, Optimal Tax Rates, and Welfare Effects, as a Function of the Elasticity of Substitution in Production

Varying the Elasticity of Substitution						
	$\xi_i = 1.00$	$\xi_i = 0.85$	$\xi_i = 0.70$	$\xi_i = 0.55$	$\xi_i = 0.40$	$\xi_i = 0.25$
G	0.198	0.2012	0.2055	0.211	0.217	0.2247
K_d	4.5	4.55	4.6	4.62	4.68	4.73
LSK	1.37	1.39	1.42	1.46	1.495	1.528
α_1	0.176	0.176	0.176	0.176	0.176	0.176
α_2	0.525	0.509	0.482	0.437	0.353	0.185
β_1	0.148	0.152	0.157	0.162	0.177	0.208
β_2	0.6	0.62	0.65	0.69	0.725	0.753
a_L	7.3	7.3	7.3	7.3	7.3	7.3
a_{C1}	6.15	6.15	6.15	6.15	6.15	6.15
a_{C2}	4.08	4.05	3.96	3.8	3.65	3.38
γ_1	0.615	0.615	0.615	0.615	0.615	0.615
γ_2	1.22	1.22	1.22	1.22	1.22	1.22
γ_L	0.413	0.412	0.415	0.417	0.418	0.421
Invariant Parameters						
$\frac{\tau_F}{1+\tau_F} = 0.20$	$p_2 = 0.9$	$\phi_{LSK} = 0$	$\theta = 0.8$	$\mu = 0.16$	$\omega_I = 0.35$	
$\frac{\tau_H}{1+\tau_H} = 0.05$	$r = 0.1$	$\phi_E = 0.35$	$H = 2.85$	$\eta = 0.65$		
$\frac{\tau_{LSK}}{1+\tau_{LSK}} = 0.375$	$\rho_F = 0.35$	$\phi_F = 0.01$				
Optimal Tax Rates						
$\frac{\tau^*}{1+\tau^*}$	0.160	0.165	0.170	0.177	0.182	0.188
$\frac{\tau_L^*}{1+\tau_L^*}$	0.241	0.236	0.230	0.223	0.216	0.210
Excess Burden (% of Capital Income Tax Revenue at Initial Calibration Point)						
$\frac{\tau}{1+\tau} = 0.18$	0.53%	0.29%	0.11%	0.00%	0.00%	0.06%
$\frac{\tau}{1+\tau} = 0.00$	4.97%	5.92%	7.03%	8.08%	8.64%	8.75%
Capital Investment Changes Under Reform ($\tau = 0.00 \rightarrow \tau^*$)						
$\%\Delta(K_1 + K_2)$	-29.36%	-24.90%	-20.28%	-15.60%	-11.04%	-6.33%
$\%\Delta FSK$	-46.31%	-39.41%	-32.34%	-25.22%	-18.35%	11.08%

of around 60 percent, and an overall labor share of around 52.5 percent. We assume that the labor share in sector one (the domestic sector) corresponds to the global share ($\alpha_2 = 0.525$) and the labor share in sector two (the multinational corporate sector) corresponds to the global corporate share ($\beta_2 = 0.60$).

Cronin et al. (2013) estimate that roughly 63 percent of corporate income is due to above-normal returns. Given a corporate labor income share of 60 percent, we choose the shares of ordinary capital and firm-specific capital to be consistent with the Cronin et al. estimate. That is, we choose our parameters so that the ratio of the total earnings attributable to above-normal returns to FSK, defined as the excess of actual returns to FSK over the returns to ordinary capital, to the total earnings from the normal returns to ordinary capital is 1.7 (=0.63/(1–0.63)). This in turn implies that the ordinary capital and FSK shares in the MNC production function are $\beta_1 = 0.148$ and $1 - \beta_1 - \beta_2 = 0.252$. Similarly, assuming a labor share of 52.5 percent in the domestic sector implies $\alpha_1 = 0.176$ and $1 - \alpha_1 - \alpha_2 = 0.299$.

To calibrate the relative rate of return to FSK, we consider the literature studying the rate of return to investment in research and development. In a study of UK firms, Greenhalgh and Rogers (2006) find that the ratio of the shadow value of intangible to tangible assets is 3.5, but that this ratio varies considerably by sector, from 2.34 for software firms to 7.97 for production intensive firms. Following their baseline result, we set $r = 0.1$ and $\rho_F = 0.35$.

It is less clear how the rate of return to LSK should compare to the return to ordinary capital. Hou and Robinson (2006) find that in the United States firms in more concentrated markets earn lower stock market returns, while Gallagher, Ignatieva, and McCulloch (2015) find that in Australia firms in more concentrated markets are able to earn excess returns. Gallagher, Ignatieva, and McCulloch hypothesize that a more rigorous regulatory environment in United States explains this difference. Given this ambiguity, we choose a rate of return to LSK that is only 25 percent higher than the rate earned by ordinary capital, $\rho_L = 0.125$.

Utility Function Parameters

In 2012, foreign-controlled enterprises produced 37 percent of total GDP in the EU countries.[11] Accordingly, the MNC produces 37 percent of GDP in our base case. To achieve this, we set the consumption share parameters for the representative resident at $\alpha_{C1} = 6.15$ and $\alpha_{C2} = 4.08$. The various γ parameters determine the responsiveness of consumption and labor supply to changes in prices (including the wage) and income. We calibrate our demand price elasticity for the multinational good to -1.1 ($\gamma_2 = 1.22$), consistent with Senhadji's (1998) estimate that the average long-run price elasticity of import demand is slightly higher than one. Seale and Regmi (2006) estimate price elasticities across good types for a wide selection of countries; we select an intermediate value for the uncompensated price elasticity of the domestic good of -0.8 ($\gamma_1 = 0.615$).

Turning to the labor supply parameters, in a Congressional Budget Office survey of recent research on labor supply elasticities, McClelland and Mok (2012) conclude that the substitution elasticity of labor supply for the total population in the U.S. is between 0.1 and 0.3, and that the income elasticity is between -0.1 and zero. Accordingly, we set the parameters of our utility function so that the labor supply substitution elasticity is 0.2, and the income elasticity is -0.05; this implies $\gamma_L = 0.413$ and $\alpha_L = 7.3$. Note that these parameter values yield an uncompensated labor supply elasticity of 0.15, a value that is consistent with the consensus estimates in McClelland and Mok (2012) and comparable to the value of 0.18 used by Jacobs (2009).

Government Spending and Tax Rates

We fix government services, which are assumed to be separable from the individual utility function, at roughly 16 percent of national income. This is consistent with

[11] Authors' calculations based on data from Eurostat, `http://ec.europa.eu/eurostat/data/database`, "GDP and main components" and "Foreign control of enterprises by economic activity and a selection of controlling countries."

the average level (16.2 percent) reported by The World Bank's World Development Indicators for high-FDI countries between 2000 and 2013.[12]

As discussed above, our "capital income tax rate" is a proxy for several concepts of capital income taxation, including statutory and various effective tax rates. We calibrate our model at a capital tax rate of $\tau/(1+\tau) = 0.18$, which reflects the average effective business-level capital income tax rate estimated by PricewaterhouseCoopers (2011) for high-FDI countries.[13] Under our base case assumption that the elasticity of substitution in production is $\xi_1 = \xi_2 = 1.0$, this implies a labor tax rate of $\tau_L/(1+\tau_L) = 0.22$. This labor tax rate, which is endogenously determined to balance the government budget constraint, assumes that 35 percent of labor income is exempted from the tax base ($\phi_E = 0.35$), reflecting provisions such as standard deductions, personal exemptions, and a variety of other deductions and exclusions. For example, in 2013, about 69 percent of the income reported on US tax returns was taxable, a figure that overstates the share of taxable income since filers with very low income levels are not required to file US tax returns.[14]

Globally, taxes on domestic natural resources vary considerably. In a recent survey, the International Monetary Fund (2012) reports high average effective tax rates on extractive industries. For the petroleum industry, these rates are generally between 65 and 85 percent of net present value. For mining industries, rates are somewhat lower, ranging from 45 to 65 percent. Accordingly, in our benchmark case, the direct tax on location-specific capital is set at 60 percent ($\tau_{LSK} = 0.6$). We initially assume that

[12] We identify high-FDI countries as those whose average (2000–2013) foreign direct investment (FDI) net inflows as a share of GDP are in the top 50 percent reported internationally. This corresponds to countries whose FDI net inflows average above 3.7 percent of GDP between 2000 and 2013. These data were obtained from http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators.

[13] The unweighted average of effective tax rates for high-FDI countries (as defined in footnote 11) in this study is 17.5 percent, rising to 19.2 percent if the samples is restricted to countries with at least 10 observations.

[14] See IRS SOI Tax Statistics, "Table 1.1 All Returns: Selected Income and Tax Items, Tax Year 2013," https://www.irs.gov/uac/SOI-Tax-Stats---Individual-Statistical-Tables-by-Size-of-Adjusted-Gross-Income.

none of the location-specific capital is subject to this tax, $\phi_{LSK} = 0$, since LSK does not necessarily represent extraction activity, but consider the full range of possible values in our simulations ($0 \leq \phi_{LSK} \leq 1$).

As discussed in the introduction, in most circumstances the fraction of firm-specific capital that is subject to residual taxation in the home country (ϕ_F) is likely be relatively small. However, it may be significant for (1) countries attempting to attract a significant share of their foreign direct investment from US-based MNCs that are not (and are not likely to be) in an excess foreign tax credit position, or (2) countries with tax rates that are (or will become with reform) sufficiently low that they trigger current residual home country taxation under various anti-base-erosion provisionsa category that may increase over time as more countries adopt such provisions.[15] In our base case, we assume that the fraction of firm-specific capital that is subject to residual taxation is very small ($\phi_F = 0.01$) and subject to a gross residual tax rate of 20 percent. However, we simulate a wide variety of potential residual taxation scenarios, including $0.05 \leq \tau_F/\left(1+\tau_F\right) \leq 0.30$ and $0 \leq \phi_F \leq 0.30$, corresponding to the range of values that might arise under anti-base-erosion provisions.

Finally, we assume that the effective tax haven rate is $\tau_H/\left(1+\tau_H\right) = 0.05$, reflecting a combination of very low tax haven rates coupled with the costs of shifting income and deferring repatriation, which Grubert and Altshuler (2013) suggest range from 1–7 percent.

Income Shifting Parameters

There is considerable disagreement about the fraction of capital income that is currently shifted abroad. Riedel (2014) surveys the literature on international tax avoidance and reports a range of 5 percent (found in the United Kingdom by HMRC (2014)) to 30 percent (found in the United States by Clausing (2011)). In her most

[15] In fact, as controlled foreign corporation rules become more common, it may be reasonable to model the level of residual taxation as a function of the domestic tax rate since these rules only apply to countries with low corporate income tax rates. We leave this consideration to future analysis.

recent work, Clausing (2016) estimates that the amount of income shifted from the US corporate income tax base is 32–46 percent of current revenues. In our benchmark case, we adopt a fairly conservative assumption that income shifting is 15 percent of the corporate tax base ($\phi_S/(1-\phi_S) = 0.15$ or $\phi_S = 0.13$).[16,17] Under the tax rates assumed in the model, this implies that the capital income shifting parameter is $\eta = 0.65$. However, given the uncertainty about the extent of income shifting, we simulate a wide range of values for the share of income that is shifted abroad, $0.05 \leq \phi_S/(1-\phi_S) \leq 0.50$.

There is considerably less literature on the shifting of labor income to the corporate income tax base. However, we expect the share of labor income shifted to be modest, as relatively few individuals both have the capability to shift labor income and potentially benefit from it. The two groups most likely to engage in labor income shifting are the self-employed and individuals working in small corporations. According to The World Bank's World Development Indicators, about 35 percent of the employed population in high-FDI countries is self-employed, while in a sample of 20 OECD countries, around 24 percent of individuals work for companies with 10 or fewer employees.[18] Accordingly, in our benchmark case we set $\omega_I = 0.35$ and also consider cases where up to 50 percent of labor income can potentially be shifted. Given our assumption that 35 percent of labor income is exempt from taxation, we

---

[16]This aligns closely with the Dyreng and Markle (2015) estimate that income shifting the United States is roughly 13 percent of revenues — although they note that because their sample size is relatively small, their estimate is not necessarily inconsistent with larger estimates such as those found by Clausing (2011).

[17]Estimates of the tax semi-elasticity of income shifting provide another indicator of the degree of uncertainty about the extent of income shifting. For example, Clausing notes that her larger estimate implies a tax semi-elasticity of 3.3. This value, however, is relatively large in comparison to most others found in the literature; for example, Heckemeyer and Overesch (2013) argue that the consensus estimate of the tax semi-elasticity of income shifting is 0.8, although Clausing (2016) argues that most of the papers cited in this study use data that does not adequately capture income shifting to tax havens.

[18]This calculation is based on values from OCED (2012). The 20 countries with available data include Austria, Belgium, Brazil, the Czech Republic, Denmark, Finland, Germany, Hungary, Italy, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, and the United Kingdom.

then assume 75 percent of remaining labor income is taxed at a rate exceeding the capital income tax rate. Additionally, we simply assume that a quarter of this potentially shiftable income is actually shifted to the corporate tax base. This calculation suggests that about 7 percent of labor income is shifted to the corporate tax base ($\phi_I/(1-\phi_I) = 0.07$), implying $\mu = 0.16$. With 7 percent of labor income shifted to the corporate tax base, 8.7 percent of revenue raised by the capital tax reflects revenue raised from taxation of shifted labor income. This figure is slightly below the range of 10 to 17 percent labor income shifting estimated in for the EU by de Mooij and Nicodme (2006).[19]

Other Parameters

Sercu and Vanpe (2007) examine a sample of 42 countries and estimate that the share of domestically-owned equity capital in total market capitalization is 80 percent. Accordingly, we assume in our benchmark case that the domestically-owned share of the location-specific capital is $\theta = 0.8$. In the simulations, we consider the full range of possibilities for this parameter, $0 \leq \theta \leq 1$.

3.4.3 Simulation Results

As mentioned above, we calibrate our model for various values of the elasticity of substitution in production, ranging from $\xi_1 = \xi_2 = 1$ to $\xi_1 = \xi_2 = 0.25$, using the Cobb-Douglas formulation as the benchmark. In Table 1, we present the parameters used for calibration and welfare analysis for each 0.15 increment over this range of the production substitution elasticity.

Note that as the elasticity of substitution in production declines, the optimal capital income tax rate rises, as capital income taxation is less distortionary if capital-

[19]Our estimates may be conservative. Gordon and Slemrod (2000) estimate that a one percentage point decrease in the differential between the labor income and businesss tax rates leads to a fairly large 2.9 percent increase in personal income. When we simulate the effects of a small change in this tax rate differential at the initial equilibrium in our model, we obtain a smaller tax semi-elasticity of -1.36.

labor substitution in production is more difficult. For example, when the elasticity of substitution in production is $\xi_1 = \xi_2 = 1$, the optimal capital income tax rate is $\tau * /(1 + \tau *) = 0.160$, but as the production elasticity declines to $\xi_1 = \xi_2 = 0.25$, the optimal capital income tax rate increases by nearly 18 percent to $\tau * /(1 + \tau *) = 0.188$.

In addition, as the optimal capital income tax rate approaches the level in our baseline, $\tau/(1+\tau) = 0.180$, the welfare gains associated with reform — defined as the equivalent variation associated with moving from the benchmark initial equilibrium to the optimal capital income tax rate — naturally approach zero.[20] For example, at the substitution elasticity $\xi_1 = \xi_2 = 0.40$, the optimal capital income tax rate $\tau*/(1+\tau*) = 0.182$ is very close to the observed rate, so that capital income tax reform produces negligible welfare gains. By comparison, moving to the optimal capital income tax rate in the Cobb-Douglas case is equivalent to receiving a transfer in the initial equilibrium equal to 0.53 percent of CIT revenues. Alternatively, consider the effects of moving from no taxation of capital income to the optimal capital income tax rate. In the Cobb-Douglas case, this results in a welfare gain equivalent to a transfer worth 4.97 percent of CIT revenues. However, at lower elasticities of substitution in production, the distortionary effects of capital income taxation are smaller, so the welfare gains associated with introducing a positive capital income tax rate are generally larger; for example, moving to the optimal capital income tax rate results in a welfare gain worth 8.75 percent of CIT revenues in the case of an elasticity of substitution in production of 0.25.

In our benchmark calibration, 35 percent of labor income can be potentially be shifted ($\omega_I = 0.35$), only 1 percent of MNC capital income is subject to residual taxation ($\phi_F = 0.01$), there is no direct taxation of LSK ($\phi_{LSK} = 0$), and 20 percent of LSK is foreign-owned ($\theta = 0.8$). In this case, the optimal capital income tax rate is $\tau * /(1 + \tau *) = 0.160$ and the labor income tax rate, which is determined as a

[20]Equivalent variation is measured as the income transfer that would make the individual indifferent between receiving the transfer and remaining in the initial equilibrium and moving to the equilibrium that occurs with the move to the optimal capital income tax rate.

residual from the government budget constraint, is $\tau_L/(1+\tau_L) = 0.241$.

The results of various simulations of the model are shown in Figures 3.1–3.7, where the benchmark calibration, when included, is indicated with a triangle. The basic variations on the benchmark result are illustrated in Figures 3.1a-c, which show the optimal capital income tax rates for various assumptions about the share of LSK owned by foreigners $(1-\theta)$, the share of labor income that can be feasibly shifted (ω_I), and the fraction of unshifted income subject to residual taxation (ϕ_F). Note that, in contrast to our main result in the analytical model, the optimal capital income tax rate is not zero even when all location-specific capital is owned domestically and there is no residual taxation, since a portion of the capital income tax base (LSK) is inelastic.[21] However, the optimal capital income tax rate is small when there is no residual taxation, no potential for labor income shifting, and no foreign ownership of LSK, as the optimal rate is less than 3 percent, $\tau*/(1+\tau*) = 0.027$(not shown). Thus, considered in isolation, the opportunity to tax immobile location-specific rents accruing to domestic residents does not provide much of a rationale for capital income taxation in the model.

With only 1 percent of capital in the multinational sector subject to residual taxation and no labor income shifting, Figure 3.1a shows that the optimal capital income tax rate is roughly linear with respect to the share of LSK that is owned by foreigners, beginning at $\tau/(1+\tau) = 0.03$ when the foreign-owned share of LSK is zero and reaching a maximum of $\tau/(1+\tau) = 0.26$ when all of LSK is foreign-owned. Thus, the opportunity to tax foreign rents may provide an important rationale for taxing capital income, as stressed by Huizinga and Nielsen (1997). At the benchmark level of foreign ownership of 20 percent (with minimal residual taxation and no income shifting), the optimal capital income tax rate is $\tau*/(1+\tau*) = 0.077$, which implies

[21] Tests removing LSK from domestic production indicate that the optimal capital tax rate is zero (with no residual taxation) as long as all capital investment is perfectly mobile, since the elasticity of labor supply is finite but non-zero. Note also that the presence of LSK does not produce a positive optimal capital income tax rate in our analytical model because the alternative of taxing fixed labor supply has no distortionary cost in that case.

