MACROECONOMIC EFFECTS OF CONSUMPTION VERSUS INCOME TAXES

A Senior Honors Thesis

Presented to

the Faculty of the Department of Economics

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

Economics

By

Jackson Crawford

December, 2018

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ABSTRACT

This paper adds to the empirical literature on the effects of tax structure on investment with a panel data analysis of up to 120 countries from 1980 to 2015. Specifically, this paper uses the relative percentage between individual income tax receipts and goods and services tax receipts as the primary explanatory variable of interest. The results, which are robust across different dynamic models, suggest that most countries are too close to the lower bound of this relative percentage to be able to spur meaningful increases in investment by shifting taxation from income to consumption. However, outlier countries heavily dependent on income taxation, like the United States, may be able to achieve as much as a 10% increase in investment by making this shift.

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1 Background

Economists often seek out and champion policies that defy zero-sum thinking - policies that make some people better off while making no person worse off. But, of course, this is not always possible. And so just as often, economists find themselves discussing trade-offs - when improvement in one area actually requires harm in another. Likely the most famous trade-off in the field of economics is the one between efficiency and equality [Okun and Summers, 2015]. Very often, the policies that can spur economic growth and improvements in standard of living appear to be the same policies that exacerbate inequality, both in wealth and income.

One specific policy dichotomy that highlights this exact trade-off is the contrast between consumption taxes versus income taxes. A consumption tax, heavily overlapping with the concept of an "indirect tax," is a tax that is in some way related to resources being utilitized, like goods and services. Examples of consumption taxes include sales taxes, value-added taxes, excise taxes, and tariffs. Income taxes, on the other hand, are "direct taxes" that are levied on what is produced, rather than consumed, by a given person or entity. Income taxes can include personal income taxes on wages, as well as capital gains taxes or corporate income taxes. As a broad generalization, consumption taxes are typically assumed to be better for efficiency, while income taxes are assumed to be better for equality. But these assumptions have not been without debate and dispute, as we can highlight by looking as the literature.

1.1 Theoretical Work

The theoretical arguments in favor of the efficiency of consumption taxes is significantly older than the counterarguments. Such arguments were made as early as 1651 by Thomas Hobbes - though it was perhaps John Stuart Mill in the mid-1800s who articulated the modern intuition for this argument [Milesi-Ferretti and Roubini, 1998]. While a basic income tax, in effect, taxes all of what will become either spending or savings, a consumption tax excludes savings from taxation, at least temporarily. While this is true in the short-term, a more long-term way to think about this argument is that income taxes have the potential to tax savings twice - once when it is earned, and again when such savings generate capital gains.

Another argument is more recent, and presented in the seminal paper that spawned the "Atkinson-Stiglitz theorem," which tells us that where the utility function is separable between labor and all commodities, there is no need to to employ indirect taxes [Atkinson and Stiglitz, 1976]. This theorem has been revisited numerous times since its publication. Notably, Emmanuel Saez investigated this robustness of this theorem when one of its assumptions - the common assumption in many economic models of "homogeneous tastes" - is challenged. He found that with consideration for heterogeneous tastes, commodity taxation can be a key tool to allow governments to expand taxation power beyond what might be possible with income taxes, and that in some of these situations, "the desirability of commodity taxation hinges ... on whether individual demand for [a given] good is less elastic than the cross-sectional demand pattern" [Saez, 2002]. Interestingly, this theory is vaguely reminiscient of the

taxation situation in the United States, in which states sometimes use sales taxes to gain additional revenue on top of what the federal government gains primarily through income taxes.

In a more recent publication, Peter Diamond and Emmanuel Saez make broader criticisms of the practicality of the Atkinson-Stiglitz model [Diamond and Saez, 2011]. In particular, they point out that when we add different workers to our model, it is optimal to tax savings of high earners while subsidizing the saving behavior of low earners.

The reason why theoretical papers primarily focusing on the implications of various models on capital income are relevant at all is because of how different kinds of taxes treat capital versus labor income. If theory dictates that it is preferable to tax labor income over capital income, then consumption taxes are favorable because of the intuition mentioned before - that they do not "doubly tax" savings in the way that traditional income taxes can be seen to do.

It is for this reason that the famous "Chamley-Judd" result stating that the optimal capital income tax rate is asymptotically zero is relevant to this question [Judd, 1985] [Chamley, 1986]. This result, also known as the "zero capital income tax result" or by similar phrases, continues to be likely the most prominent theoretical result driving current conventional wisdom in economics regarding tax structure. With that said, the result depends on a number of assumptions, and this result has been subsequently challenged on the basis of some of those assumptions. In order to show that the zero capital income tax result cannot be taken for granted, I will summarize some examples of post-Chamley-Judd theoretical results, supporting the claim from one

2001 literature review that "there is no consensus regarding the optimal tax on capital income" [Erosa and Gervais, 2001].