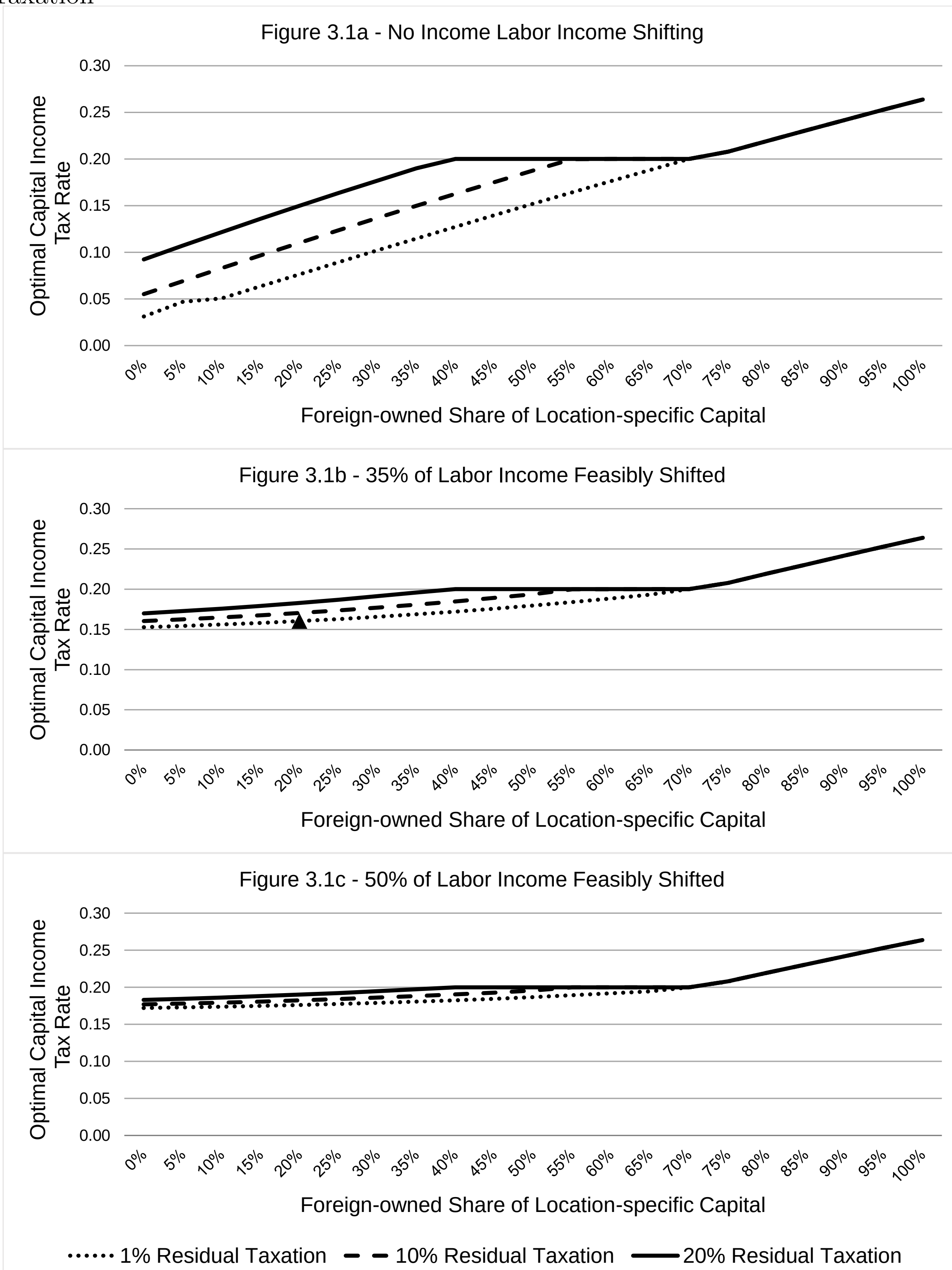
a labor income tax rate of $\tau_L/(1+\tau_L) = 0.293$.

Figure 3.1a also shows that adding the possibility of a treasury transfer effect by including residual taxation increases the optimal capital income tax rate, but only until the domestic tax rate equals the assumed residual tax rate of 20 percent. Recall that in the analytical model with full residual taxation, the optimal capital tax rate is at least as high as the foreign tax rate. By expanding the model to include ordinary capital in both sectors, we include some mobile capital that we assume is not subject to residual taxation (K_1). Although this diminishes the importance of the underlying treasury transfer effect, the presence of a residual tax still moves the optimal capital income tax rate toward the foreign tax rate. In all cases, the optimal tax rate plateaus at the assumed residual tax rate $\tau_F/(1+\tau_F) = 0.20$. Once this limit is reached, the optimal capital income tax rate remains constant until the foreign-owned share of LSK is large enough (in excess of 70 percent) to justify further increases, up to the maximum rate of 26.4 percent which occurs when all LSK is foreign-owned.

The same general pattern occurs in Figures 3.1b and 3.1c. However, these figures show that the sensitivity of the optimal capital income tax rate to foreign ownership of LSK depends heavily on the opportunity for labor income shifting. In all cases, the optimal capital income tax rate is 26.4 percent when all LSK is foreign-owned. However, at lower values of the foreign-owned share of LSK, the optimal capital income tax rate generally increases as labor-income shifting opportunities increase, as increased capital income taxation allows lower labor income tax rates, both of which reduce the incentive for labor income shifting, which reduces revenues and incurs costs. For example, when 35 (50) percent of labor income can be feasibly shifted to the capital income tax base, the optimal capital income tax rate rises to $\tau * /(1+\tau*) = 0.153$ (0.172), even with minimal residual taxation and no foreign-ownership of LSK. This of course reduces the sensitivity of the optimal capital income tax rate to variation in the share of LSK that is foreign-owned.

Figure 3.2 illustrates that if some direct taxation of location-specific capital is

Figure 3.1 : Varying Labor Income Shifting, Foreign Ownership of LSK, and Residual Taxation



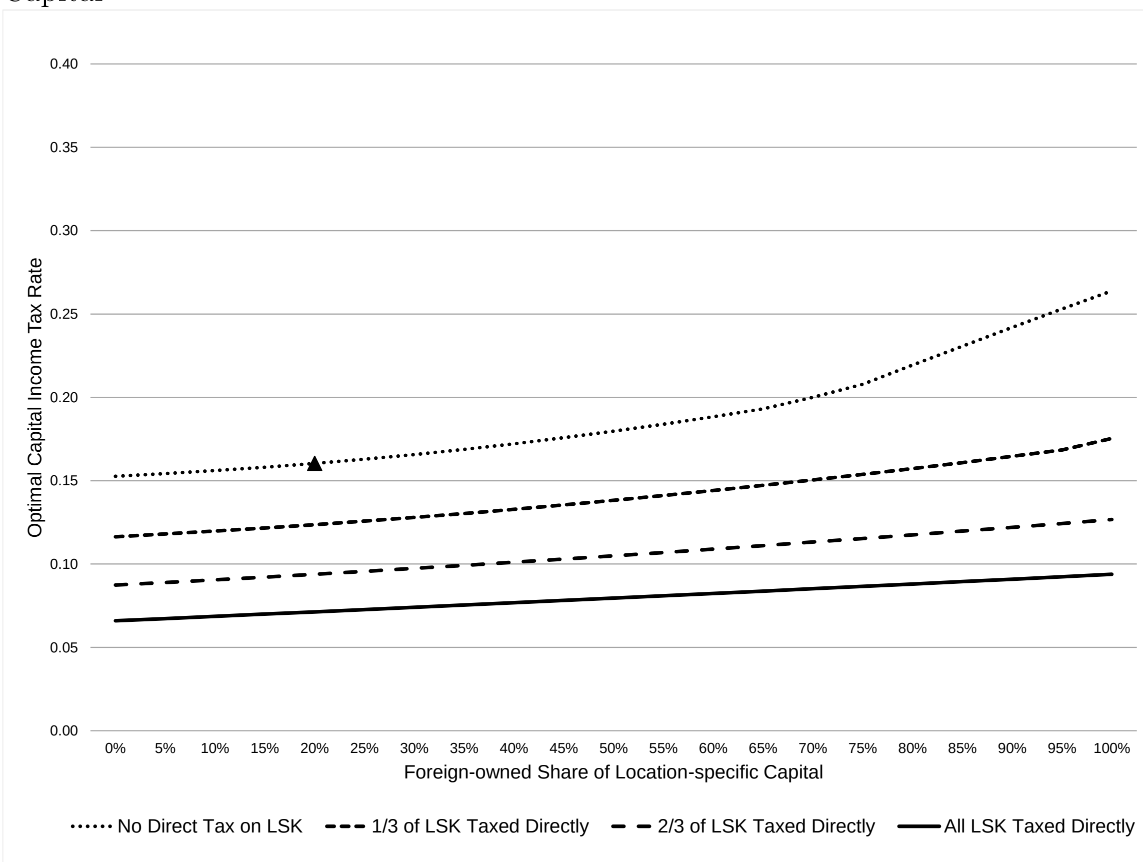
Note: All parameters are set to base-case values unless otherwise indicated. For these figures, this implies that there is no direct taxation of LSK, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, the gross residual tax rate is 20%, and 1% of capital in the multinational sector is subject to residual taxation.

available (under the assumption that direct taxes paid on location-specific rents are deductible from the capital income tax), the optimal capital income tax rate declines significantly. As discussed above, this occurs because an alternative tax instrument can be used to extract rents from the owners of location-specific rents, including foreigners, without the negative consequences on capital flight and capital income shifting associated with use of the capital income tax. For example, under our base-case assumption that 20 percent of location-specific capital is foreign-owned, the optimal capital income tax rate drops from $\tau * /(1 + \tau *) = 0.16$ or 16 percent to 7.1 percent if all rents from LSK can be taxed directly.[22] And, if all LSK is foreign-owned, the optimal capital income tax rate drops from 26.4 percent to 9.4 percent. In addition, the sensitivity of the optimal capital income tax rate with respect to foreign ownership of LSK declines with direct taxation, since rents earned by foreigners can be taxed directly. Indeed, in the extreme case in which all location-specific capital can be taxed directly, the optimal capital income tax barely increases with the foreign-owned share of LSK (from $\tau */(1+\tau *) = 0.066$ with $\theta = 1$ to $\tau */(1+\tau *) = 0.094$ with $\theta = 0$). This slight increase occurs because above-normal returns to foreign-owned LSK are still included in the capital income tax base, with the direct tax on LSK deductible.

We turn next to the sensitivity of the results to changes in firm production function parameters. Figure 3.3 examines the interaction of the relative capital shares in the production of the domestic good with the availability of a direct tax on LSK. Specifically, consider an increase in the production cost share of LSK coupled with a reduction in the production cost share of ordinary capital. When there is no direct taxation of LSK, this increases the optimal capital income tax rate, as LSK is a

[22]The optimal capital income tax rate does not drop to zero because it is still desirable to raise capital income revenue, reducing the labor income tax rate and the corresponding incentive for labor income shifting. If labor income shifting were impossible, the optimal capital income tax rate would be very near zero in this case (1.7 percent), even with variable labor supply. This small amount of capital taxation persists because LSK is still included in the capital income tax base (although the direct tax on LSK is fully deductible).

Figure 3.2 : Optimal Capital Income Tax Rates and Taxation of Location-Specific Capital



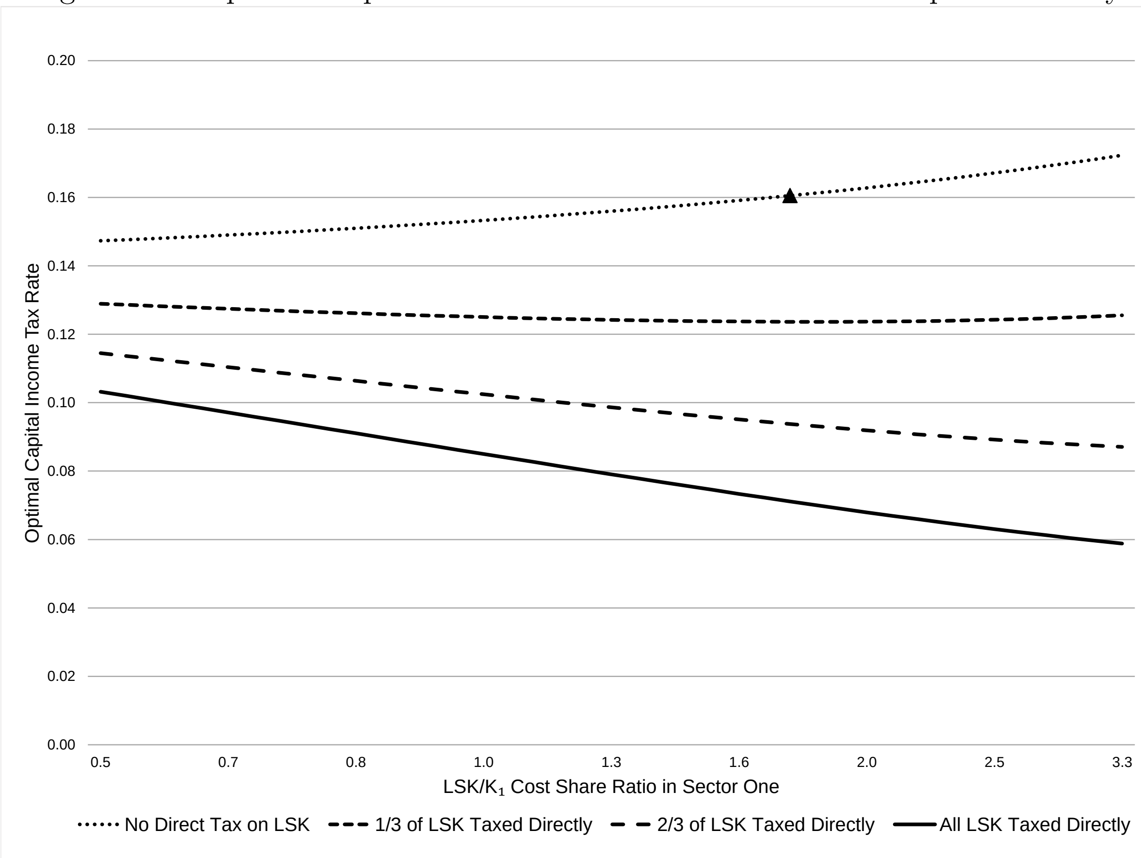
Note: All parameters are set to base-case values unless otherwise indicated. For this figure, this implies 35% of labor income can be feasibly shifted, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, the gross residual tax rate is 20%, and 1% of capital in the multinational sector is subject to residual taxation.

greater share of the capital tax base. However, when LSK is taxed directly, any increases in the relative cost share of LSK increase the revenue raised from the direct taxation of LSK, lowering the optimal capital income tax rate (as well as the corresponding labor income tax rate since more revenue is available). For example, in the absence of direct LSK taxation, increasing the cost-share ratio for LSK to ordinary capital from 0.5 to 3.0 (the benchmark value is 1.7) increases the optimal capital income tax rate from $\tau * /(1 + \tau *) = 0.147$ to $\tau * /(1 + \tau *) = 0.172$, while the labor income tax rate (not shown) declines from $\tau_L/\,(1 + \tau_L) = 0.259$ to $\tau_L/\,(1 + \tau_L) = 0.229$. However, if all LSK is taxed directly, the optimal capital income tax rate declines from $\tau * /(1 + \tau *) = 0.103$ to $\tau * /(1 + \tau *) = 0.059$ and the labor income tax rate declines from $\tau_L/\,(1 + \tau_L) = 0.224$ to $\tau_L/\,(1 + \tau_L) = 0.123$.

Figure 3.4 demonstrates that the amount of residual taxation is generally more influential in determining the optimal capital income tax rate than the residual tax rate. Changes in the residual tax rate have no effect on the optimal capital income tax rate so long as the residual tax rate is less than the domestic optimal capital income tax rate, which, in our base case, is as long as $\tau_F/\,(1 + \tau_F) \leq 0.160$. However, once the residual tax rate exceeds 16 percent, the optimal capital income tax rate equals the residual tax rate until the level of capital income taxation takes maximum advantage of the treasury transfer effect for the given amount of income subject to residual taxation (the kink point in each of the four graphs lies in the range $0.16 \leq \tau_F/(1 + \tau_F) \ \leq 0.20$). Beyond that point, the optimal capital income tax rate increases only slightly with increases in the residual tax rate.

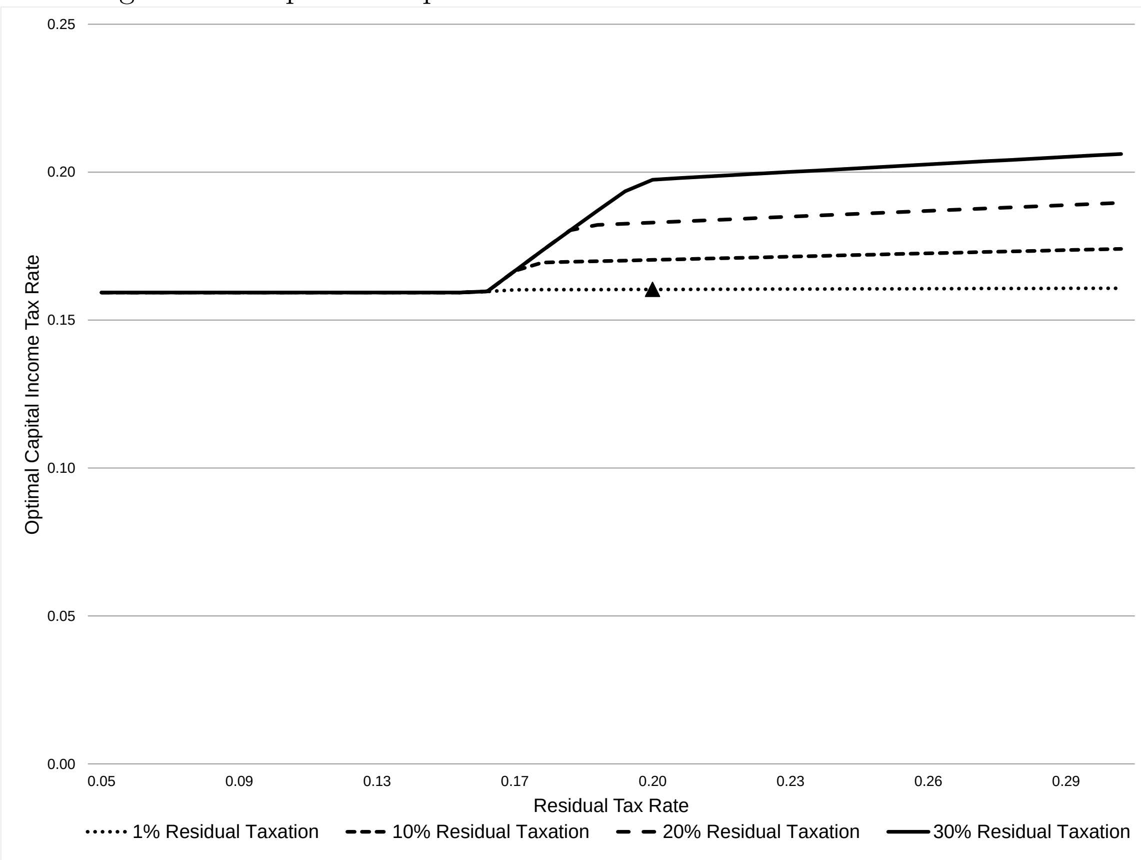
In our benchmark calibration, 35 percent of labor income is exempt from labor taxation, producing a base-case optimal capital income tax rate of $\tau * /(1 + \tau *) = 0.160$ and a corresponding labor income tax rate of $\tau_L/\,(1 + \tau_L) = 0.241$. However, Figure 3.5 shows that as the amount of taxable labor income declines, higher marginal tax rates on labor income are needed to raise revenue, increasing the labor-leisure distortion and the amount of labor income shifting associated with labor taxation.

Figure 3.3 : Optimal Capital Income Tax Rates and Domestic Capital Intensity



Note: All parameters are set to base-case values unless otherwise indicated. For this figure, this implies 35% of labor income can be feasibly shifted, 20% of LSK is foreign-owned, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, the gross residual tax rate is 20%, and 1% of capital in the multinational sector is subject to residual taxation.

Figure 3.4 : Optimal Capital Income Tax Rates and Residual Taxation



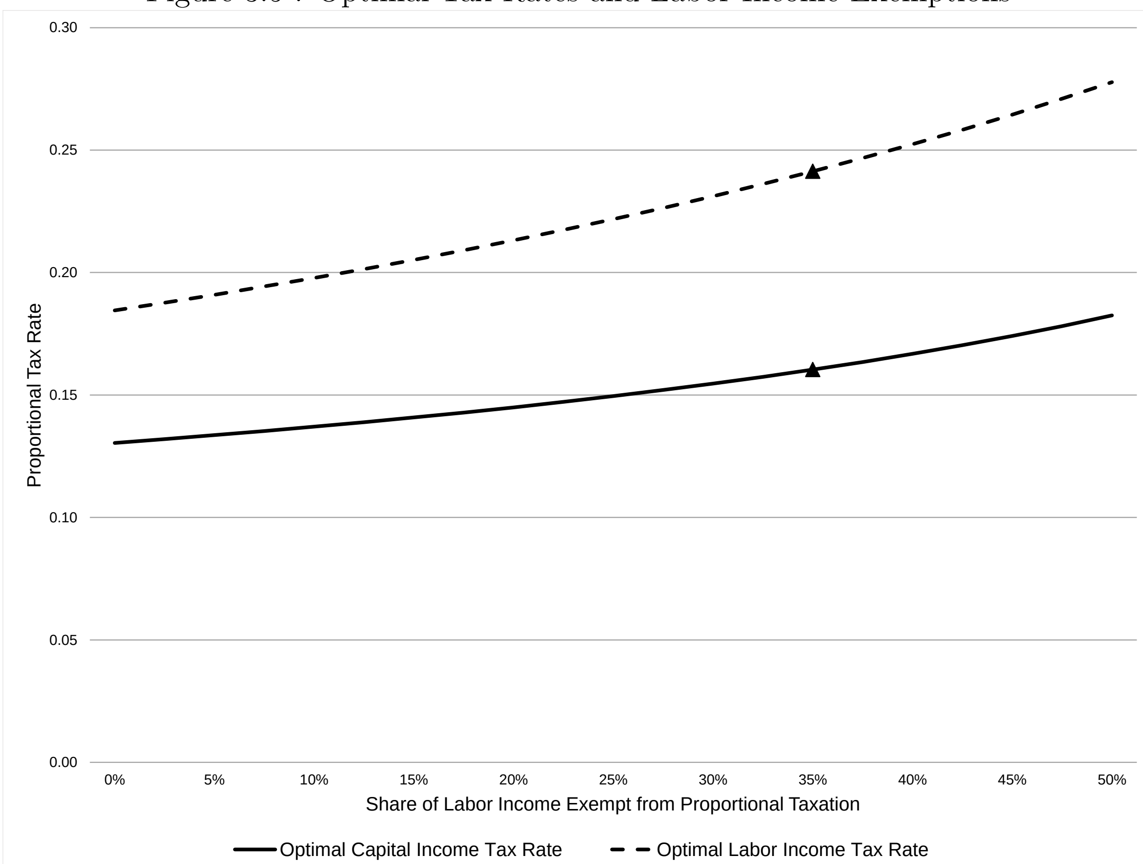
Note: All parameters are set to base-case values unless otherwise indicated. For this figure, this implies 35% of labor income can be feasibly shifted, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, 20% of LSK is foreign-owned, and there is no direct taxation of LSK.

For example, with the 35 percent exemption, labor income shifting is calibrated to $\phi_I/(1-\phi_I) = 0.07$ (or 7 percent), but if 25 percent of income is exempt, shifted labor income decreases to 4.8 percent of taxable unshifted income. With these decreases in the distortionary cost of labor taxation, the optimal capital income tax rate also decreases modestly (from 16 percent to 15 percent). Consequently, as the amount of exempt labor income increases, both the optimal capital income and labor income tax rates increase. However, Figure 3.5 demonstrates that the labor income tax increases more in response to labor exemptions than does the optimal capital income tax rate, which is only moderately sensitive to changes in the share of exempt labor income.

Finally, and perhaps surprisingly, differences in opportunities for international income shifting have relatively little effect on the optimal capital income tax rate in the model. The simulation results presented in Figure 3.6 examine the effects of changes in the share of capital income shifted to the tax haven — achieved by changing the international income shifting cost parameter — on the optimal capital income tax rate, for three levels of residual taxation. Holding all other parameters at their base-case values and adjusting capital income shifting costs so that the share of capital income shifted to a tax haven in the base case increases from 5 percent to 50 percent, the optimal capital income tax declines only from $\tau * /(1 + \tau *) = 0.162$ to $\tau * /(1 + \tau *) = 0.155$.

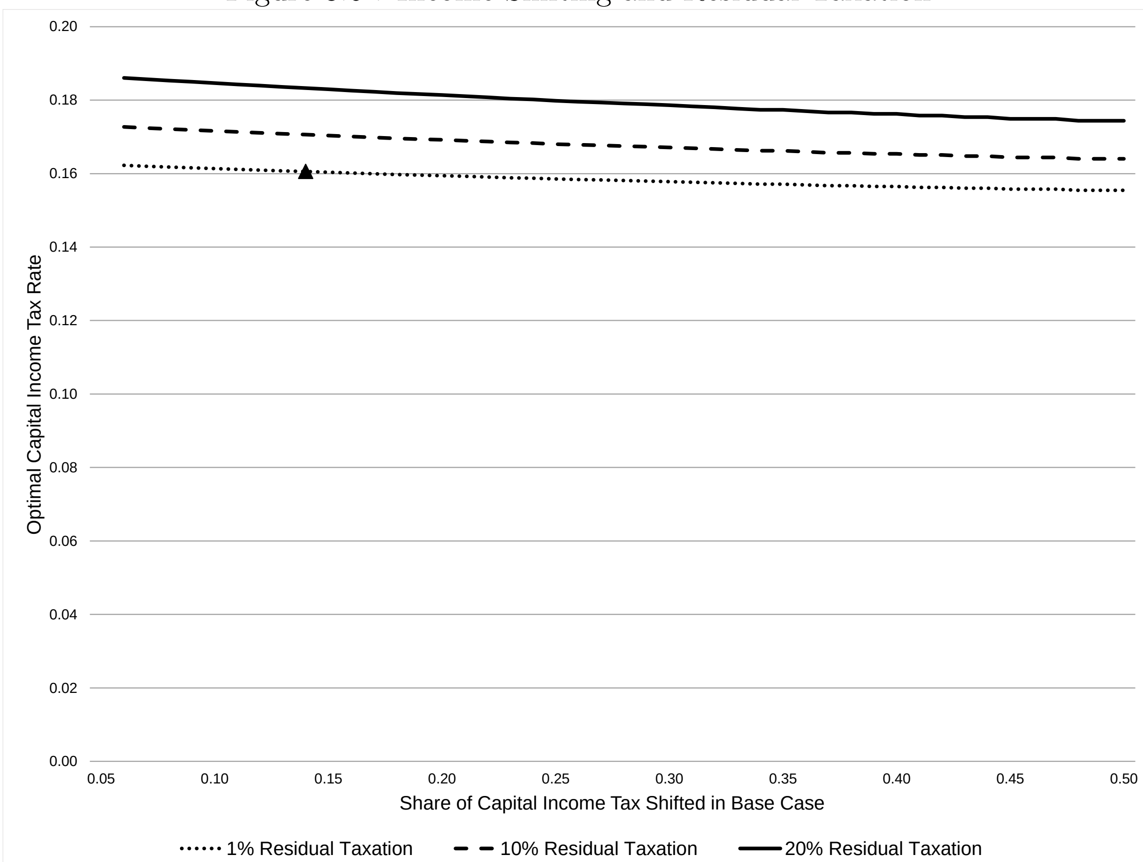
This relatively small effect reflects three offsetting effects of an increase in international income shifting opportunities on the optimal capital income tax rate. First, as international income shifting increases due to lower shifting costs, the size of the domestic capital income tax base decreases so that the revenue raised by the capital income tax declines; the government's desire to avoid this revenue loss puts downward pressure on the optimal capital income tax rate. Second, since location-specific capital cannot be shifted internationally, increased capital income shifting implies a larger share of the capital income tax base is immobile; this makes capital income taxation relatively more attractive and puts upward pressure on the optimal capital income

Figure 3.5 : Optimal Tax Rates and Labor Income Exemptions



Note: All parameters are set to base-case values unless otherwise indicated. For this figure, this implies 35% of labor income can be feasibly shifted, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, 20% of LSK is foreign-owned, there is no direct taxation of LSK, the gross residual tax rate is 20%, and 1% of capital in the multinational sector is subject to residual taxation.

Figure 3.6 : Income Shifting and Residual Taxation



Note: Adjustments to the share of capital income shifted in the base case are achieved by adjusting the shifting cost. All other parameters are set to base-case values unless otherwise indicated. For this figure, this implies 35% of labor income can be feasibly shifted, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, 20% of LSK is foreign-owned, there is no direct taxation of LSK, and the gross residual tax rate is 20%.

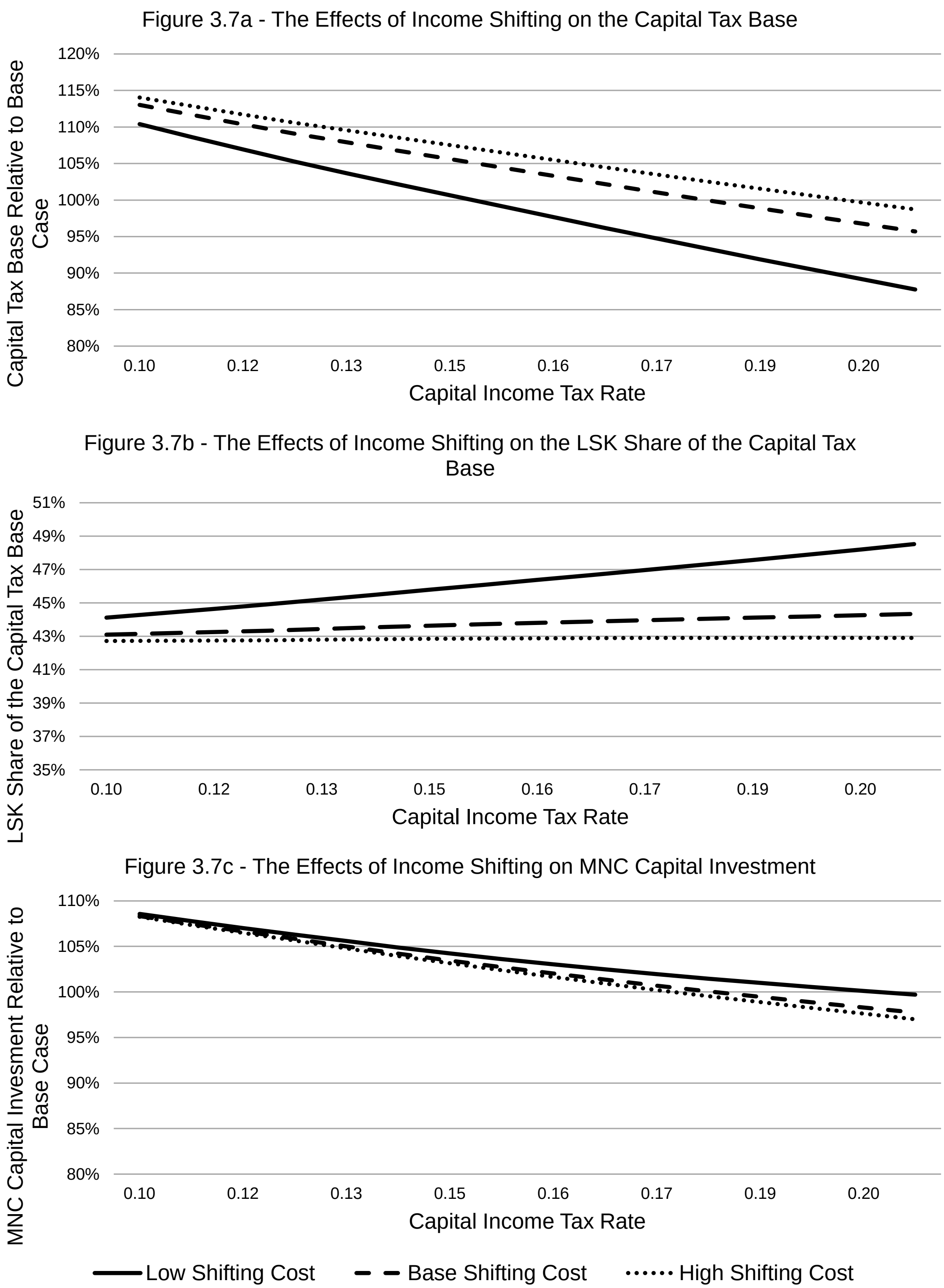
tax rate. Third, as international capital income shifting increases, the negative effect on foreign direct investment of higher capital income taxes is muted, as foreign MNCs recognize that the cost of a higher domestic statutory tax rate is diminished by the potential to shift some of the income earned to a low tax jurisdiction — the cost of capital in the multinational sector is less affected by the statutory rate in the presence of income shifting, implying foreign direct investment is less sensitive to the capital income tax rate. This makes capital income taxation less costly to the government and puts upward pressure on the optimal capital income tax rate.

These three effects are illustrated in Figures 3.7a-c. Figure 3.7a shows the capital tax base, relative to the base case, as a function of the capital income tax rate for different levels of international income shifting costs. It demonstrates that lower shifting costs, which lead to more capital income shifting, result in a smaller capital income tax base and thus revenue losses for the domestic government, putting downward pressure on the optimal capital income tax rate.

Figure 3.7b shows the LSK share of the capital income tax base as a function of the capital income tax rate for different levels of international income shifting costs. It demonstrates that lower shifting costs, which lead to more capital income shifting, result in a larger relative share of the capital tax base for LSK, making capital income taxation more attractive and thus putting upward pressure on the optimal capital income tax rate.

Finally, Figure 3.7c shows MNC investment, relative to the base case, as a function of the capital income tax rate for different levels of international income shifting costs. It demonstrates that lower shifting costs, which lead to more capital income shifting, result in slightly more investment at each value of the capital tax rate, as the potential for income shifting dampens the effect of capital income taxation on MNC investment. Figure 3.6 indicates that the last two factors are not large enough to offset the first factor described above, so that the optimal capital income tax rate declines, but only slightly, as the amount of international income shifting increases.

Figure 3.7 : Income Shifting and Capital Investment



Note: All parameters are set to base-case values unless otherwise indicated. For this figure, this implies 35% of labor income can be feasibly shifted, 35% of labor income is exempt from taxation, the elasticity of substitution in production is one, 20% of LSK is foreign-owned, there is no direct taxation of LSK, the gross residual tax rate is 20%, and 1% of capital in the multinational sector is subject to residual taxation. The low shifting cost is chosen so 50% of capital income is shifted internationally in the base case. The high shifting cost is chosen so 5% of capital income is shifted internationally in the base case.

3.5 Conclusion

In this paper, we analyze the optimal taxation of capital income for a small open economy that is attempting to balance the wide variety of factors that bear on the decision to impose a source-based tax on capital. On the one hand, the standard argument — the burden of a capital income tax imposed on internationally mobile capital will be borne entirely by local factors — suggests that the optimal capital income tax rate is zero. This argument is reinforced by concerns that mobile capital may include highly productive firm-specific capital owned by MNCs that earns above-normal returns, and that high capital income tax rates may induce international income shifting by MNCs that will reduce revenues, perhaps significantly. On the other hand, some capital income taxation is desirable even in a small open economy to tax above-normal returns earned by location-specific capital, especially to the extent that capital is owned by foreigners, to limit the shifting of labor income to the capital income tax base, and to take advantage of any "treasury transfer" effects that may be available. An additional complicating factor is that the opportunity to shift income internationally may mitigate the negative effects of higher capital income tax rates on FDI (since MNCs will know that the effects of a relatively high tax rate will be dampened via income shifting) and will increase the relative capital share of location-specific capital, increasing the relative desirability of more capital income taxation.

Our base analysis confirms the standard results: if all foreign-owned capital is perfectly mobile and there is no residual taxation, the optimal capital income tax rate is zero, while with full residual taxation, the optimal capital income tax rate never falls below the foreign residual tax rate as the government takes maximum advantage of the treasury transfer effects. But in the more relevant and more general cases, the optimal capital income tax rate falls between these two extremes, and is typically below the tax rate applied to labor income.

The simulation results of course depend on the model specification and parameter values used. Subject to that caveat, the simulations provide several noteworthy results. First, although the opportunity to tax immobile location-specific rents accruing to domestic residents does not provide a significant rationale for capital income taxation in our benchmark case, the optimal capital income tax rate increases approximately linearly as the fraction of location-specific rents that accrue to foreigners increases, in some cases exceeding the tax rate on labor income. Second, an operative treasury transfer effect provides a strong rationale for capital income taxation — an effect that currently is not likely to be very important, but may become much more relevant over time, especially as domestic capital income tax rates decline, if more countries enact strict anti-base-erosion provisions. Third, the potential for labor income shifting puts upward pressure on capital income tax rates to reduce the labor-capital income tax differential, and also tends to reduce the variation in capital income tax rates. Fourth, the availability of a separate tax on the income earned by location-specific capital significantly reduces optimal capital income tax rates; for example, in the resource sector, this could be a separate income tax on LSK earnings or a resource rent tax (or any cash flow-based tax) that would apply tax only to the rents earned in that sector. Fifth, the optimal capital income tax rate is only moderately sensitive to wide variations in the shares of location-specific and ordinary capital. Sixth, the amount of residual taxation is generally more influential in determining the optimal capital income tax rate than the residual tax rate. Seventh, several offsetting effects of international income shifting imply that the optimal capital tax rate is only marginally sensitive to the costs of international income shifting, declining slightly as such costs decrease and the amount of income shifting increases.

These simulations suggest that determining the optimal level of source-based capital income taxation is indeed a difficult problem.[23] For many countries, various factors

[23] There are of course numerous other factors not considered in our model that would also impact this decision (see, for example, Auerbach (2008) and Zodrow (2007)); in particular, we consider only business level taxation and ignore equity concerns. One particularly interesting factor is the extent to which capital income taxation can serve as a proxy for welfare-enhancing age-specific taxation (Erosa and Gervais, 2002; Weinzierl, 2011).

are likely to make the standard argument for complete exemption of capital income from source-based taxation an incomplete guide to tax policy, as some taxation of capital income is desirable under most circumstances. The primary exception is when a separate tax can be applied to much or all of the income of location-specific capital (or such capital is an insignificant factor in production); in this case, optimal capital income tax rates are quite low, and administrative concerns suggest that maintaining capital income taxation only to tax capital income at a very low rate may not be desirable.

At the same time, the optimal level of capital income taxation in our simulations is typically significantly below the tax rate applied to labor income, especially as the share of labor income exempt from taxation decreases, suggesting that the standard comprehensive income tax approach is not likely to be desirable either. Instead, more flexible tax systems, such as the dual income tax systems observed in several Nordic countries and elsewhere, may be optimal as they can achieve a balance between capital and labor income taxation that is best suited to the circumstances of a particular country — assuming that income shifting from the relatively highly taxed labor income base to the relatively lowly taxed capital income tax base can be controlled.

We note that the prospect of residual taxation can potentially play an important role in determining the optimal capital income tax rate. This is currently a relatively unimportant issue, since the United States is the only major country with a residence-based system and tempers its effects by allowing deferral of tax until funds are repatriated to a US parent and allowing generous cross-crediting of foreign tax credits. Nevertheless, residual taxation may become a more important factor, especially at relatively low levels of domestic capital income taxation, if more countries introduce current residual taxes as part of anti-base-erosion measures.

We close by noting that our results are generated in a static setting, and thus ignore some interesting dynamics that might affect the optimal capital income tax rate and should be the subject of further research. For example, Coates (1993) highlights the importance of imperfect capital mobility in a repeated game, arguing that the relative immobility of capital that could be attracted to a region puts further downward pressure on the capital income tax rate. However, the overall impact of dynamic considerations on capital tax competition is not obvious. Cardarelli, Taugourdeau, and Vidal (2002) acknowledge the reality that competition for mobile capital is a repeated game and consider the potential impacts of cooperation in rate setting. By employing trigger strategies, countries may be able to increase capital taxes simultaneously, raising revenue without generating capital outflows — although the gains from cooperation are limited by asymmetry between countries.