A 2003 paper considered the optimal taxation question in a model where agents' skills are unobservable and change stochastically over time [Golosov et al., 2003]. Under this model, the results suggest an increased degree of randomness in choosing future consumption, which creates distorted consumption paths and, in turn, a possibility for optimal nonzero capital taxation.

The nuances of a tax code can also, of course, make a difference. A 2007 paper showed that if those who purchase capital are allowed to deduct capital expenditures from taxable capital income, then a positive capital income tax rate may be optimal [Abel, 2007]. In this sense, the author argues, a revenue-collecting zero *effective* tax rate on capital may be optimal, though this is still different from the Chamley-Judd result.

A 2009 paper provides a useful review and categorization of the theoretical literature on capital taxation up to that point, as well as contributing some new theoretical work [Conesa et al., 2009]. The review segment of the paper highlights the two modelling choices that pose the biggest threat to the validity of the Chamley-Judd result. The first is that if households face especially restrictive borrowing constraints or are subject to "uninsurable idiosyncratic income risk," then optimal tax structure may include a positive capital income tax. The second is that life cycle models, in contrast with the infinite lives models associated with the Chamley-Judd result, generally find a nonzero optimal capital income tax rate, assuming that capital taxation is not levied precisely based on age. The Conesa paper itself seeks optimal taxation in a model

with overlapping generations, uninsurable idiosyncratic income shocks, and permanent productivity differences between households, and finds a significantly positive optimal capital income tax rate.

A 2014 paper made a more ambitious criticism of the Chamley-Judd result, arguing that even within the infinite lives general equilbrium model used to derive the result, the zero capital income tax result does not follow [Straub and Werning, 2014]. The paper shows that in Judd's 1985 model, optimal long-run capital income tax is positive and significant when the intertemporal elasticity of substitution is below one. It also shows that in the 1986 Chamley model, optimal long-run capital taxes are positive (in the case that select upper bounds on capital taxes "bind forever") or depend on being accompanied by zero private wealth in the long-run.

It is worth revisiting why the zero capital income tax result is such a vital part of the discussion regarding the optimality consumption versus income taxes. When economists use the phrase "income taxes" in literature, they are typically referring to a general income tax on both labor income and capital income. Because a consumption tax has no equivalent component taxing capital income, the Chamley-Judd result is very much at the core of this question.

1.2 Empirical Work

The empirical literature on the efficiency differences between consumption taxes and income taxes is more recent, based on availability of macroeconomic data, but nonetheless incredibly rich as well. I will highlight several instances of this empirical work that is especially relevant to the work I do in this paper. It should be noted

that in the cases of papers in which there are efficiency gains to consumption taxes, this could reflect not necessarily ignorance on the part of the government, but a "willingness to pay for equality" from said government.

In a 1999 paper by Richard Kneller, Michael Bleaney, and Norman Gemmell [Kneller et al., 1999] the authors define two categories of taxation - (1) "distortionary taxation" which includes income taxes (as well as property and payroll taxes) and (2) "non-distortionary taxation" which includes any domestic consumption taxes. In a study of 22 OECD countries from 1970 to 1995, they find that distortionary taxation reduces growth, while non-distortionary taxation does not.

Empirical work on tax structure in Africa is sparse, which is why it is worth noting a narrow example of such. A 2005 paper focusing on South Africa's tax structure over 42 years found some typical results - like that decreased tax burdens increased economic potential - but also some surprising results. For example, in South Africa, "decreased indirect taxation relative to direct taxation" was "strongly correlated with increased economic growth potential."

Another paper focusing on OECD countries, published in 2011 [Xing, 2011] and analyzing 17 countries over the period 1970 to 2004, found different results than Kneller et al. Their results did not display any robust ranking of different taxes in terms of their growth effects. Most notably, they did not find superior growth effects from taxes that focus on labor income over capital income, including when comparing personal versus corporate income taxes, and when comparing consumption and income taxes. Only shifts towards property taxes appeared to generate higher levels of income per capita in the long run.