Chapter 4

The EITC and the Labor Supply of Adult Dependents: Direct Effects and Family Income Effects

4.1 Introduction

In 2014, over 13 million non-child individuals were claimed as dependents in the United States, with this type of claim appearing on approximately 1 in every 15 returns.[1] These claims, if made legally, represent very low-income individuals (earning less than $3,950 in 2014) receiving the majority of their financial support from the primary filers who claimed them. Since these individuals have very low income levels, small changes in tax liability can generate sizable welfare effects. Despite these considerations, little is known about how taxes affect the labor supply of non-child dependents. Acknowledging this, I use the 1993 expansion of the Earned Income Tax Credit (EITC) to study how taxation affects their labor force participation decisions.

Two features of the 1993 EITC expansion potentially affected adult dependents. First, for dependents attached to low-income households, family credits could have increased by as much as $1,017, changing family income and the value of dependent labor force participation. Second, starting in 1994, individuals without children could claim up to $306 in wage subsidies under the credit. This credit for childless individuals generally follows the form of the credit for filers with children. The value starts at $0 for individuals without wage income and increases proportionately with wages until reaching its maximum value. Then, for higher-wage individuals, the credit be-

[1] These numbers are based on the Internal Revenue Service's Statistics of Income Table 2.3.

gins to be phased out. For example, in 1994, no childless individuals earning $9,000 or more could claim the EITC. Noting these two relevant changes, I look for evidence that the expansion affected labor force participation for three separate categories of dependents: adult children living with their parents (who are too old to be "child dependents"), older individuals living with their children, and non-nuclear relatives. I find that the 1993 reform increased the labor force participation for non-nuclear, adult dependents by about 5 percentage points. In contrast, for adult children, I find that the absence of a net response to the EITC expansion is likely due to a previously undocumented effect: increases in family credits decreased their labor force participation.[2]

To identify these effects, I use difference-in-differences estimation and data from the Annual Social and Economic Supplement (ASEC) to the Current Population Survey (CPS), which observes more than 28,000 potential adult dependents between 1991 and 1996. I use difference-in-differences estimation for studying the labor supply response of working-age dependents because, due in part to the EITC, these individuals can have highly complex budget constraints.[3] Using this methodology to study the effects of the EITC has considerable precedent. Eissa and Liebman (1996) use the 1987 expansion of the EITC to identify an increase in labor force participation among single women with children, while Eissa and Hoynes (2004) demonstrate that the 1993 EITC expansions led to a decrease in labor force participation by married women.

This paper proceeds as follows. Section 4.2 outlines the 1993 EITC expansion and its predicted impacts. Section 4.3 discusses the sample selection methodology applied to the Current Population Survey and resulting sample characteristics. Section 4.4 studies labor force participation responses using difference-in-differences methodology.

---

[2]My observation that family resources may affect dependent labor supply decisions aligns with Hahn and Yang (2016), who demonstrate that access to parental health insurance reduces the labor supply of young adults.

[3]For more discussion of the issues raised by nonlinear budget constraints, see Blomquist (1996).

Section 4.5 concludes.

4.2 Policy Changes Under OBRA 1993

This empirical study examines the labor supply response of potential adult dependents, focusing on the impact of the EITC expansion included in the Omnibus Budget Reconciliation Act of 1993 (OBRA 1993). Before and after the reform, the EITC acted as a wage subsidy for eligible individuals, following a consistent general structure. With no credit available for non-workers, the value of the refundable credit increases linearly with earned income until reaching a maximum credit value. Individuals are eligible for this maximum credit over a range of incomes, but it is eventually phased out as the filer's income continues to rise. For example, in 1993 a filer with two qualifying children received a 19.5 percent credit on earned income up to $7,750. For filers earning between $7,750 and $12,200, the credit was a constant $1,511. For incomes above $12,200, the credit began phasing out at a 13.93 percent rate, so that filers earning more than $23,050 were not eligible for the EITC.

While the general shape of the EITC schedule was unaffected by OBRA 1993, the reform did include two notable EITC expansions. First, OBRA 1993 increased the maximum credit for filers with EITC-qualifying children. Between 1993 and 1994, the maximum credit increased by $604 for filers with one qualifying child and $1,017 for filers with two qualifying children. Consequently, this expansion could notably change after-tax family income for dependents in families with qualifying children.[4] Second, starting in 1994, this reform enabled childless filers to claim some EITC, with a maximum credit of $306 given to filers earning between $4,000 and $5,000.

Due to the 1994 extension of the EITC to childless individuals, forgoing dependent status and filing separately potentially minimized a family's tax burden for the first time. The optimality of separate filing is determined by two considerations: the

[4] Historical EITC parameters going back to 1975 can be obtained from the Tax Policy Center at http://tpcprod.urban.org/taxfacts/displayafact.cfm?Docid=36.

family's tax savings from claiming an additional dependent and the refundable credits the dependent individual can claim when filing separately. Importantly, the tax savings associated with an additional dependent is largely determined by the family's income. For very low-income families, including any families where the primary filers can claim the EITC, an additional dependent claim produces no tax savings. For higher-income families, the value of an additional claim is capped by the product of the top marginal tax rate and the personal exemption, implying an approximate maximum value of $970 in 1994. Since the maximum value of the EITC for childless individuals falls somewhere between these values, the dependent's optimal filing status varies with family income. Figure 4.1 demonstrates this divide, showing the tax savings associated with an additional dependent claim across a range of family incomes. This figure assumes that the dependent could claim the maximum EITC credit for childless individuals. Consequently, savings is negative over very low family income levels beginning in 1994.[5]

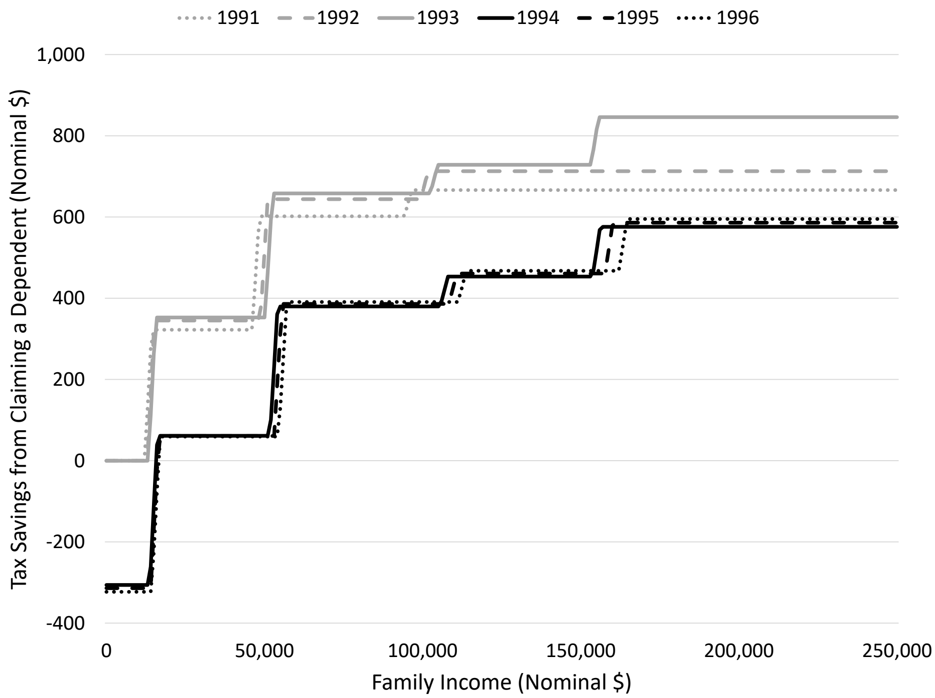
There is one additional way in which OBRA 1993 may have affected dependent individuals: the law increased marginal tax rates for very high-income filers. Beginning with 1993 returns, OBRA 1993 added top rates of 36 percent and 39.6 percent, while the previous top marginal tax rate on wage income was 31 percent. For filers affected by the increased top marginal tax rates, the value of claiming dependents increased, reducing the value of potential dependents earning above the dependent threshold. I ignore this last aspect of OBRA 1993 in the studies below because it affected relatively few households — only married couples (single individuals, heads of household) with taxable income exceeding $140,000 ($115,000, $127,500). Indeed, within my sample, this change is unlikely to affect many individuals. Between 1990 and 1992, only 127 out of 15,173 potential dependents are attached to a family that would be, holding income constant, affected by the marginal tax rate increases.[6]

---

[5]Negative values in Figure 4.1 suggest the individual filing separately minimizes the family's tax liability.

[6]For these calculations, I assume that no adult dependents are claimed by the primary family.

Figure 4.1 : Historical Tax Savings from Claiming a Dependent Eligible for the Maximum (No-Child) EITC



Tax savings shown are for a married couple filing jointly, with one dependent child. Grey lines indicate pretreatment years, and black lines indicate post-treatment years. Tax savings are calculated as the difference in total family tax liability between the individual being claimed as a dependent and filing separately. Negative values reflect positive credits claimed by the dependent if filing separately. Assumes the potential dependent can claim the full value of the EITC for single individuals with no children.

4.3 Sample Methodology and Characteristics

Successful estimation of dependent labor supply responses requires careful identification of these individuals. Under the U.S. tax system, individuals could be claimed as dependents during 1991–1996 so long as: (1) they lived with the primary filer(s), (2) they received more than half of all support from the primary filer(s), (3) they did not file jointly with another individual,[7] (4) their income did not exceed the value of

---

If the dependents of interest were claimed, this would only further reduce the possibility that the primary filer(s) would be affected by the tax bracket changes.

[7]There are some exceptions to this for dependent children. More details are provided in IRS Publication 17, Chapter 3.

the personal exemption, and (5) they were a U.S. citizen or resident alien. Alternatively, nuclear relatives (parent, sibling, or child) could be claimed as dependents if they met all of the previous qualifications except for (1); nuclear relatives do not have to reside with the primary filer(s). Using the ASEC sample of individuals from March CPS surveys between 1991 and 1996,[8] I identify potential dependents as unmarried relatives over the age of 18 (or 24 if the individual is a child of a primary filer) residing with the primary family. Spouses and siblings of the head are both excluded from the sample of potential dependents. I exclude siblings because selection of a household head between siblings may be arbitrary. Finally, I exclude all married individuals from the set of potential dependents.

I apply a few additional exclusion rules to the sample population. I exclude individuals who are active in the military, as it is unlikely these individuals choose their short-term labor supply in response to changes in net wage or family income. I also exclude individuals with obvious errors in their CPS survey results, including individuals with negative earned income, positive earned income paired with no labor supply, and individuals with no recorded labor force status. I further exclude individuals with likely errors in either age or relationship to the household head: children (of the household head) over the age of 65 and parents (of the household head) under the age of 40.[9] Accounting for these restrictions, the sample includes 28,672 potential dependents between 1991 and 1996. Within the sample, 18,786 individuals identify as children,[10] 4,066 identify as parents, and 5,820 identify as an "other relative." The last category excludes relatives who are spouses, children, parents, siblings, or grandchildren, and consequently, they are referred to as non-nuclear family members throughout this paper. Economic indicators for non-nuclear family members suggest that they may be residing with the family due to financial need. Only approximately 40 percent of these individuals report working in the week prior to the interview, and

[8] I extracted CPS data using IPUMS-CPS (Flood et al., 2015).

[9] Neither of these restrictions has a notable impact on the results.

[10] Step children are counted as children throughout this paper.

Table 4.1 : Summary Statistics

	Children		Parents		Non-Nuclear Relatives	
	1991-1993	1994-1996	1991-1993	1994-1996	1991-1993	1994-1996
Observations	9,985	8,801	1,934	2,132	3,187	2,633
Mean Age	33.44	34.14	72.03	70.63	52.58	52.43
Mean Unearned Income ($1994)	2,141	2,061	6,883	6,752	4,237	4,091
Mean Earned Income ($1994)	13,081	12,884	2,241	2,596	6,244	5,656
State Unemployment Rate (%)	7.22	5.94	7.31	6.06	7.40	6.16
Black (%)	14.2	15.1	12.9	14.4	14.4	12.6
White (%)	81.5	79.0	78.3	75.8	78.4	74.5
Female (%)	36.1	35.9	85.3	83.9	57.5	57.3
EITC-Qualifying Children (%)	13.0	11.3	35.1	35.3	41.2	44.3
Head Education≤12 Yrs (%)	73.2	68.3	56.9	55.6	65.9	63.0
Income-Eligible Dependent (%)	24.8	27.3	74.4	75.9	51.6	56.5
Reports Working Last Week (%)	68.2	69.3	14.8	17.3	40.8	39.6
Worked <50 Weeks Last Year (%)	43.9	43.3	88.2	85.4	70.2	72.7
Has a Work-Affecting Disability (%)	13.6	14.6	22.6	25.4	16.2	17.5

EITC-Qualifying Children indicates that the household contains children who can be claimed for EITC benefits. *Head Education≤12 Yrs* indicates that the head of household has a high school education or less. *Income-Eligible Dependent* represents the share of individuals whose income is low enough to meet the dependent qualification. 1991–1993 covers the study years prior to the EITC expansion. 1994–1996 covers the study years after the expansion.

over 70 percent of them report working fewer than 50 weeks in the prior year.

The characteristics of this sample are described in Table 4.1. Within the sample, children are generally the youngest potential dependents and parents are generally the oldest. While racial identification does not vary widely by the type of dependent, older potential dependents (parents and non-nuclear relatives) are more likely to be female and more likely to be attached to families with EITC-qualifying children. Unearned income is generally lower for children and higher for parents, while the opposite is true for earned income. Lastly, a larger proportion of children reside in families where the head has a high school education or less.

Of course, individuals whose taxable income exceeds the personal exemption cannot actually be claimed as dependents. If the sample is composed of individuals whose income drastically exceeds the level of the personal exemption, the dependent tax structure described thus far would not reasonably predict their behavior. With this concern in mind, I also observe each individual's taxable income relative to the concurrent personal exemption.[11] This reveals that a minority (26 percent) of identified children earn little enough income to be claimed as a dependent, but a majority of parents and non-nuclear relatives can be claimed as dependents. These values may understate the true proportion of individuals who consider dependency status if individuals fail to report some income when filing, especially if this misreporting is chosen strategically to maintain dependency status.[12] Further, individuals may consider the potential value of being claimed as a dependent and still decide to work at levels which eliminate eligibility. In combination, these two effects make it difficult to determine what proportion of the sample may consider dependency status. As an indication of the sample density around the eligibility cutoff, note that more than

[11]Taxable income is calculated using total income less retirement income, survivor's benefits, and disability benefits, provided the sum of these deductions is under $25,000. I also deduct worker's compensation if the individual does not receive social security or social security insurance, and social security income if the individual's total income is under $25,000. Personal exemptions and standard deductions are not deducted.

[12]Evidence of strategic income reporting can be found in LaLumia (2009) and Saez (2010).

42 percent of children, 70 percent of non-nuclear relatives, and 85 percent of parents have income less than four times the eligibility cutoff.

One remaining family characteristic, EITC-qualifying children, is important to the estimation below, since the number of children can have a significant impact on the EITC-eligibility of the primary filer(s). Children younger than 19, or younger than 24 and in school, may be claimed as dependents for EITC filing so long as they live with the primary filer(s), receive more than half of their support from the primary filer(s), and do not file a separate return. Thus, when calculating the number of EITC-qualifying children in a family, I include all unmarried individuals who identify as a child of the household head and are younger than 19 or younger than 24 and in school.

4.4 Estimation and Results

This empirical study examines the labor force participation response of the potentially dependent individuals identified above, focusing on the impact of the EITC expansion included in OBRA 1993. As discussed in Section 4.2, this reform is expected to affect dependent labor force participation through two channels. First, OBRA 1993 extended the EITC program to individuals without qualifying children. Because this program acted as a wage subsidy to childless individuals, it is expected to increase their labor force participation. Second, the expansion increased credits for household heads with EITC-qualifying children. If these credits lead to an overall increase in household income and this increase was shared with dependents, this is expected to decrease dependent labor force participation. Consequently, the predicted effect of the expansion on labor force participation is theoretically ambiguous.

The ambiguity of the predicted effect is compounded by the observation that increases in credits may not increase family income. Expansions of the EITC have been shown to increase labor force participation by married men and single individuals (Dickert, Houser, and Scholz, 1995), while decreasing participation by married women

(Eissa and Hoynes, 2004). In fact, Eissa and Hoynes find that OBRA 1993's EITC expansion lead to an overall decrease in labor force participation among married couples. Further, EITC expansion may increase or decrease hours for people who are already working, even for primary earners.[13] Consequently, theoretical models cannot predict whether family income will increase or decrease in response to an expansion of the EITC. Nevertheless, the expansion of family credits should affect the labor supply of adult dependents as long as a portion of the family income change is passed on to the dependent.

4.4.1 The Net Impact of the EITC Expansion

Noting the multiple changes to the EITC included in OBRA 1993, I start by studying the net effect of the policy change on the labor supply of adult dependents. To do this, I compare labor force participation for individuals attached to low-income households to participation for those attached to higher-income households using difference-in-differences estimation. Only individuals attached to low-income households are expected to be affected by the EITC expansion, since only low-income household heads should experience an increase in credits and only dependents attached to low-income families would optimally file separately to claim the EITC (this optimality is discussed in Section 4.2).

Recognizing that the family's income may be endogenously affected by tax reforms, I study the net effects of the reform using three alternative proxies for family income: the head's education, family homeownership status, and reported capital income. For each family income proxy, I present a direct comparison of changes in labor force

[13]See U.S. GAO (1993) for an extensive discussion of the predicted effects of the EITC and Saez (2010) for an exploration of intensive-margin effects using a sample of U.S. tax returns.

participation as well as two full regressions of the form

$$P_{i,t} = \alpha \mathbb{1}\left\{fam.\ inc.\ indicator\right\}_i \times \mathbb{1}\left\{period\right\}_t + \beta \mathbb{1}\left\{fam.\ inc.\ indicator\right\}_i + \gamma D_t + \delta D_s + \mu X_{i,t} + \epsilon_{i,t}, \tag{4.1}$$

where $P_{i,t}$ is the individual's participation decision (1 indicates participation, 0 indicates non-participation); $\mathbb{1}\left\{fam.\ inc.\ indicator\right\}_i$ is the family income indicator (1 indicates the low-income proxy and 0 the indicates high-income proxy); $\mathbb{1}\left\{period\right\}_t$ is the period indicator (1 indicates post-reform, 0 indicates pre-reform); D_t is the set of year fixed effects; D_s is the set of state fixed effects, $X_{i,t}$ is the vector of control variables; and $\epsilon_{i,t}$ is the error term. The vector $X_{i,t}$ includes controls for gender, age, race, unearned income, the number of EITC-qualifying children in the family, education, and the state unemployment rate.[14,15]

Under the first proxy, low-income households are approximated by households where the head's education does not exceed a high school degree; among these households the average family income is \$23,386. Higher-income households are approximated by households where the head's education exceeds a high school degree; among these households the average family income is \$45,839. This suggests using the head's education roughly splits families according to family income using an indicator that is unlikely to be affected by changes in tax law. However, this proxy may present its own challenges, particularly if the household head's education affects how dependents respond to tax changes. If there is a perfect association between the head's education and family income, the high-education group does not experience a tax change, and all of the measured response should be a consequence of the EITC expansion (where the magnitude of this response is scaled by the influence of a low-education head).

[14]Kaplan (2012) shows that employment rates can be important in determining coresidence decisions.

[15]State unemployment statistics were obtained from the U.S. Bureau of Labor of Statistics (1988–2000). Values are March seasonally adjusted unemployment rates.

However, if some high-education heads are affected by the EITC policy change and their associated dependents respond in a manner opposite to individuals attached to low-education heads, this could lead to an overestimate of the EITC's impact.[16] Recognizing this concern, I use TAXSIM to estimate family tax liability in each household with and without an additional dependent exemption.[17] Using these estimates, I find that only 6.8 percent of high-education household heads in my sample could plausibly claim EITC credits. Further, only 13.5 percent of dependents attached to high-education heads would optimally file separately, assuming the maximum credit amount of $306.