Likely the most popular version of a consumption tax among economists is the value-added tax, or VAT, which is administratively unique in that it levies the tax on each stage of production. Some have investigated whether this particular consumption tax lives up to its praise. A 2010 paper [Keen and Lockwood, 2010] for example, used a dummy variable indicating the presence of a VAT in a particular country in a particular year to conduct a massive international empirical investigation as to whether the VAT is an effective revenue tool. Their estimates suggest that the VAT has proven to be an effective revenue-gathering policy instrument in developed countries, though notably this does not provide answers as to whether or not the VAT encourages investment.

A 2013 paper [Canavire-Bacarreza et al., 2013] which investigated this question in Latin America found that income taxes do not necessarily have the expected negative effects on economic growth. However, this is often because actual collection of income taxes is so minimal compared to what may be the nominal rates. This is an important consideration for any empirical work on this question that includes data on developing countries, as this thesis will. This investigation of Latin American countries also found that greater reliance on consumption taxes has had positive effects on growth for many of these countries. The authors warn, however, that this may have come at the expense of weaker poverty reduction.

Perhaps the most recent empirical paper of this type, a 2017 paper [Stoilova, 2017] investigated data from the European Union member countries for the recent period from 1996 to 2013. This paper found results that broadly contradict most assumptions about tax structure. The results imply that the EU's value-added taxes (a form of

consumption tax) actually have had a negative impact on the region's economies in comparison to personal income taxes in the EU. While some of the results in this paper raise questions (for example, the positive growth effects of import taxes) it is still worth including due to its recency.

The vast majority of empirical work on taxes has not investigated the implications of different tax structures. Much of the research has focused more broadly on the relationship between overall taxation levels and economic growth. The results have been mixed. As Stoilova explains, "on the one hand, higher taxes cause potentially higher distortions and impact negatively on economic growth, but on the other hand, higher taxes suppose higher levels of public expenditure, some of which may foster economic growth" [Stoilova, 2017]. Research on corporate income taxation, which generally finds it to be a harm to economic growth, is also even more common than comparative tax structure analysis, possibly because changes to corporate income taxes are more politically realistic, and thus pragmatically interesting, in many countries. An OECD analysis of existing literature on tax structure as of 2009 found what we generally see here from some of the highlighted studies - that income taxes tend to see worse growth effects compared to consumption taxes [Myles, 2009]. However, the author of that review warns that causality is not necessarily clearly established.

At least one example of experimental work on this specific question also exists in the form of a 2012 paper [Blumkin et al., 2012]. The authors constructed an experiment in which participants could work for pay (solving multiplication companies for "points") and then use that pay on food items. For every 15 seconds the participants chose not to solve problems, they also received a voucher for a drink to both create a substitution

element between labor and leisure and to amplify the leisure effect beyond simply the benefit of "relaxing" for 15 seconds. This experiment then allowed the authors to introduce simulated taxation to different participants. The authors found that subjects would "reduce their labor supply significantly more in response to an income tax than they do in response to an equivalent consumption tax."

This review of the literature highlights two areas of potential for new investigations in the existing empirical work - (1) a lack of use of broad international data thus far, particularly the inclusion of countries in Africa, and (2) the importance of work that includes recent data, given recent papers that seem to contradict our assumptions about the implications of tax structure.

2 Representative Agent Models

2.1 Representative Consumer

The purpose of this model is to analyze how three types of taxation - consumption taxes, labor income (or wage) taxes, and total income taxes - might affect the decisions of a representative consumer related to consumption, saving, labor, and leisure. These problems answer this question in the context of a two-period model with perfect foresight. The consumer takes prices (both interest rates and wages) as given, as well as tax rates. The consumer then chooses labor supply (which can be thought of as hours worked) and consumption level over the two periods. The introduction to the first problem, the representative consumer with no tax, describes this model in more specificity.

2.1.1 Two-Period Consumer with no Tax

Let there be a representative consumer choosing levels of consumption (c_1, c_2) and hours of work (h_1, h_2) in two periods (t_1, t_2). The consumer can save or borrow an amount, s, in period t_1. This amount, negative or positive, increases by a percentage determined by an interest rate, r, before t_2, at which point it either adds to or subtracts from the possible consumption in the second period. Hours of work are converted to potential consumption at a price of labor, w. The hours worked in either period cannot exceed a constant T limiting the amount of hours that can be used for labor or leisure $(T - h_1, T - h_2)$ in each period. The consumer also receives an endowment of wealth z in t_1 which is exogenous before the firm is introduced.

We assume that the consumer seeks to maximize utility as a function of some combination of total consumption (C) and leisure (L), subject to time preferences for the immediate period represented by the parameter β and preferences for leisure relative to consumption represented by the parameter α.