The second proxy I use for family income is the family's homeownership status. Homeownership, like the head's education, is relatively difficult to adjust in response to a tax change and correlated with income (in my sample average family income among non-homeowners is $18,460; average family income among homeowners is $34,320). However, rental and purchasing decisions can vary significantly geographically. If geographic location affects the direction of a dependent's response to tax changes, and some individuals in homeowning families are affected by the EITC change, this could lead to overestimation. Again using TAXSIM to estimate liability, I find that only 5.8 percent of homeowning households could plausibly claim the EITC, but that 20.5 percent of dependents attached to these households would optimally file separately.

The last proxy I use for family income is reported capital income. While the level of capital income reported is likely to be affected by taxation, I rely only on the presence of capital income (positive or negative) to distinguish between low- and high-income families. This eliminates endogeneity concerns as long as completely eliminating capital income is sufficiently costly. Under this approach, I approximate low-income households with households where the primary filers report no capital income; among

---

[16]If dependents attached to high-education heads respond in the same manner, but to a differing extent, this would lead to underestimated effects.

[17]For more discussion of the TAXSIM model, see Feenberg and Coutts (1993).

these households, the average family income is \$21,523. Among households which report non-zero capital income, the average family income is \$32,609. The primary limitation of this proxy comes from the imperfect separation of low- and high-income families: capital income reporting can be very noisy and may only reflect differences in the type of income earned. These concerns may explain why capital income generates the narrowest family income difference. However, unless individuals attached to families with capital investments respond differently (in direction, not degree) to a tax change, noisy group assignments will only bias estimates towards zero.

Table 4.2 presents the change in labor force participation before and after the reform for potential dependents attached to low- and higher-income families, where $P_{i,t} = 1$ if the individual reports active labor force participation. Using these changes, Table 4.2 then presents the difference-in-differences estimate with no controls. These observations suggest that responses to the EITC expansion varied according to family interrelationship. The naive results using the head's education suggest that parents and non-nuclear relatives increased their labor force participation in response to the EITC expansion, a change that can be explained by these dependents choosing to forgo dependency status and claiming their new-found wage subsidies. On the other hand, the naive results using family capital income suggest that children may have exited the labor force, plausibly as a consequence of increases in family credits.

To test the validity of these naive results, I present a few robustness checks in Table 4.3. First, I adjust the standard errors for clustering at the state level and incorporate control variables, including state and year fixed effects. Broadly, these considerations do not affect the sign of the results presented in Table 4.2, although the significance of the results declines for both parents and children. Second, I repeat the uncontrolled regression estimation using an alternative indicator for labor force participation: positive reported labor hours in the week before the survey was taken. Using this alternative indicator, with and without controls, the significance of the non-nuclear relative response remains at the 1% level with the head-education family

Table 4.2 : Labor Force Participation Changes Using Family Income Proxies

A comparison of labor force participation between dependents attached to low-income families (the treated group) and those attached to higher-income families (the untreated group).

	Children	Parents	Non-Nuclear
Treated = Head's Education $\leq$ High School Degree			
Δ*Participation* for the treated	-0.024	0.053	0.024
	(0.007)	(0.016)	(0.016)
Δ*Participation* for the untreated	-0.012	-0.011	-0.091
	(0.010)	(0.018)	(0.021)
DD estimate (α)	-0.012	0.064***	0.115***
	(0.013)	(0.024)	(0.027)
Treated = No Homeownership			
Δ*Participation* for the treated	-0.022	0.031	-0.003
	(0.016)	(0.024)	(0.021)
Δ*Participation* for the untreated	-0.016	0.020	-0.034
	(0.006)	(0.013)	(0.016)
DD estimate (α)	-0.006	0.011	0.031
	(0.015)	(0.025)	(0.026)
Treated = Zero Capital Income			
Δ*Participation* for the treated	-0.059	0.028	-0.009
	(0.017)	(0.027)	(0.024)
Δ*Participation* for the untreated	-0.012	0.015	-0.032
	(0.006)	(0.013)	(0.015)
DD estimate (α)	-0.047***	0.013	0.023
	(0.017)	(0.027)	(0.029)

Participation is measured using reported labor force status. All changes compare participation rates between 1991–1993 and 1994–1996. Significance is indicated at the 1% (***), 5% (**), and 10% (*) levels.

income proxy. Additionally, using reported hours worked, the non-nuclear relative response is significant at the 5% level using the family homeownership proxy. In contrast, using an alternative labor force participation proxy for parents and children weakens the significance of their responses, with no evidence of a response when control variables are included. Overall, Table 4.3 only provides robust evidence that non-nuclear relatives increased their labor force participation in response to the EITC

Table 4.3 : Robustness Checks on Labor Force Participation Changes Using Family Income Proxies

A comparison of labor force participation between dependents attached to low-income families (the treated group) and those attached to higher-income families (the untreated group).

	Child	Parent	Non-Nuclear
Treated = Head's Education $\leq$ High School Degree			
DD estimate (α) with controls	-0.007	0.029*	0.053***
	(0.012)	(0.017)	(0.017)
DD estimate (α) using reported hrs	-0.014	0.053**	0.115***
	(0.015)	(0.023)	(0.026)
DD estimate (α) reported hrs, controls	-0.011	0.021	0.061***
	(0.016)	(0.018)	(0.015)
Treated = No Homeownership			
DD estimate (α) with controls	0.004	-0.003	0.019
	(0.021)	(0.025)	(0.021)
DD estimate (α) using reported hrs	0.014	0.012	0.053**
	(0.018)	(0.024)	(0.026)
DD estimate (α) reported hrs, controls	0.025	-0.002	0.044**
	(0.024)	(0.024)	(0.020)
Treated = Zero Capital Income			
DD estimate (α) with controls	-0.027	0.016	0.036
	(0.019)	(0.017)	(0.030)
DD estimate (α) using reported hrs	-0.040*	0.024	0.012
	(0.021)	(0.026)	(0.029)
DD estimate (α) reported hrs, controls	-0.017	0.026	0.026
	(0.021)	(0.019)	(0.034)

"Reported hrs" indicates *Participation* uses hours worked in the previous week rather than reported labor force status. All changes compare participation rates between 1991–1993 and 1994–1996. Control variables include unearned income, education, age, the number of EITC-qualifying children in the family, state unemployment, state and year fixed effects, and gender and race indicators. Significance is indicated at the 1% (***), 5% (**), and 10% (*) levels. Standard errors are adjusted for clustering at the state level.

expansion.[18] Based on the estimates in Tables 4.2 and 4.3, it appears that these individuals increased their labor force participation by about 5 percentage points in response to the EITC expansion. This value is somewhat higher than the effect found for single women (3.3 percentage points) by Dickert, Houser, and Scholz (1995).

Concentrating on the effects observed for non-nuclear relatives, two concerns need to be addressed. First, any difference-in-differences regression is subject to concern that the trends over time for each group are inherently different and that any significance picked up in these regressions is merely a consequence of pre-existing trends. To address this concern, I test for differential trends in labor force participation between the treated and untreated group between 1988 and 1993. These tests are performed for non-nuclear relatives with and without controls. They fail to reject the null hypothesis that dependent labor force participation followed the same trend regardless of the head's education level or family homeownership status. The trends in labor force participation are depicted in Figure 4.2.

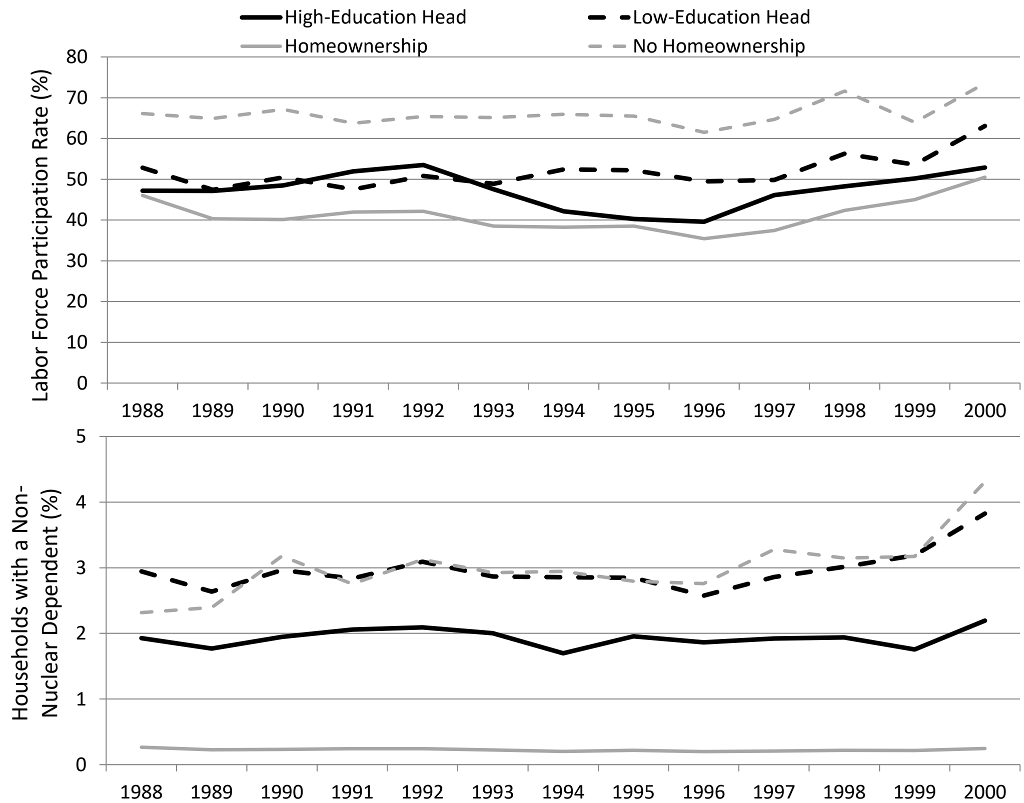
Second, since the CPS survey only covers individuals living in the household, it is possible that OBRA 1993 changed living arrangements, biasing the results in Table 4.3. This problem is highlighted by McElroy (1985), who emphasizes that living at home cannot be treated as an exogenous variable. While Rosenzweig and Wolpin (1994) find that welfare has little effect on coresidence decisions, Kaplan (2012) finds that coresidence and employment are likely jointly determined. Further, the effect of employment on the decision to the leave the household appears to vary with the quality of employment (e.g., wages and job security) as shown by Card and Lemieux (2000) and Becker et al. (2010). Consequently, if OBRA 1993 encouraged changes in labor force participation, it may have also produced changes in housing decisions.[19]

---

[18] Rosenzweig and Wolpin (1994) find that government transfers are partial substitutes for family support. In this case, it is possible that children do not respond to an increase in their own credits because they are countered by a decrease in family support.

[19] Labor force participation and job quality are only two of several factors that may affect the decision to leave the household. Other factors include age (Rosenzweig and Wolpin, 1993; Ahn and Sanchez-Marcos, forthcoming); sibling relationships (Aparicio-Fenoll and Oppedisano, 2016); mort-

Figure 4.2 : Participation Trends and Sample Sizes for Non-Nuclear Relatives



Labor force participation rates are presented for sampled dependent individuals.

To provide an indication of any change in living arrangements, I graph the percent of families reporting a non-nuclear dependent by type between 1988 and 2000 in Figure 4.2. This figure does not reveal any evidence of a notable shift in living arrangements around the reform, although in 1994 there is a one-year dip in reported non-nuclear relatives for households with a high-education head. In combination, changes in participation and observation rates leave little reason to doubt the result found in Tables 4.2 and 4.3: Non-nuclear relatives increased their labor force participation in response to the 1993 EITC expansion. There are two plausible explanations for this change. First, these individuals may have increased their participation to take

gage interest rates (Martins and Villanueva, 2009); and family resources (Rosenzweig and Wolpin, 1993; Manacorda and Moretti, 2006; Battistin et al., 2009; Stella, forthcoming).

advantage of their new-found eligibility for the EITC. Alternatively, these individuals may have increased their participation due to decreases in family income generated by large labor responses from other family members. Since any decrease in labor supply would have to overwhelm increased EITC benefits, I hypothesize that these individuals increased their labor force participation in response to their own EITC eligibility. This hypothesis is explored in the following section, where I study labor supply responses to increased family credits.

4.4.2 Dependent Responses to Changes in Family Tax Liability

As noted above, the EITC expansion had two primary effects on dependent individuals: It made them newly eligible to claim EITC benefits, and it expanded benefits for primary filers. In an effort to disentangle these effects, I compare individuals based on the presence of EITC-qualifying children in the household. Low-income families with EITC-qualifying children experienced the largest increases in EITC benefits under OBRA 1993. With no children, the maximum credit increased by $306 between 1993 and 1994. With one child, the maximum credit increased by $604 between 1993 and 1994. With two or more children, the maximum credit increased by $1,017 between 1993 and 1994. While EITC-qualifying children were associated with a significant expansion of family EITC benefits, they had a small impact on the optimality of claiming a dependent (relative to letting the dependent file separately). In 1994, an optimizing married couple without an EITC-qualifying child would always claim a dependent at incomes exceeding $13,287; an optimizing married couple with one qualifying child would always claim a dependent at incomes exceeding $15,737. Consequently, while EITC-qualifying children have a significant effect on tax liability for low-income families, they should have little effect on the tax filing decision for any associated dependents.

In this section I compare the labor force participation response for dependents using EITC-qualifying children as an indicator of expanded family credits. This comparison follows the form of the regression specified in (4.1), with two changes: the treated group includes only individuals attached to families with EITC-qualifying children, and the vector of control variables, $X_{i,t}$, no longer includes the number of EITC-qualifying children. Accounting for these changes, the regressions studying the impact of expanded credits have the form

$$P_{i,t} = \alpha \mathbb{1}\left\{qual.\ children\right\}_i \times \mathbb{1}\left\{period\right\}_t + \beta \mathbb{1}\left\{qual.\ children\right\}_i + \gamma D_t + \delta D_s + \mu X_{i,t} + \epsilon_{i,t}. \tag{4.2}$$

Under the specification in (4.2), the α coefficient should capture the impact of expanded benefits for families with EITC-qualifying children on the labor force participation of dependents. Because EITC-qualifying children only affect family credits for low-income households, I restrict this comparison to families with married household heads whose education does not exceed the high school level.

The results from comparing potential dependents attached to families with and without EITC-qualifying children are included in Table 4.4. These results suggest that an increase in family EITC credits decreased labor force participation for adult children. For parents and non-nuclear relatives, estimation does not produce robust evidence that individuals responded to changes in family credits.[20] As a consequence, the most reasonable explanation of the results in Tables 4.2 and 4.3 is that non-nuclear relatives increased their labor supply in response to their own expanded EITC eligibility, not in response to changes in family income.

To address the concern that these results for adult children may be driven by differential underlying trends in participation or changes in living arrangements, I

[20]The limited response among parental dependents could be explained in one of two ways. First, increases in family wealth may be shared less with parents. Alternatively, the limited response may be a consequence of complex childcare decisions for parents of the household head. Wheelock and Jones (2002) find that grandparents may exchange childcare for support from their children. Aassve, Meroni, and Pronzato (2012) find that the availability of grandparents for childcare affects family planning.

Table 4.4 : Dependent Labor Force Participation by Predicted Family EITC Increase

A comparison of labor force participation between dependents attached to families with EITC-qualifying children (the treated group) and those attached to families without (the untreated group).

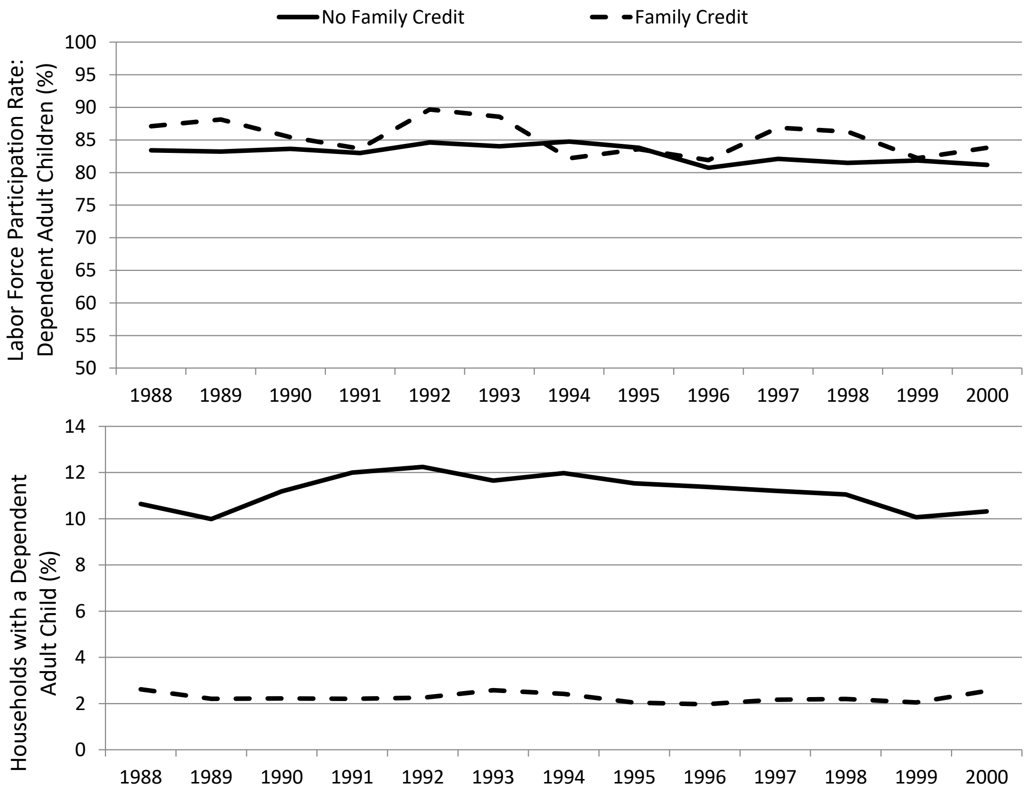
	Child	Parent	Non-Nuclear
Δ*Participation* for the treated	-0.051	0.016	0.014
	(0.022)	(0.036)	(0.028)
Δ*Participation* for the untreated	-0.006	0.047	0.039
	(0.010)	(0.033)	(0.028)
DD estimate (α) without controls	-0.045*	-0.031	-0.025
	(0.025)	(0.051)	(0.040)
DD estimate (α) with controls	-0.064**	-0.055	0.038
	(0.029)	(0.034)	(0.027)
DD estimate (α) using reported hrs	-0.067**	-0.052	-0.009
	(0.030)	(0.048)	(0.039)
DD estimate (α) reported hrs, controls	-0.075**	-0.075**	0.047*
	(0.033)	(0.031)	(0.028)

Significance is indicated at the 1% (***), 5% (**), and 10% (*) levels; reported standard errors cluster at the state level. "Reported hrs" indicates *Participation* uses hours worked in the previous week rather than reported labor force status. All changes compare particpation rates between 1991–1993 and 1994-1996. Control variables include unearned income, education, age (linear and quadratic terms), state unemployment rates, state fixed effects, year fixed effects, and indicators for gender and race (black and white). Observations are restricted to families with a married household head whose education does not exceed a high school degree.

perform validity tests using comparison groups that align with Table 4.4. Studying the labor force participation of adult children over 1988–1993, tests fail to reject the null hypothesis that labor force participation followed the same trend for individuals in families with and without EITC-qualifying children. These labor force participation patterns are depicted in Figure 4.3. Since I do not find evidence of underlying differential trends for adult children, this observation does not undermine the significant results noted in Table 4.4.

To investigate the possibility that changes in living arrangements biased results, I again calculate the percent of families reporting dependents between 1988 and 2000. As depicted in Figure 4.3, observation rates for dependent adult children were fairly

Figure 4.3 : Participation Trends and Sample Sizes Using EITC-Qualifying Children as a Proxy for Family Credits



"No Family Credit" indicates the dependent belongs to a family without EITC-qualifying children; these families are not expected to experience a significant EITC increase. "Family Credit" indicates the dependent belongs to a family with at least one EITC-qualifying child; these families are expected to experience a significant credit increase.

constant between 1990 and 1996. There is a slight decline in the rate of dependent adult children living at home beginning in 1995 for families without EITC-qualifying children. Assuming that dependents who move out of the home are more likely to work, an assumption which aligns with the results found by both Rosenzweig and Wolpin (1993) and Kaplan (2012), this suggests sample observations over 1995–1996 understate labor force participation for adult children in the untreated group.[21] This

[21]Kaplan (2012) thinks about the decisions to move back home as a consequence of labor market outcomes. From this perspective, he finds that youths who become unemployed are 63 percent more likely to move in with their parents. Similarly, employment increases the likelihood of moving out by 27 percent.

is similar to overestimating participation in the treated group — it generates upwards bias in the α coefficient. Since the coefficient values reported in Table 4.4 for adult children are significantly negative, a potential upwards bias in the coefficient should not be driving the result. On the whole, review of Figure 4.3 offers little reason to doubt the suggestion that an increase in family credits led to a decrease in labor force participation for adult children.

One explanation for the negative labor supply response of adult children is that the EITC expansion led to a net increase in family income, which was then shared with adult children. An EITC expansion leading to an increase in family income is broadly consistent with the existing literature. Eissa and Liebman (1996), Meyer and Rosenbaum (2001), and Saez (2010) all suggest limited intensive margin responses to the EITC. Chetty, Friedman, and Saez (2013) find an intensive margin response for individuals in areas generally knowledgeable about the EITC. So, while well-informed individuals may be likely to adjust their hours in response to the EITC, the literature suggests a small overall response in hours worked. There is less evidence that increases in family income are shared with adult children. Rosenweig and Wolpin (1994) find that changes in family income have minimal effects on transfers to children and suggest that this may be because household heads face fewer liquidity constraints and smooth consumption over time. However, consumption smoothing opportunities are likely to be more limited for very low-income families. For example, Rosenweig and Wolpin (1993) find evidence that, in black families where the mother has less than eight years of schooling, changes in family income affect transfers to adult children.

4.5 Conclusion

Using the EITC expansions introduced in OBRA 1993, this paper provides an initial exploration of the impact of taxes on the labor supply decisions of dependent individuals. In this study, I differentiate between dependents based on their relationship to the household head, finding different responses across categories. Relatives living with extended family, who identify as neither a parent nor a child of the household head, increased their labor supply by about 5 percentage points in response to the 1993 EITC expansion. Decomposing the EITC expansion, I find an increase in the family's EITC benefits decreased labor force participation for adult children. This observation suggests the absence of a net effect for adult children may be due to the two offsetting features of the EITC expansion under OBRA 1993. The expansion increased family income, discouraging labor force participation for dependents, but also extended EITC eligibility to these individuals, encouraging labor force participation.

Since this study relies on difference-in-differences estimation centering around a single policy change, any concurrent reform could bias the results, particularly if the reform differentially affected individuals based on family income or the presence of EITC-qualifying children in the household. Indeed, several major pieces of federal legislation were passed in the early 1990s, and a few of these reforms should be noted. The North American Free Trade Agreement (NAFTA) came into effect January 1, 1994. If NAFTA generated rapid changes in the U.S. job market it could bias the above results, although controlling for state unemployment rates should attenuate any such bias. The Family and Medical Leave Act took effect in August of 1993, protecting unpaid leave for individuals caring for new children or sick nuclear relatives. While this protection is particularly relevant for dependents with poor health, these dependents are typically unable to work and I do not expect policy changes to impact their labor force participation. Lastly, starting in 1993, the federal government began to issue welfare waivers to some states. Under these waivers, states were able to adjust their Aid to Families with Dependent Children (AFDC) programs. These adjustments took many forms and often included increases in job-training program requirements, new eligibility time-limits, increases in disregarded income, and increases in resource limits. Since these reforms were diverse and staggered between 1993 and 1996, it is difficult to discern their effect on the results identified here.

The evidence in this paper provides a few lessons for future revisions to EITC benefits. First, since the EITC expansion influenced the labor supply decisions of dependent individuals, future reforms should not only weigh the value of the EITC to primary and secondary earners, but also to tertiary earners attached to primary filers. Notably, estimates of the EITC cost for this group may be overstated if they ignore any associated decreases in dependent claims. Second, by simultaneously adjusting credits for filers with and without children, future EITC reforms can minimize participation-discouraging effects on adult children. The importance of this consideration depends on why adult children decrease their labor supply in response to an increase in family income. If labor force exit represents a decrease in human capital development, discouraging labor force participation for adult children may be exceptionally inefficient. However, if the decline in participation reflects an extended job search process due to relaxed liquidity constraints, similar to the impacts of unemployment insurance observed by Chetty (2008) or the effective insurance of living with parents observed by Kaplan (2012), decreased participation may be a desirable consequence of the EITC. Differentiating these two effects is an important consideration for future research, as they affect the optimal level of EITC benefits for filers with and without children.

Bibliography

[1] Aassve, Arnstein, Elena Meroni, and Chiara Pronzato, 2012. "Grandparenting and Childbearing in the Extended Family." *European Journal of Population* 28 (4), 499-518.

[2] Ahn, Namkee, and Virginia Sánchez-Marcos, forthcoming. "Emancipation Under the Great Recession in Spain." *Review of Economics of the Household.*

[3] Altig, David, Alan J. Auerbach, Laurence J. Kotlikoff, Kent A. Smetters, and Jan Walliser, 2001. "Simulating Fundamental Tax Reform in the United States." *The American Economic Review* 91 (3), 574-595.

[4] Altshuler, Rosanne, and Harry Grubert, 2006. "Governments and Multinational Corporations in the Race to the Bottom." *Tax Notes* 110 (February 6), 459-474.

[5] Aparicio-Fenoll, Ainhoa, and Veruska Oppedisano, 2016. "Should I Stay or Should I Go? Sibling Effects in Household Formation." *Review of Economics of the Household* 14 (4), 1007-1027.

[6] Apergis, Nicholas, and Chris Tsoumas, 2009. "A Survey of the Feldstein-Horioka Puzzle: What Has Been Done and Where We Stand." *Research in Economics* 63 (2), 64-76.

[7] Atkinson, Anthony B., and Joseph E. Stiglitz, 1976. "The Design of Tax Structure: Direct versus Indirect Taxation." *Journal of Public Economics* 6, 55-75.

[8] Auerbach, Alan J., 2006. "The Future of Capital Income Taxation." *Fiscal Studies* 27 (4), 399-420.

[9] Auerbach, Alan J., 2008. "Tax Reform in the 21st Century." In J. W. Diamond and G. R. Zodrow (eds.), *Fundamental Tax reform: Issues, Choices, and Implications*, pp. 27-74. MIT Press, Cambridge, MA.

[10] Battistin, Erich, Agar Brugiavini, Enrico Rettore, and Guglielmo Weber, 2009. "The Retirement Consumption Puzzle: Evidence from a Regression Discontinuity Approach." *The American Economic Review* 99 (5), 2209-2226.

[11] Becker, Sascha O., Samuel Bentolila, Ana Fernandes, and Andrea Ichino, 2010. "Youth Emancipation and Perceived Job Insecurity of Parents and Children." *Journal of Population Economics* 23 (3), 1047-1071.

[12] Becker, Johannes, and Clemens Fuest, 2011." Optimal Tax Policy when Firms are Internationally Mobile." *International Tax and Public Finance* 18 (5), 580-604.

[13] Bettendorf, Leon, Michael P. Devereux, Albert van der Horst, Simon Loretz, and Ruud A. de Mooij, 2009. "Corporate Tax Harmonization in the EU." CPB Discussion Paper 133. The Hague: CPB Netherlands Bureau for Economic Policy Analysis.

[14] Blomquist, Sören, 1996. "Estimation Methods for Male Labor Supply Functions: How to Take Account of Nonlinear Taxes." *Journal of Econometrics* 70, 383-405.

[15] Boadway, Robin, and Pierre Pestieau, 2003. "Indirect Taxation and Redistribution: The Scope of the Atkinson Stiglitz Theorem." In Arnott, Richard, Bruce Greenwald, Ravi Kanbur, and Barry Nalebuff (eds.), *Economics for an Imperfect World: Essays in Honor of Joseph E. Stiglitz*, pp. 387-403. MIT Press, Cambridge, MA.

[16] Bucovetsky, Sam, and John Douglas Wilson, 1991. "Tax Competition with Two Tax Instruments." *Regional Science and Urban Economics* 21 (3), 333-350.

[17] Brueckner, Jan K., 2000. "A Tiebout/Tax-Competition Model." *Journal of Public Economics* 77, 285-306.

[18] Burbidge, John B. and Gordon M. Myers, 1994. "Population Mobility and Capital Tax Competition." *Regional Science and Urban Economics* 24 (4), 441-459.

[19] Card, David, and Thomas Lemieux, 2000. "Adapting to Circumstances: The Evolution of Work, School, and Living Arrangements Among North American Youth." In Richard Freeman and David Blanchflower (eds), *Youth Employment and Joblessness in Advanced Countries*. University of Chicago Press: Chicago, IL.

[20] Cardarelli, Roberto, Emmanuelle Taugourdeau, and Jean-Pierre Vidal, 2002. "A Repeated Interactions Model of Tax Competition." *Journal of Public Economic Theory* 4 (1), 19-38.

[21] Chamley, Christophe, 1986. "Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives." *Econometrica* 54 (3), 607-622.

[22] Chetty, Raj, 2008. "Moral Hazard versus Liquidity and Optimal Unemployment Insurance." *Journal of Political Economy* 116 (2), 173-234.

[23] Chetty, Raj, John N. Friedman, and Emmanuel Saez, 2013. "Using Differences in Knowledge Across Neighborhoods to Uncover the Impacts of the EITC on Earnings." *American Economic Review* 103 (7), 2683-2721.

[24] Chirinko, Robert S., 2002. "Corporate Taxation, Capital Formation, and the Substitution Elasticity between Labor and Capital." *National Tax Journal* 55 (2), 339-355.

[25] Clausing, Kimberly A., 2011. "The Revenue Effects of Multinational Firm Income Shifting." *Tax Notes* 130 (March 28), 1580-1586.

[26] Clausing, Kimberly A., 2016. "The Effect of Profit Shifting on the Corporate Tax Base in the United States and Beyond." Manuscript. Reed College, Portland, OR.

[27] Coates, Dennis, 1993. "Property Tax Competition in a Repeated Game." *Regional Science and Urban Economics* 23 (1), 111-119.

[28] Coeurdacier, Nicolas, and Hélène Rey, 2012. "Home Bias in Open Economy Financial Macroeconomics." *Journal of Economic Literature* 51 (1), 63-115.

[29] Cremer, Helmuth, Pierre Pestieau, and Jean-Charles Rochet, 2001. "Direct Versus Indirect Taxation: The Design of the Tax Structure Revisited." *International Economic Review* 42 (3), 781-799.

[30] Cronin, Julie Anne, Emily Y. Lin, Laura Power, and Michael Cooper, 2013. "Distributing the Corporate Income Tax: Revised U.S. Treasury Methodology." *National Tax Journal* 66 (1), 239-262.

[31] de Mooij, Ruud A., and Michael P. Devereux, 2011. "An Applied Analysis of ACE and CBIT Reforms in the EU." *International Tax and Public Finance* 18 (1), 93-120.

[32] de Mooij, Ruud A., and Gaëten Nicodéme, 2006. "Corporate Tax Policy, Entrepreneurship and Incorporation in the EU." Economic Papers No 269. Brussels: European Commission Directorate-General for Economic and Financial Affairs.

[33] Deloitte, 2014. "Guide to Controlled Foreign Company Regimes." http://www2.deloitte.com/content/dam/Deloitte/global/Documents/Tax/dttl-tax-guide-to-cfc-regimes-210214.pdf.

[34] Devereux, Michael P., Clemens Fuest, and Benjamin Lockwood, 2014. "The Taxation of Foreign Profits: A Unified View." Manuscript. Centre for Business Taxation, Oxford University, Oxford, UK.

[35] Devereux, Michael P., and Simon Loretz, 2013. “What Do We Know about Corporate Tax Competition?” *National Tax Journal* 66 (3), 745-773.

[36] Dickert, Stacy, Scott Houser, and John Karl Scholz, 1995. “The Earned Income Tax Credit and Transfer Programs: A Study of Labor Market and Program Participation.” In James M. Poterba (ed.), *Tax Policy and the Economy, Volume 9.* MIT Press, Cambridge, MA.

[37] Dowd, Tim, Paul Landefeld, and Anne Moore, 2016. “Income Shifting of U.S. Multinationals.” Manuscript, Joint Committee on Taxation, Washington, DC.

[38] Dunning, John H., 1981. *International Production and the Multinational Enterprise.* Allen and Unwin, London, UK.

[39] Dyreng, Scott D., and Kevin S. Markle, 2015. “The Effects of Financial Constraints on Tax-motivated Income Shifting by U.S. Multinationals.” Manuscript. Duke University, Durham, NC.

[40] Economic Commission for Latin America and the Caribbean, 2012. “Foreign Direct Investment in Latin America and the Caribbean.” United Nations Economic Commission for Latin America and the Caribbean, New York, NY.

[41] Eissa, Nada, and Hilary Hoynes, 2004. “Taxes and the Labor Market Participation of Married Couples: The Earned Income Tax Credit.” *Journal of Public Economics* 88 (9-10), 1931-1958.

[42] Eissa, Nada, and Jeffrey B. Leibman, 1996. “Labor Supply Response to the Earned Income Tax Credit.” *Quarterly Journal of Economics* 111 (2), 605-637.

[43] Erosa, Andrés, and Martin Gervais, 2002. “Optimal Taxation in Life-Cycle Economies.” *Journal of Economic Theory* 105 (2), 338-369.

[44] Feenberg, Daniel R., and Elisabeth Coutts, 1993. ”An Introduction to the TAXSIM model.” *Journal of Policy Management and Analysis* 12 (1), 189-194.

[45] Fehr, Hans, Sabine Jokish, Ashwin Kambhampati,and Laurence J. Kotlikoff, 2013. "Simulating the Elimination of the U.S. Corporate Income Tax." NBER Working Paper 19757, Cambridge, MA.

[46] Feldstein, Martin, 1978. "The Welfare Cost of Capital Income Taxation." *Journal of Political Economy* 86 (2), S29-S51.

[47] Feldstein, Martin, and Charles Horioka, 1980. "Domestic Saving and International Capital Flows." *The Economic Journal* 90 (358), 314-329.

[48] Flood, Sarah, Miriam King, Steven Ruggles, and J. Robert Warren, 2015. *Integrated Public Use Microdata Series, Current Population Survey: Version 4.0.* [Machine-readable database]. Minneapolis: University of Minnesota.

[49] French, Kenneth R., and James M. Poterba, 1991. "Investor Diversification and International Equity Markets." *The American Economic Review* 81 (2), 222-226.

[50] Gallagher, David R., Katja Ignatieva, and James McCulloch, 2015. "Industry Concentration, Excess Returns, and Innovation in Australia." *Accounting & Finance* 55 (2), 443-466.

[51] Gordon, Roger H., 1986. "Taxation of Investment and Savings in a World Economy." *The American Economic Review* 76 (5), 1086-1102.

[52] Gordon, Roger H., and James R. Hines Jr., 2002. "International Taxation." In Alan J. Auerbach and Martin Feldstein (eds.), *Handbook of Public Economics*, volume 4, pp. 1935-1995. North Holland/Elsevier, Amsterdam, the Netherlands.

[53] Gordon, Roger H., and James Mackie-Mason, 1995. "Why is there Corporate Taxation in a Small Open Economy? The Role of Transfer Pricing and Income Shifting." In Martin Feldstein, James R. Hines Jr., and R. Glenn Hubbard (eds.), *The Effects of Taxation on Multinational Corporations*, pp. 67-91. University of Chicago Press, Chicago, IL.

[54] Gordon, Roger H., and Joel Slemrod, 2000. "Are 'Real' Responses to Taxes Simply Income Shifting between Corporate and Personal Income Tax Bases?" In Joel Slemrod (ed.), *Does Atlas Shrug? The Economic Consequences of Taxing the Rich*, pp. 240-280. Russell Sage Foundation and Harvard University Press, New York, NY.

[55] Graetz, Michael J., and Alvin C. Warren, Jr., forthcoming. "Integration of Corporate and Shareholder Taxes." *National Tax Journal*.

[56] Gravelle, Jane G., and Kent A. Smetters, 2006. "Does the Open Economy Assumption Really Mean that Labor Bears the Burden of the Capital Income Tax?" *The B.E. Journal of Economic Analysis & Policy* 6 (1), 1-44.

[57] Greenhalgh, Christine, and Mark Rogers, 2006. "The Value of Innovation: The Interaction of Competition, R&D, and IP." *Research Policy* 35 (4), 562-580.

[58] Grubert, Harry, and Rosanne Altshuler, 2013. "Fixing the System: An Analysis of Alternative Proposals for the Reform of International Tax." *National Tax Journal* 66 (3), 671-712.

[59] Grubert, Harry, and Rosanne Altshuler, forthcoming. "Shifting the Burden of Taxation from the Corporate to the Personal Level and Getting the Corporate Tax Rate Down to 15 Percent." *National Tax Journal*.

[60] Gugl, Elisabeth, and George R. Zodrow, 2006. "International Tax Competition and Tax Incentives for Developing Countries." In Alm, James, Jorge Martinez-Vazquez, and Mark Rider (eds.) *The Challenges of Tax Reform in a Global Economy*, pp. 167-191. Springer, New York, NY.

[61] Hahn, Youjin, and Hee-Seung Yang, 2016. "Do Work Decisions Among Young Adults Respond to Extended Dependent Coverage?" *Industrial and Labor Relations Review* 69 (3), 737-771.

[62] Harberger, Arnold C., 1995. "The ABCs of Corporate Tax Incidence: Insights into the Open-Economy Case." In *Tax Policy and Economic Growth*. ACCF Center for Policy Research, Washington, DC.

[63] Harberger, Arnold C., 2008. "Corporate Tax Incidence: Reflections on What is Known, Unknown, and Unknowable." In John W. Diamond, and George R. Zodrow (eds.), *Fundamental Tax Reform: Issues, Choices, and Implications*, pp. 283-307. MIT Press, Cambridge, MA.

[64] Hartman, David G., 1985. "Tax Policy and Foreign Direct Investment." *Journal of Public Economics* 26 (1), 107-121.

[65] Haufler, Andreas, and Guttorm Schjelderup, 2000. "Corporate Tax Systems and Cross Country Profit Shifting." *Oxford Economic Papers* 52 (2), 306-325.

[66] Heckemeyer, Jost H., and Michael Overesch, 2013. "Multinationals' Profit Response to Tax Differentials: Effect Size and Shifting Channels." Manuscript. University of Cologne, Cologne, Germany.

[67] HM Revenue and Customs (HMRC), 2014. "Tax Gap Estimates for 2012-23." *Measuring Tax Gaps 2014 edition*. London, UK.

[68] Hong, Qing, and Michael Smart, 2010. "In Praise of Tax Havens: International Tax Planning and Foreign Direct Investment." *European Economic Review* 54 (1), 82-95.

[69] Hou, Kewei, and David T. Robinson, 2006. "Industry Concentration and Average Stock Returns." *The Journal of Finance* 61 (4), 1927-1956.

[70] Hubbard, R. Glenn, and Kenneth L. Judd, 1986. "Liquidity Constraints, Fiscal Policy, and Consumption." *Brookings Papers on Economic Activity* 17 (1), 1-60.

[71] Huizinga, Harry, and Gaëten Nicodéme, 2006. "Foreign Ownership and Corporate Income Taxation: An Empirical Evaluation." *European Economic Review* 50 (5), 1223-1244.