The representative consumer will choose (c_1, c_2, h_1, h_2) to maximize utility under the function:

$$U(C, L) = log(c_1) + \alpha log(T - h_1) + \beta log(c_2) + \alpha\beta log(T - h_2)$$

This maximization is subject to constraints in line with the description above. That is:

$$c_1 + s = h_1 w_1 + z$$

$$c_2 = h_2 w_2 + s(1+r)$$

$$h_{1,2} \leq T$$

The first two constraints in particular can be rewritten as a single equation:

$$c_1 + \frac{c_2}{1+r} = z + h_1 w_1 + \frac{h_2 w_2}{1+r}$$

Then our first order conditions are:

$$0 = \frac{1}{c_1} - \lambda(1+r)$$

$$0 = \frac{\beta}{c_2} - \lambda$$

$$0 = -\frac{\alpha}{T - h_1} + \lambda w_1 (1+r)$$

$$0 = -\frac{\alpha\beta}{T - h_2} + \lambda w_2$$

Using these, we find two significant equations. Our first equation, representing the consume/save decision is:

$$\frac{c_2}{c_1} = \beta(1+r)$$

We can see from this equation that as the interest rate increases, the consumer will increase c_2 relative to c_1 - that is, the consumer will prioritize future consumption. This, in turn, applies to both borrowing and saving. As the interest rate increases, the consumer will be more likely to save and less likely to borrow.

Our second equation, representing the labor/leisure decision is:

$$\frac{T - h_1}{c_1} = \frac{\alpha}{w_1}$$

We see from this equation that as wage increases, the consumer is more likely to prioritize consumption (and as a requirement, labor) relative to leisure.

Finally, using the budget constraint combined with our first order conditions, we can treat all prices as exogenous and find a partial equilibrium of choice variables for the represenative consumer. We will also normalize T to be 1. This partial equilibrium is represented by the following equations:

$$c_1 = \frac{z}{(1+\beta)(1+\alpha)} + \frac{w_1}{(1+\beta)(1+\alpha)} + \frac{w_2}{(1+r)(1+\beta)(1+\alpha)}$$

$$c_2 = \frac{\beta((1+r)(z+w_1)+w_2)}{(1+\beta)(1+\alpha)}$$

$$h_1 = \frac{(1+r)(1+\beta(1+\alpha))}{(1+\beta)(1+\alpha)} - \frac{\alpha((1+r)z+w_2)}{w_1(1+\beta)(1+\alpha)}$$

$$h_2 = \frac{1+\beta-\alpha}{(1+\beta)(1+\alpha)} - \frac{\alpha\beta(1+r)(z+w_1)}{w_2(1+\beta)(1+\alpha)}$$

While these equations leave some ambiguity for several parameters, there are certain relationships we can note that are certain in this model. A larger endowment causes this consumer to consume more in both periods and work less in both periods. An increase in wage in either period causes the consumer to increase consumption in both periods. An increase in the interest rate causes the consumer to consume less in the first period and consume more in the second period. An increase in the weighting

parameter determining utility of leisure relative to consumption, expectedly, decreases consumption in either period.

2.1.2 Two-Period Consumer with Consumption Tax

Consider the same representative consumer with identical variables from the first section, but with one modification. The real price of consumption in each period is increased by a percentage determined by a tax rate, τ.

Then it is still the case that the representative consumer will choose (c_1, c_2, h_1, h_2) to maximize utility under the function:

$$U(C, L) = log(c_1) + \alpha log(T - h_1) + \beta log(c_2) + \alpha\beta log(T - h_2)$$

However, the consumer is now subject to a modified set of budget constraints:

$$(1 + \tau)c_1 + s = h_1 w_1 + z$$

$$(1 + \tau)c_2 = h_2 w_2 + s(1 + r)$$

$$h_{1,2} \leq T$$

The first two constraints can be simplified into one budget constraint:

$$c_1(1 + \tau) + \frac{c_2(1 + \tau)}{1 + r} = z + h_1 w_1 + \frac{h_2 w_2}{1 + r}$$

Our first order conditions are:

$$0 = \frac{1}{c_1} - \lambda(1+r)(1+\tau)$$

$$0 = \frac{\beta}{c_2} - \lambda(1+\tau)$$

$$0 = -\frac{\alpha}{T-h_1} + \lambda w_1(1+r)$$

$$0 = -\frac{\alpha\beta}{T-h_2} + \lambda w_2$$

Our equation representing the consume/save decision is:

$$\frac{c_2}{c_1} = \beta(1+r)$$

The tax does not distort this decision, and so our interpretation is limited to what we found in the first section.