[72] Huizinga, Harry, and Søren Bo Nielsen, 1997. "Capital Income and Profit Taxation with Foreign Ownership of Firms." *Journal of International Economics* 42 (1-2), 149-165.

[73] Internal Revenue Service, 1992-2011. Statistics of Income Division, Table 2.3, http://www.irs.gov/uac/SOI-Tax-Stats—Individual-Statistical-Tables-by-Size-of-Adjusted-Gross-Income.

[74] International Monetary Fund, 2012. "Fiscal Regimes for Extractive Industries: Design and Implementation." https://www.imf.org/external/np/pp/eng/2012/081512.pdf.

[75] Jacobs, Bas, 2009. "Is Prescott Right? Welfare State Policies and the Incentives to Work, Learn, and Retire." *International Tax and Public Finance* 16 (2), 253-280.

[76] Judd, Kenneth L., 1985. "Redistributive Taxation in a Simple Perfect Foresight Model." *Journal of Public Economics* 28 (1), 59-83.

[77] Kaplan, Greg, 2012. "Moving Back Home: Insurance against Labor Market Risk." *Journal of Political Economy* 120 (3), 446-512.

[78] Kaplow, Louis, 2008. *The Theory of Taxation and Public Economics.* Princeton University Press: Princeton, New Jersey.

[79] Karabarbounis, Loukas, and Brent Neiman, 2014. "The Global Decline of the Labor Share." *Quarterly Journal of Economics* 129 (1), 61-103.

[80] LaLumia, Sara, 2009. "The Earned Income Tax Credit and Reported Self-Employment Income." *National Tax Journal* 62 (2), 191-217.

[81] Lejour, Arjan M., and Harrie A. A. Verbon, 1998. "Source-based versus Residence-based Capital Income Taxes in a Dynamic Model." *European Journal of Political Economy* 14 (3), 529-541.

[82] Manacorda, Marco, and Enrico Moretti, 2006. "Why Do Most Italian Youths Live with their Parents? Intergenerational Transfers and Household Structure." *Journal of the European Economic Association* 4 (4), 800-829.

[83] Martins, Nuno, and Ernesto Villanueva, 2009. "Does the High Cost of Mortgage Debt Explain Why Young Adults Live with their Parents?" *Journal of the European Economic Association* 7 (5), 974-1010.

[84] McClelland, Robert, and Shannon Mok, 2012. "A Review of Recent Research on Labor Supply Elasticities." Working Paper 2012-12. Congressional Budget Office, Washington, DC.

[85] McElroy, Marjorie B., 1985. "The Joint Determination of Household Membership and Market Work: The Case of Young Men." *Journal of Labor Economics* 3 (3), 293-316.

[86] McKeehan, Margaret K., and George R. Zodrow, 2017. "Balancing Act: Weighing the Factors Affecting the Taxation of Capital Income in a Small Open Economy." *International Tax and Public Finance* 24 (1), 1-35.

[87] Meyer, Bruce D., and Dan T. Rosenbaum, 2001. "Welfare, the Earned Income Tax Credit, and the Labor Supply of Single Mothers." *Quarterly Journal of Economics* 116 (3), 1063-1114.

[88] Mintz, Jack, 1995. "The Corporation Tax: A Survey." *Fiscal Studies* 16 (4), 23-68.

[89] Naito, Hisahiro, 1999. "Re-examination of Uniform Commodity Taxes Under a Non-linear Income Tax System and its Implications for Production Efficiency."

Journal of Public Economics 71 (2), 165-188.

[90] Nicodéme, Gaëten, 2008. “Corporate Income Tax and Economic Distortions.” CESifo Working Paper No. 2477. CESifo, Munich, Germany.

[91] Organisation for Economic Co-operation and Development, 2012. OECD.Stat, (database). SDBS Business Demography Indicators. Accessed Sep 10, 2015.

[92] Organisation for Economic Co-operation and Development, 2013. “Addressing Base Erosion and Profit Shifting.” OECD, Paris, France.

[93] PricewaterhouseCoopers, 2011. “Global Effective Tax Rates.” `http://businessroundtable.org/sites/default/files/Effective_Tax_Rate_Study.pdf`.

[94] Razin, Assaf, and Efraim Sadka, 1991. “International Tax Competition and Gains from Tax Harmonization.” *Economic Letters* 37 (1), 69-76.

[95] Riedel, Nadine, 2014. “Quantifying International Tax Avoidance: A Review of the Academic Literature.” ETPF Policy Paper 2.

[96] Rosenzweig, Mark R., and Kenneth I. Wolpin, 1993. “Intergenerational Support and the Life-Cycle Income of Young Men and Their Parents: Human Capital Investments, Coresidence, and Intergenerational Transfers.” *Journal of Labor Economics* 11 (1), 84-112.

[97] Rosenzweig, Mark R., and Kenneth I. Wolpin, 1994. “Parental and Public Transfers to Young Women and their Children.” *The American Economic Review* 84 (5), 1195-1212.

[98] Saez, Emmanuel, 2002. “The Desireability of Commodity Taxation Under Nonlinear Income Taxation and Heterogeneous Tastes.” *Journal of Public Economics* 83 (2), 217-230.

[99] Saez, Emmanuel, 2010. "Do Taxpayers Bunch at Kink Points?" *American Economic Journal: Economic Policy* 2 (3), 180-212.

[100] Seale Jr., James L., and Anita Regmi, 2006. "Modeling International Consumption Patterns." *Review of Income and Wealth* 52, 603-624.

[101] Senhadji, Abdelhak, 1998. "Time-series Estimation of Structural Import Demand Equations: A Cross-country Analysis." *IMF Staff Papers* 45 (2), 236-268.

[102] Sercu, Piet, and Rosanne Vanpée, 2007. "Home Bias in International Equity Portfolios: A Review." Working paper AFI 0710. Department of Accountancy, Finance, and Insurance, Katholieke Universiteit, Leuven, Belgium.

[103] Sinn, Hans-Werner, 1987. "Capital Income Taxation and Resource Allocation." Amsterdam: North Holland.

[104] Slemrod, Joel, 1997. "The Taxation of Foreign Direct Investment: Operational and Policy Perspectives." In James M. Poterba (ed.), *Borderline Case: International Tax Policy, Corporate Research and Development, and Investment*, pp. 11-38. National Academy Press, Washington, DC.

[105] Slemrod, Joel, and John D. Wilson, 2009. "Tax Competition with Parasitic Tax Havens." *Journal of Public Economics* 93, 1261-1270.

[106] Stella, Luca, forthcoming. "Living Arrangements in Europe: Whether and Why Paternal Retirement Matters." *Review of Economics of the Household.*

[107] Toder, Eric, and Alan D. Viard, forthcoming. "Replacing Corporate Tax Revenues with a Mark-to-Market Tax on Shareholder Income." *National Tax Journal.*

[108] U.S. Bureau of Labor Statistics, 1988–2000. *Regional and State Employment and Unemployment.*

[109] United States General Accounting Office, 1993. "Earned Income Tax Credit: Design and Administration Could Be Improved." Report No. GAO/GGD-93-145. Washington, DC.

[110] Weinzierl, Matthew, 2011. "The Surprising Power of Age-Dependent Taxes." *Review of Economic Studies* 78 (4), 1490-1518.

[111] Wheelock, Jane, and Katharine Jones, 2002."'Grandparents Are the Next Best Thing': Informal Childcare for Working Parents in Urban Britain." *Journal of Social Policy* 31 (3), 441-463.

[112] Wilson, John D., 1986. "A Theory of Interregional Tax Competition." *Journal of Urban Economics* 19 (3), 296-315.

[113] Wilson, John D., 1995. "Mobile Labor, Multiple Tax Instruments, and Tax Competition." *Journal of Urban Economics* 38, 333-356.

[114] Zodrow, George R., 2007. "Should Capital Income be Subject to Consumption-Based Taxation?" In Henry J. Aaron, Leonard E. Burman, abd C. Eugene Steuerle (eds.), *Taxing Capital Income*, pp. 49-81. Urban Institute Press, Washington, DC.

[115] Zodrow, George R., 2010a. "Capital Mobility and Capital Tax Competition." *National Tax Journal* 63 (4), 865-902.

[116] Zodrow, George R., 2010b. "International Taxation and Company Tax Policy in Small Open Economies." In Iris Claus, Norman Gemmell, Michelle Harding, and David White (eds.), *Tax Reform in Open Economies: International and Country Perspectives*, pp. 109-134. Edward Elgar, Cheltenham, UK.

[117] Zodrow, George R., and Peter Mieszkowski, 1983. "The Incidence of the Property Tax: The Benefit View versus the New View." In Zodrow, George R. (ed) *Local Provision of Public Services: The Tiebout Model after Twenty-Five Years* (pp. 109-129). Academic Press: New York, NY.

[118] Zodrow, George R., and Peter Mieszkowski, 1986. "Pigou, Tiebout, Property Taxation, and the Under-Provision of Local Public Goods." *Journal of Urban Economics* 19 (3), 356-370.

Appendix A

Appendix

A.1 Chapter 1 Appendices

A.1.1 Consumption and Leisure Responses to Taxation

Applying the Slutsky decomposition for consumption and leisure, the individual's response to either tax can be characterized with

$$\begin{aligned}\frac{1}{c_t^1}\frac{\partial c_t^1}{\partial \tau} &= \left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau}\right)\left(\epsilon_{c_t^1,w_t}+\psi_{h_t^1}\eta_{c_t^1}\right)+\left(\frac{1}{p_t}\frac{\partial p_t}{\partial \tau}\right)\left(\epsilon_{c_t^1,p_t}-\psi_{c_t^1}\eta_{c_t^1}\right) \\ &+ \left(\frac{1}{w_{t+1}^D}\frac{\partial w_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{c_t^1,w_{t+1}^D}+\psi_{h_{t+1}^2}\eta_{c_t^1}\right)+\left(\frac{1}{p_{t+1}^D}\frac{\partial p_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{c_t^1,p_{t+1}^D}-\psi_{c_{t+1}^2}\eta_{c_t^1}\right)\end{aligned} \tag{A.1}$$

$$\begin{aligned}\frac{1}{c_{t+1}^2}\frac{\partial c_{t+1}^2}{\partial \tau} &= \left(\frac{1}{w_{t+1}^D}\frac{\partial w_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{c_{t+1}^2,w_{t+1}^D}+\psi_{h_{t+1}^2}\eta_{c_{t+1}^2}\right) \\ &+ \left(\frac{1}{p_{t+1}^D}\frac{\partial p_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{c_{t+1}^2,p_{t+1}^D}-\psi_{c_{t+1}^2}\eta_{c_{t+1}^2}\right) \\ &+ \left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau}\right)\left(\epsilon_{c_{t+1}^2,w_t}+\psi_{h_t^1}\eta_{c_{t+1}^2}\right)+\left(\frac{1}{p_t}\frac{\partial p_t}{\partial \tau}\right)\left(\epsilon_{c_{t+1}^2,p_t}-\psi_{c_t^1}\eta_{c_{t+1}^2}\right)\end{aligned} \tag{A.2}$$

$$\begin{aligned}\frac{1}{l_t^1}\frac{\partial l_t^1}{\partial \tau} &= \left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau}\right)\left(\epsilon_{l_t^1,w_t}+\psi_{h_t^1}\eta_{l_t^1}\right)+\left(\frac{1}{p_t}\frac{\partial p_t}{\partial \tau}\right)\left(\epsilon_{l_t^1,p_t}-\psi_{c_t^1}\eta_{l_t^1}\right) \\ &+ \left(\frac{1}{w_{t+1}^D}\frac{\partial w_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{l_t^1,w_{t+1}^D}+\psi_{h_{t+1}^2}\eta_{l_t^1}\right)+\left(\frac{1}{p_{t+1}^D}\frac{\partial p_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{l_t^1,p_{t+1}^D}-\psi_{c_{t+1}^2}\eta_{l_t^1}\right)\end{aligned} \tag{A.3}$$

$$\begin{aligned}\frac{1}{l_{t+1}^2}\frac{\partial l_{t+1}^2}{\partial \tau} &= \left(\frac{1}{w_{t+1}^D}\frac{\partial w_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{l_{t+1}^2,w_{t+1}^D}+\psi_{h_{t+1}^2}\eta_{l_{t+1}^2}\right) \\ &+ \left(\frac{1}{p_{t+1}^D}\frac{\partial p_{t+1}^D}{\partial \tau}\right)\left(\epsilon_{l_{t+1}^2,p_{t+1}^D}-\psi_{c_{t+1}^2}\eta_{l_{t+1}^2}\right) \\ &+ \left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau}\right)\left(\epsilon_{l_{t+1}^2,w_t}+\psi_{h_t^1}\eta_{l_{t+1}^2}\right)+\left(\frac{1}{p_t}\frac{\partial p_t}{\partial \tau}\right)\left(\epsilon_{l_{t+1}^2,p_t}-\psi_{c_t^1}\eta_{l_{t+1}^2}\right),\end{aligned} \tag{A.4}$$

where $\epsilon_{c_t^i,P}$ is the compensated elasticity of demand for c_t^i with respect to price P, $\epsilon_{l_t^i,P}$ is compensated elasticity of demand for l_t^i with respect to price P, $\psi_{c_t^i}$ is the individual's expenditure share on c_t^i as a fraction of potential income $w_t T^1 + w_{t+1}^D T^2$, $\psi_{h_t^i}$ is the individual's income from h_t^i as a fraction of potential income, $\eta_{c_t^i}$ is the income elasticity of c_t^i, and $\eta_{l_t^i}$ is the income elasticity of l_t^i.

A.1.2 Residence-based Taxation and the Inter-temporal Elasticity of Substitution

The savings response to residence-based taxation can generally be written as

$$\frac{1}{b_t}\frac{\partial b_t}{\partial \tau_I} = \frac{w_t l_t^1}{b_t}\left(\frac{1}{w_t}\frac{\partial w_t}{\partial \tau_I} - \frac{1}{l_t^1}\frac{\partial l_t^1}{\partial \tau_I}\right) - \frac{p_t c_t^1}{b_t}\left(\frac{1}{c_t^1}\frac{\partial c_t^1}{\partial \tau_I} + \frac{1}{p_t}\frac{\partial p_t}{\partial \tau_I}\right). \tag{A.5}$$

Accounting for price responses (2.29), (2.30), (2.40), and (2.44) as well as the individual responses in (A.1) and (A.3), this suggests the savings response in the small open economy is

$$\begin{aligned}\frac{1}{b_t}\frac{\partial b_t}{\partial \tau_I} = & -\frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{1+\rho_{t+1}^N}\left(\frac{w_t l_t^1}{b_t}\right)\left(\epsilon_{l_t^1, w_{t+1}^D} + \epsilon_{l_t^1, p_{t+1}^D} - \psi_{b_t}\eta_{l_t^1}\right) \\ & -\frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{1+\rho_{t+1}^N}\left(\frac{p_t c_t^1}{b_t}\right)\left(\epsilon_{c_t^1, w_{t+1}^D} + \epsilon_{c_t^1, p_{t+1}^D} - \psi_{b_t}\eta_{c_t^1}\right),\end{aligned} \tag{A.6}$$

where ψ_{b_t} is the ratio of savings to the individual's total potential income, $w_t T^1 + w_{t+1}^D T^2$. In this expression $\epsilon_{c_t^1, p_{t+1}^D}$ captures the inter-temporal elasticity of substitution, which is inversely related to the elasticity of savings with respect to the residence-based tax rate.

Alternatively, applying the partially open economy price responses (2.57) and

(2.60), the savings response to the residence-based tax is

$$\begin{aligned}\frac{1}{b_t}\frac{\partial b_t}{\partial \tau_I} &= -\chi_{r_t^d}\left(\frac{\theta_{K_t}}{\theta_{L_t}}\right)\frac{w_t l_t^1}{b_t} + \chi_{r_t^d}\left(\frac{\theta_{K_t}}{\theta_{L_t}}\right)\frac{w_t l_t^1}{b_t}\left(\epsilon_{l_t^1,w_t} + \epsilon_{l_t^1,w_{t+1}^D} + \psi_h \eta_{l_t^1}\right) \\ &+ \frac{w_t l_t^1}{b_t}\frac{\rho_{t+1}^N}{1+\rho_{t+1}^N}\left[\left(\frac{r_{t+1}^d b_t^d}{\rho_{t+1} b_t}\right)\chi_{r_{t+1}^d} - \frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{\rho_{t+1}^N}\right]\left(\epsilon_{l_t^1,p_{t+1}^D} + \epsilon_{l_t^1,w_{t+1}^D} - \psi_{b_t}\eta_{l_t^1}\right) \\ &+ \chi_{r_t^d}\left(\frac{\theta_{K_t}}{\theta_{L_t}}\right)\left(\frac{p_t c_t^1}{b_t}\right)\left(\epsilon_{c_t^1,w_t} + \epsilon_{c_t^1,w_{t+1}^D} + \psi_h \eta_{c_t^1}\right) \\ &+ \frac{p_t c_t^1}{b_t}\frac{\rho_{t+1}^N}{1+\rho_{t+1}^N}\left[\left(\frac{r_{t+1}^d b_t^d}{\rho_{t+1} b_t}\right)\chi_{r_{t+1}^d} - \frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{\rho_{t+1}^N}\right]\left(\epsilon_{c_t^1,p_{t+1}^D} + \epsilon_{c_t^1,w_{t+1}^D} + \psi_{b_t}\eta_{c_t^1}\right),\end{aligned} \tag{A.7}$$

where ψ_h is the ratio of labor income to total potential income and $\chi_{r_t^d}$ is an abbreviation for $\left(\frac{1}{r_t^d}\frac{\partial r_t^d}{\partial \tau_I}\right)$.

A.1.3 Residence-based Taxation and Consumption-Leisure Complementarity

Using second-period leisure and consumption responses, the savings response to residence-based taxation is

$$\begin{aligned}\frac{1}{b_t}\frac{\partial b_t}{\partial \tau_I} = \frac{p_{t+1}^D c_{t+1}^2}{b_t}&\left(\frac{1}{c_{t+1}^2}\frac{\partial c_{t+1}^2}{\partial \tau_I} + \frac{1}{p_{t+1}^D}\frac{\partial p_{t+1}^D}{\partial \tau_I}\right) \\ + \frac{w_{t+1}^D l_{t+1}^2}{b_t}&\left(\frac{1}{l_{t+1}^2}\frac{\partial l_{t+1}^2}{\partial \tau_I} - \frac{1}{w_{t+1}^D}\frac{\partial w_{t+1}^D}{\partial \tau_I}\right).\end{aligned} \tag{A.8}$$

Applying the small open economy price responses derived in Section 2.3 as well as Euler's homogeneous function theorem to the individual responses in (A.2) and (A.4), the savings response becomes

$$\begin{aligned}\frac{1}{b_t}\frac{\partial b_t}{\partial \tau_I} &= \frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{1+\rho_{t+1}^N}\left(\frac{p_{t+1}^D c_{t+1}^2}{b_t}\right)\left(2\epsilon_{c_{t+1}^2,w_{t+1}^D} + \epsilon_{c_{t+1}^2,p_{t+1}^D} - \psi_{b_t}\eta_{c_{t+1}^2}\right) \\ &+ \frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{1+\rho_{t+1}^N}\left(\frac{w_{t+1}^D l_{t+1}^2}{b_t}\right)\left(\epsilon_{l_{t+1}^2,w_{t+1}^D} - \psi_{b_t}\eta_{l_{t+1}^2}\right) + \frac{\rho_{t+1}\left(1-\phi_{t+1}^I\right)}{1+\rho_{t+1}^N}.\end{aligned} \tag{A.9}$$

In this expression $\epsilon_{c^2_{t+1},w^D_{t+1}}$ captures the complementarity of second-period consumption and leisure, which is clearly directly related to the elasticity of savings with respect to the residence-based tax rate.