Our equation representing the labor/leisure decision is:

$$\frac{T-h_1}{c_1} = \frac{\alpha(1+\tau)}{w_1}$$

The tax distorts this decision. As the tax rate increases, the consumer will increasingly prioritize leisure relative to consumption.

Finally, using the budget constraint combined with our first order conditions, we can treat all prices as exogenous and find a partial equilibrium of choice variables for the represenative consumer. We will also normalize T to be 1. This partial equilibrium

is represented by the following equations:

$$c_1 = \frac{z}{(1+\beta)(1+\alpha)(1+\tau)} + \frac{w_1}{(1+\beta)(1+\alpha)(1+\tau)} + \frac{w_2}{(1+r)(1+\beta)(1+\alpha)(1+\tau)}$$

$$c_2 = \frac{\beta((1+r)(z+w_1)+w_2)}{(1+\beta)(1+\alpha)(1+\tau)}$$

$$h_1 = \frac{(1+r)(1+\beta(1+\alpha))}{(1+\beta)(1+\alpha)} - \frac{\alpha((1+r)z+w_2)}{w_1(1+\beta)(1+\alpha)}$$

$$h_2 = \frac{1+\beta-\alpha}{(1+\beta)(1+\alpha)} - \frac{\alpha\beta(1+r)(z+w_1)}{w_2(1+\beta)(1+\alpha)}$$

Note that in this partial equilibrium, the consumption tax decreases consumption in both periods (as the tax increases).

2.1.3 Two-Period Consumer with Labor Income (Wage) Tax

Consider the same representative consumer with identical variables from the first section, but with one modification. Potential consumption from labor earnings ($h_{1,2}w$) is decreased in each period by a percentage determined by a tax rate, τ.

Then it is still the case that the representative consumer will choose (c_1, c_2, h_1, h_2) to maximize utility under the function:

$$U(C,L) = log(c_1) + \alpha log(T-h_1) + \beta log(c_2) + \alpha\beta log(T-h_2)$$

However, the consumer is now subject to a modified set of budget constraints:

$$c_1 + s = z + h_1 w_1(1-\tau)$$

$$c_2 = h_2 w_2(1-\tau) + s(1+r)$$

$$h_{1,2} \leq T$$

The first two constraints can be simplified into one budget constraint:

$$c_1 + \frac{c_2}{1+r} = z + h_1 w_1(1-\tau) + \frac{h_2 w_2(1-\tau)}{1+r}$$

Our first order conditions are:

$$0 = \frac{1}{c_1} - \lambda(1+r)$$

$$0 = \frac{\beta}{c_2} - \lambda$$

$$0 = -\frac{\alpha}{T-h_1} + \lambda w_1(1+r)(1-\tau)$$

$$0 = -\frac{\alpha\beta}{T-h_2} + \lambda w_2(1-\tau)$$

Our equation representing the consume/save decision is:

$$\frac{c_2}{c_1} = \beta(1+r)$$

The tax does not distort this decision, and so our interpretation is limited to what we found in the first section.

Our equation representing the labor/leisure decision is:

$$\frac{T - h_1}{c_1} = \frac{\alpha}{w_1(1-\tau)}$$

The tax distorts this decision. As the tax rate increases, the consumer will increasingly prioritize leisure relative to consumption.

Finally, using the budget constraint combined with our first order conditions, we can treat all prices as exogenous and find a partial equilibrium of choice variables for the represenative consumer. We will also normalize T to be 1. This partial equilibrium is represented by the following equations:

$$c_1 = \frac{z}{(1+\beta)(1+\alpha)} + \frac{w_1(1-\tau)}{(1+\beta)(1+\alpha)} + \frac{w_2(1-\tau)}{(1+r)(1+\beta)(1+\alpha)}$$

$$c_2 = \frac{\beta((1+r)(z+w_1(1-\tau)) + w_2(1-\tau))}{(1+\beta)(1+\alpha)}$$

$$h_1 = \frac{(1+r)(1+\beta(1+\alpha))}{(1+\beta)(1+\alpha)} - \frac{\alpha((1+r)\frac{z}{1-\tau} + w_2)}{w_1(1+\beta)(1+\alpha)}$$

$$h_2 = \frac{1+\beta-\alpha}{(1+\beta)(1+\alpha)} - \frac{\alpha\beta(1+r)(\frac{z}{1-\tau} + w_1)}{w_2(1+\beta)(1+\alpha)}$$

Note that much like the consumption tax, the labor income tax decreases consumption in both periods as it increases. Because this labor income tax does not tax the endowment, it also amplifies the effect of wealth, which in this case discourages work.

2.1.4 Two-Period Consumer with Total Income Tax

Consider the same representative consumer with identical variables from the first section, but with one modification. Potential consumption from all earnings ($h_{1,2}w$ as well as $s(1+r)$ in the second period) is decreased in each period by a percentage determined by a tax rate, τ. In other words, both labor income and capital income are being taxed.

Then it is still the case that the representative consumer will choose (c_1, c_2, h_1, h_2) to maximize utility under the function:

$$U(C, L) = log(c_1) + \alpha log(T - h_1) + \beta log(c_2) + \alpha\beta log(T - h_2)$$

However, the consumer is now subject to a modified set of budget constraints:

$$c_1 + s = (z + h_1 w_1)(1 - \tau)$$

$$c_2 = (1 - \tau)(h_2 w_2 + sr) + s$$

$$h_{1,2} \leq T$$

The first two constraints can be simplified into one budget constraint:

$$c_1 + \frac{c_2}{1 + (1 - \tau)r} = (1 - \tau)z + (1 - \tau)h_1 w_1 + \frac{(1 - \tau)h_2 w_2}{1 + (1 - \tau)r}$$

Our first order conditions are:

$$0 = \frac{1}{c_1} - \lambda(1 + r(1 - \tau))$$

$$0 = \frac{\beta}{c_2} - \lambda$$

$$0 = -\frac{\alpha}{T - h_1} + \lambda w_1(1 - \tau)(1 + r(1 - \tau))$$

$$0 = -\frac{\alpha\beta}{T - h_2} + \lambda w_2(1 - \tau)$$

Our equation representing the consume/save decision is:

$$\frac{c_2}{c_1} = \beta[1 + r(1 - \tau)]$$

The tax distorts this decision. As the tax increases, the consumer will increase consumption in the first period relative to the second period. In turn, this makes the consumer more likely to borrow and less likely to save.

Our equation representing the labor/leisure decision is:

$$\frac{T - h_1}{c_1} = \frac{\alpha}{w_1(1 - \tau)}$$

The tax distorts this decision. As the tax rate increases, the consumer will increasingly prioritize leisure relative to consumption.

Finally, using the budget constraint combined with our first order conditions, we can treat all prices as exogenous and find a partial equilibrium of choice variables for

the represenative consumer. We will also normalize T to be 1. This partial equilibrium is represented by the following equations:

$$c_1 = \frac{z}{(1+\beta)(1+\alpha)} + \frac{w_1(1-\tau)}{(1+\beta)(1+\alpha)} + \frac{w_2(1-\tau)}{(1+r(1-\tau))(1+\beta)(1+\alpha)}$$

$$c_2 = \frac{\beta((1+r(1-\tau))(z+w_1(1-\tau))+w_2(1-\tau))}{(1+\beta)(1+\alpha)}$$

$$h_1 = \frac{1+\beta+\alpha\beta}{(1+\beta)(1+\alpha)} - \frac{\alpha z}{w_1(1+\beta)(1+\alpha)} - \frac{\alpha w_2}{(1+r(1-\tau))w_1(1+\beta)(1+\alpha)}$$

$$h_2 = \frac{1}{1+\alpha} + \frac{\alpha w_1}{w_2(1+\beta)(1+\alpha)} - \frac{\alpha\beta(1+r(1-\tau))(z+w_1)}{w_2(1+\beta)(1+\alpha)}$$

We see that the main effect of this tax is to decrease the effect of the interest rate on these choices. However, this tax has two effects. One is to decrease consumption in both periods, by making consumption indirectly more expensive. The other is to potentially increase consumption in the first period while decreasing consumption in the second period due to the aforementioned effect on the interest rate.

2.1.5 Sensitivity of Representative Consumer Results

Modifications attempted on the above model did not yield significantly different results. Two main modifications were attempted. The first was to force the consumer to retire in the second period. The first order conditions in this model, as well as the implications of the different tax structures, were no different than that of the model above in which the consumer can work in both periods. The second modification attempted was to loosen existing assumptions and use indefinite parameters for a constant elasticity of intertemporal substitution for consumption, as well as a constant

elasticity of intertemporal substitution for leisure. The utility function under this modification was:

$$U(C,L) = \frac{{c_1}^{1-\theta}}{1-\theta} + \alpha\frac{(T-h_1)^{1-\gamma}}{1-\gamma} + \beta\frac{{c_2}^{1-\theta}}{1-\theta} + \alpha\beta\frac{(T-h_2)^{1-\gamma}}{1-\gamma}$$

The results of this model showed that as a consumer is more willing to substitute between present and future consumption, the effects of β and the interest rate on the decision to consume or save are amplified. However, the implications of taxation on this model were no different than on the representative consumer above. Because it did not make a difference, the simpler representative consumer model has been displayed in full in the previous sections.