Similarly, in the partially open economy the savings response is given by

$$\begin{aligned}\frac{1}{b_t}\frac{\partial b_t}{\partial \tau_I} &= -\frac{w^D_{t+1}l^2_{t+1}}{b_t}\frac{\theta_{K_t}}{\theta_{L_t}}\left(\epsilon_{l^2_{t+1},w_t}+\epsilon_{l^2_{t+1},w^D_{t+1}}+\psi_h\eta_{l^2_{t+1}}-1\right)\chi_{r^d_t} \qquad \text{(A.10)}\\ &- \frac{w^D_{t+1}l^2_{t+1}}{b_t}\frac{\rho^N_{t+1}}{1+\rho^N_{t+1}}\left[\left(\frac{r^d_{t+1}b^d_t}{\rho_{t+1}b_t}\right)\chi_{r^d_{t+1}}-\frac{\rho_{t+1}\left(1-\phi^I_{t+1}\right)}{\rho^N_{t+1}}\right]\left(\epsilon_{l^2_{t+1},w^D_{t+1}}+\psi_{b_t}\eta_{l^2_{t+1}}-1\right)\\ &- \frac{p^D_{t+1}c^2_{t+1}}{b_t}\frac{\theta_{K_t}}{\theta_{L_t}}\left(\epsilon_{c^2_{t+1},w_t}+\epsilon_{c^2_{t+1},w^D_{t+1}}+\psi_h\eta_{c^2_{t+1}}\right)\chi_{r^d_t}\\ &- \frac{p^D_{t+1}c^2_{t+1}}{b_t}\frac{\rho^N_{t+1}}{1+\rho^N_{t+1}}\left[\left(\frac{r^d_{t+1}b^d_t}{\rho_{t+1}b_t}\right)\chi_{r^d_{t+1}}-\frac{\rho_{t+1}\left(1-\phi^I_{t+1}\right)}{\rho^N_{t+1}}\right]\left(\epsilon_{c^2_{t+1},p^D_{t+1}}+2\epsilon_{c^2_{t+1},w^D_{t+1}}\right)\\ &+ \frac{p^D_{t+1}c^2_{t+1}}{b_t}\frac{\rho^N_{t+1}}{1+\rho^N_{t+1}}\left[\left(\frac{r^d_{t+1}b^d_t}{\rho_{t+1}b_t}\right)\chi_{r^d_{t+1}}-\frac{\rho_{t+1}\left(1-\phi^I_{t+1}\right)}{\rho^N_{t+1}}\right]\left(\psi_{b_t}\eta_{c^2_{t+1}}+1\right),\end{aligned}$$

which, like (A.7), uses the definition $\chi_{r^d_t}=\left(\frac{1}{r^d_t}\frac{\partial r^d_t}{\partial \tau_I}\right)$.

A.1.4 Deriving the Domestic Cost of Capital Responses to Each Tax in the Partially Open Economy

For the purposes of notational simplicity, the response of the cost of capital derivations are all presented in steady state values. In the steady state, the response of domestic capital investment to capital income taxation can be characterized by

$$\begin{aligned}\frac{1}{K}\frac{\partial K}{\partial \tau} &= -\sigma\theta_K\left(\frac{1}{w}\frac{\partial w}{\partial \tau}\right)-L_w\left(\frac{1}{w}\frac{\partial w}{\partial \tau}\right) \qquad \text{(A.11)}\\ &- L_{w^D}\left(\frac{1}{w^D}\frac{\partial w^D}{\partial \tau}\right)-L_{p^D}\left(\frac{1}{p^D}\frac{\partial p^D}{\partial \tau}\right), \quad \tau=\tau_I,\tau_F,\end{aligned}$$

where

$$L_{P_x}=\frac{l^1}{L}\xi_{l^1,P_x}+\frac{l^2}{L}\xi_{l^2,P_x}, \quad P_x=w,w^D,p^D \qquad \text{(A.12)}$$

and ξ_{l^i,P_x} is the uncompensated price elasticity of l^i with respect to price P_x. Similarly, the response of domestic saving is given by

$$\begin{aligned}\frac{1}{b}\frac{\partial b}{\partial \tau} &= \left(\frac{wl^1}{b} + b_w\right)\left(\frac{1}{w}\frac{\partial w}{\partial \tau}\right) \\ &+ b_{w^D}\left(\frac{1}{w^D}\frac{\partial w^D}{\partial \tau}\right) + b_{p^D}\left(\frac{1}{p^D}\frac{\partial p^D}{\partial \tau}\right), \quad \tau = \tau_I, \tau_F,\end{aligned} \tag{A.13}$$

where

$$b_{P_x} = \frac{wl^1}{b}\xi_{l^1,P_x} + \frac{pc^1}{b}\xi_{c^1,P_x}, \quad P_x = w, w^D, p^D \tag{A.14}$$

and ξ_{c^1,P_x} is the uncompensated price elasticity of c^1 with respect to P_x. Combining these responses with the capital market-clearing condition for the partially open economy (2.54) and the price responses outlined in Section 2.4, the steady-state domestic capital response functions are

$$\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} = \frac{\left[\frac{r^d\left(1-\phi^F\right)}{r^N}\right]\Omega_1}{\frac{b^d}{qK}\left(\frac{r^d}{z^{B''}\phi^B}\right) - \Omega_1 - \Omega_2} \tag{A.15}$$

and

$$\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I} = \frac{-\left[\frac{\rho\left(1-\phi^I\right)}{\rho^N}\right]\Omega_2}{\frac{b^d}{qK}\left(\frac{r^d}{z^{B''}\phi^B}\right) - \Omega_1 - \Omega_2}, \tag{A.16}$$

where

$$\Omega_1 = \left[\frac{b^d}{pK}\left(\frac{wl^1}{b} + b_w\right) + L_w + b_{w^D}\left(\frac{b^d}{pK}\right) + L_{w^D} - \sigma\theta_K\right]\frac{\theta_K}{\theta_L} \tag{A.17}$$

and

$$\Omega_2 = \frac{\rho^N}{1+\rho^N}\left[b_{p^D}\left(\frac{b^d}{pK}\right) + L_{p^D} + b_{w^D}\left(\frac{b^d}{pK}\right) + L_{w^D}\right]\left(\frac{r^d b^d}{\rho b}\right). \tag{A.18}$$

The expressions (A.15) and (A.16) show that $z^{B''}$ and the magnitude of the marginal effect on the domestic cost of capital are correlated. As the economy becomes increasingly open (reflected by a decrease in $z^{B''}$), both $\left|\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}\right|$ and $\left|\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right|$ decrease.

In combination (A.15) and (A.16) imply the relationship between the two responses can be written as

$$\begin{aligned}
\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} &= \left[\frac{r^d\left(1-\phi^F\right)}{r^N}\frac{\rho^N}{\rho\left(1-\phi_t^I\right)}\right]\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) \\
&\times \left\{\frac{r^d b^d}{\rho b} - \frac{\frac{b^d}{pK}\frac{r^d}{z^{B''}\phi^B}}{\left[\left(b_{p^D}+b_{w^D}\right)\left(\frac{b^d}{pK}\right)+L_{p^D}+L_{w^D}\right]\frac{\rho^N}{1+\rho^N}}\right\} \\
&- \frac{r^d\left(1-\phi^F\right)}{r^N}.
\end{aligned} \tag{A.19}$$

As the economy becomes more closed, $\rho \to r^d$, $b^d \to b$, and $z^{B''} \to \infty$. Consequently, in an increasingly closed economy $\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}$ and $\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}$ become increasingly similar. The relationship (A.19) also reveals that income sheltering decreases the relative domestic return distortion associated with the corresponding tax. For example, if firms practice a higher level of income sheltering and ϕ^F increases, $\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F}$ falls relative to $\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}$.

A closed economy is characterized by an infinite international shifting cost, $z^{B''} \to \infty$, and all savings being domestically invested, $b^d = b$ and $r^d = \rho$. Under these conditions, the relationship between the two responses simplifies to

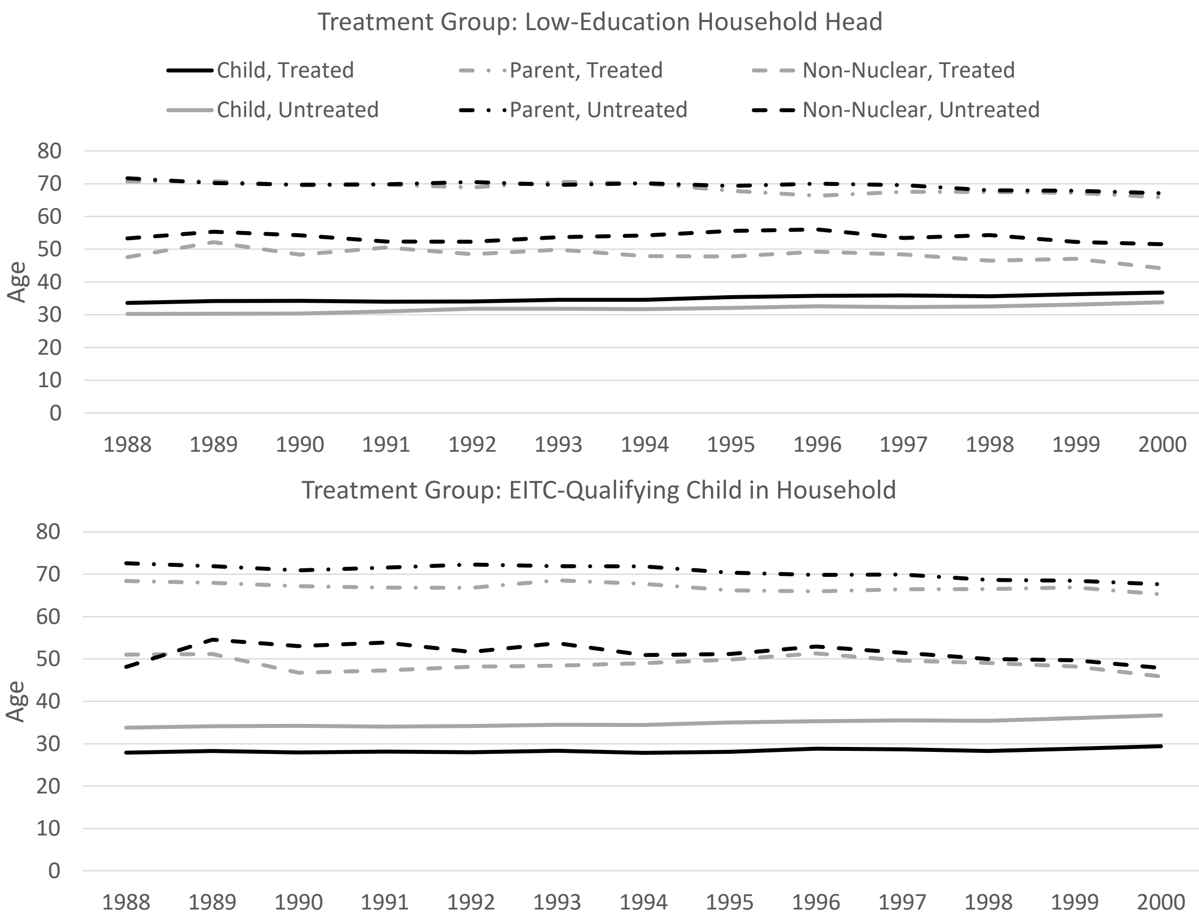
$$\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_F} = \left[\frac{\rho^N\left(1-\phi^F\right)}{r^N\left(1-\phi^I\right)}\right]\left(\frac{1}{r^d}\frac{\partial r^d}{\partial \tau_I}\right) - \frac{r^d\left(1-\phi^F\right)}{r^N}. \tag{A.20}$$

Effectively, the two responses are just scaled by the relative size of their tax bases.

A.2 Chapter 3 Appendices

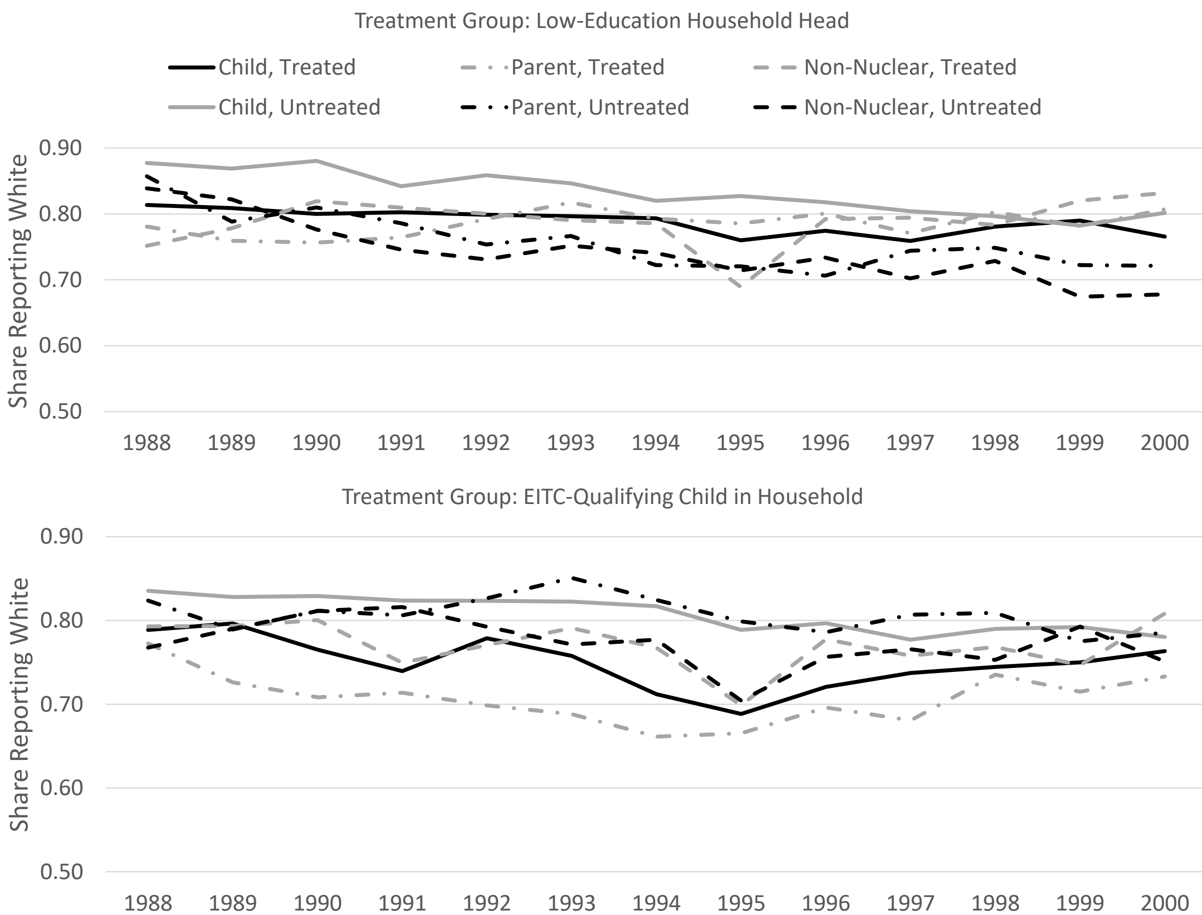
A.2.1 Demographic Trends

Figure A1 : Dependent Ages Over Time



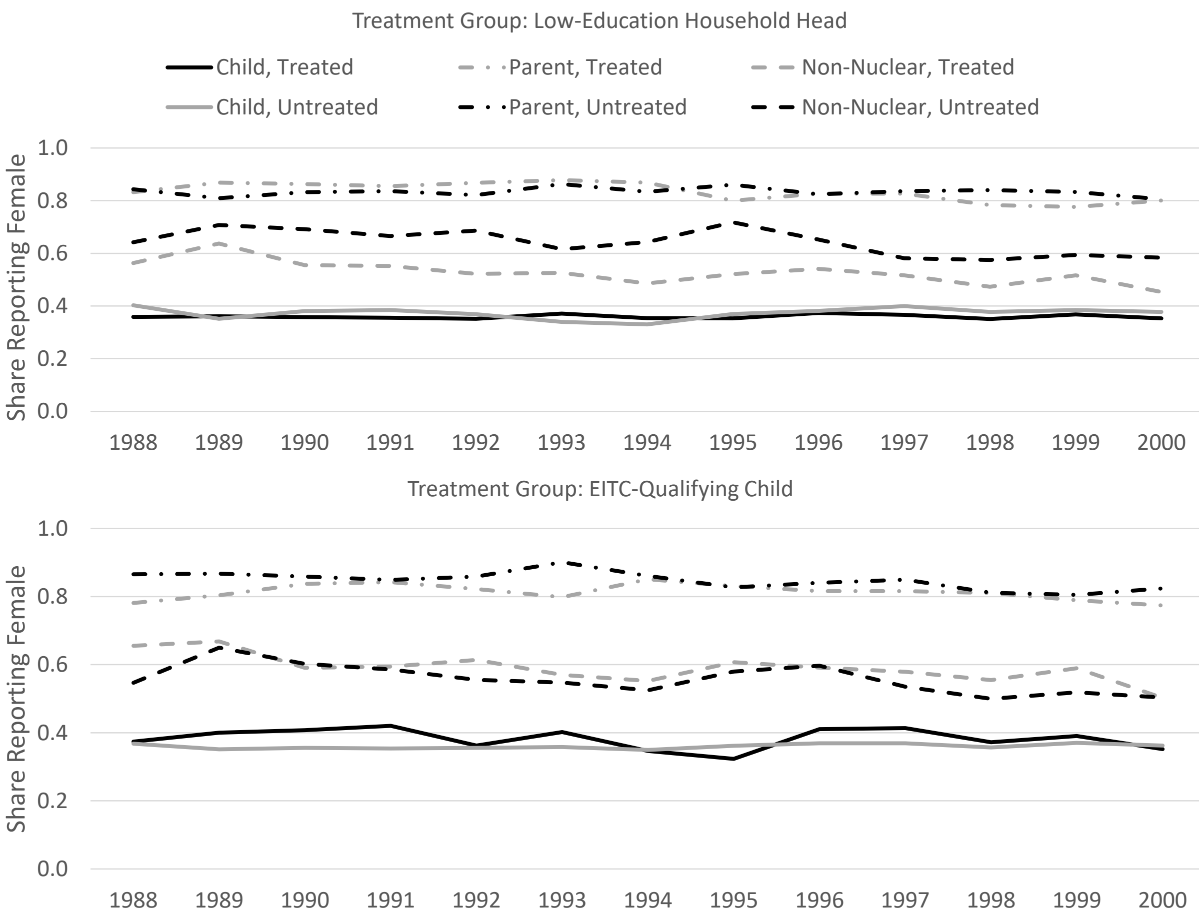
Samples are taken from the ASEC CPS using the methodology described in Section 4.3. In the upper chart, the treated group includes individuals in families where the head's education does not exceed a high school degree, and the untreated group includes individuals in families where the head had some post-secondary education, not exceeding a bachelor's degree. In the lower chart, the treated group includes individuals in families with EITC-qualifying children, and the untreated group includes individuals in families without EITC-qualifying children.

Figure A2 : Share of Dependents by Race Over Time



Samples are taken from the ASEC CPS using the methodology described in Section 4.3. In the upper chart, the treated group includes individuals in families where the head's education does not exceed a high school degree, and the untreated group includes individuals in families where the head had some post-secondary education, not exceeding a bachelor's degree. In the lower chart, the treated group includes individuals in families with EITC-qualifying children, and the untreated group includes individuals in families without EITC-qualifying children.

Figure A3 : Share of Dependents by Gender Over Time



Samples are taken from the ASEC CPS using the methodology described in Section 4.3. In the upper chart, the treated group includes individuals in families where the head's education does not exceed a high school degree, and the untreated group includes individuals in families where the head had some post-secondary education, not exceeding a bachelor's degree. In the lower chart, the treated group includes individuals in families with EITC-qualifying children, and the untreated group includes individuals in families without EITC-qualifying children.