2.1.6 Summary of Representative Consumer Results

The two-period representative consumer model provides us with several notable results, all under the assumptions and premises of the model. To review, this model surveyed the theoretical results of three tax structures. The first tax was a tax on all consumption. The second tax was a tax only on income from labor, and not on capital income - this will be called a "wage tax." The third tax was a tax on all income, both from labor and from capital.

Relative to the world with no taxation, all three forms of taxation distort the decision between labor and leisure in exactly the same way. As the tax rate increases, the consumer will increasingly prioritize leisure relative to consumption. Because there is no obvious way to tax leisure, this distortion seems to be inevitable.

Neither the consumption tax nor the wage tax create an intertemporal distortion - that is, a distortion that affects the decision between consumption and saving. This makes sense, as both a wage tax (think, for example, of a payroll tax) and a consumption tax both leave capital income untouched.

Then, out of four models (one with no tax and then three with different tax structures) the total income tax is the only one that distorts the decision between consumption and saving behavior. As the total income tax increases, the consumer will increase consumption in the first period relative to the second period. There are no domain restrictions on this saving behavior - we can also think of this total income tax as making the consumer more likely to borrow and less likely to save.

3 Data

The empirical work in this paper makes use of the Government Revenue Dataset (GRD) from the International Centre for Tax and Development (ICTD). The ICTD is a research organization, formally established in 2010, with a topical focus on tax policy and administration and a regional focus on sub-Saharan Africa. It is headquartered in the UK and funded by the Bill and Melinda Gates Foundation, as well as the UK government's Department for International Development.

The GRD is a unique dataset in that it is both the most comprehensive and arguably the most standardized dataset of tax and revenue measures across all countries. Its construction "has been based on the careful compilation, merging and cleaning of data from multiple existing data sources, in order to arrive at a markedly more complete

and accurate dataset" [Prichard et al., 2014].

The GRD has a number of advantages as a dataset - I will highlight a couple of those that are especially relevant to the empirical work I do in this paper.

The first advantage is scope. The GRD combines a number of reliable international sources into one dataset, including the IMF's *Government Finance Statistics*, the OECD *Tax Statistics* dataset, the *World Development Indicators*, the *African Economic Outlook*, several credible Latin American government revenue databases, and others. The result is a dataset that is more complete, and in particular, includes far more comprehensive data on developing countries than one can find at any one other source, even if that source is the IMF or World Bank databases.

The second advantage is the inclusion of general government data whenever possible, accurate, and relevant. That is, this dataset includes regional and local tax revenue for countries with significant taxation activity at levels other than simply the central/national government. This can make a big difference. Take for example, the United States. Central government data would suggest that all goods and services tax receipts total to around half a percentage point of US GDP. But when turning to general government data, we see this amount is closer to 4% of GDP [ICTD/UNU-WIDER, 2017]. The GRD also makes use of general government data (the data which includes regional and local taxation) for other countries where it is equally vital to do so. These countries include, but are not limited to - Argentina, Brazil, Canada, China, South Korea, Libya, Nigeria, the United Kingdom, and Germany.

These advantages are meaningful not only because using this dataset makes for a

higher quality paper, but because this is, as far as I have made myself aware through extensive literature review, the first paper to use this dataset in attempting to answer this question regarding the impact on income versus consumption taxes on investment.

The remainder of the variables - the non-tax related variables, generally - come from the World Banks' World Development Indicators.

4 Descriptive Analysis

This section reviews some of the patterns in the descriptive statistics of this dataset. This is worth analyzing both because the dataset itself is relatively new and may yield novel conclusions even before doing a causal investigation, and because analyzing the relative percentage of individual income tax receipts to goods and services tax receipts is itself a unique analysis.

4.1 Comparing Summary Statistics, 1995 and 2015

The key explanatory variable used in this paper is a relative percentage of individual income taxes receipts to goods and services tax receipts. In this paper, this variable will also be referred to in short as the individual income to goods and services tax percentage (IIGST percentage) or just the "tax relative percentage." Individual income tax receipts will capture tax revenue from individual income taxes, payroll taxes, and capital gains taxes. Notably, they will not capture corporate income taxes. Luckily, the empirical literature on corporate income taxes is itself already fairly rich. Using a measure of income tax receipts which included corporate income taxes would only

necessitate using data with more gaps, and with the possible risk of conflating separate tax policy issues. Goods and services tax receipts include revenue from taxes like sales taxes, value-added taxes, and excise taxes. Notably, this measure does not, in most cases, include revenue from tariffs, though there is some ambiguity when it comes to certain taxes collected by the customs agencies of some countries.

Of course, this relative percentage does not tell us everything about tax structure. Perhaps most importantly, it says nothing about the overall tax burden of a country. A country that takes in $5,000 in individual income taxes and $10,000 in goods and services taxes will have the same relative percentage as a country that takes in $2 in individual income taxes and $4 in goods and services taxes. This is why, in the later regression analysis, one of the covariates is total tax revenue relative to GDP.

To better understand the empirical nature of this relative percentage, I present two tables - the first showing the state of this percentage internationally and in some select regions in 1995, and the second showing the same in 2015.

One important caveat with these tables is that in some cases, not every country is represented in a given year with a corresponding data point, based on data availability. This could lead to some bias towards the data being more representative of developed countries in earlier years. However, this is why when I move to my regression analysis, I confirm the robustness of my results with a balanced panel of countries as well.

Note again that this percentage has been normalized to 100 for these tables and for the later regression analysis. That is, a value of 100 indicates equal tax revenues from individual income taxes versus goods and services taxes. A value of 200 would indicate twice as much revenue coming from individual income taxes.

Table 1: Summary Statistics for Relative Percentage of Individual Income Taxes to Goods and Services Taxes, 1995

Statistic	All	OECD	Europe	Africa	South & Central America
Mean	51.2	94.2	84.1	37.8	15.1
Median	40.0	81.6	78.5	30.0	8.5
95th Percentile	145.5	191.1	178.3	98.5	55.9
5th Percentile	0.0	27.5	27.5	8.3	0.0

Table 2: Summary Statistics for Relative Percentage of Individual Income Taxes to Goods and Services Taxes, 2015

Statistic	All	OECD	Europe	Africa	South & Central America
Mean	57.7	97.4	85.7	42.6	14.5
Median	48.7	90.5	89.6	35.7	17.1
95th Percentile	141.7	167.1	154.0	89.8	34.0
5th Percentile	4.5	31.6	29.1	0.0	1.1

The most clear pattern we can observe from both of these tables is that developed countries seem to have higher relative percentages than developing countries, on average. The amount of individual income tax receipts relative to goods and services tax receipts in European countries, for example, is roughly double that of African countries and over five times that of countries in South America and Central America.

Over time, based on these tables, tax structure does not seem to have shifted much. But these are only two points in time, and do not account for developing countries entering the sample as time goes on.

4.2 Extreme Values

We can provide additional context to the relative tax percentage used in this paper by noting our extreme observations.

Many observations exist on the low end, because a number of countries have, at one time or another, brought in not a single dollar in individual income taxes. These countries, then, have a percentage of 0. In the most recent year of the dataset, 2015, one country reported this result - the Seychelles, an island nation with an enormous tourism sector off the eastern coast of Africa. For a country like this, it intuitively makes sense to depend on a tax base that is the expenses of foreigners who pass through the country, rather than the income of those who actually live on the island.

The upper tail of observations of this perentage is less crowded. The highest IIGST relative percentage recorded of individual income taxes to goods and services taxes is 716.7 - a relative percentage achieved by the African nation of Swaziland in 2007, indicating over 7 times as much revenue from individual income taxes as from goods and services taxes.

In 2015, again the most recent year of the dataset, the country achieving the highest relative percentage is a very different nation - the United States. In 2015, the United States' such percentage was 254.8, or just above 2.5 times as much revenue from individual income taxes as from goods and services taxes.

5 Regression Analysis

5.1 Methodology

In the regression analysis in this paper, two types of models are used to demonstrate the robustness of the result.

5.1.1 Fixed Effects Model

The first of the two model types is a standard fixed effects regression of the form:

$$y_{it} = \beta X_{it} + \alpha_i + \alpha_t + u_{it}$$

y_{it} is the dependent variable, which in this paper is investment (gross fixed capital formation) relative to GDP. X_{it} is the matrix of regressors and β is the coefficient on each regressor. α_i represents the country fixed effects while α_t represents the time (year) fixed effects. u_{it} is the error term.

As usual, the strength of this model is its simplicity. However, the somewhat strict assumptions of this model are a weakness in the context of the question being asked here. Most concerning is the exogeneity assumption, which does not seem consistent with the macroeconomic variables being used here. This assumption in particular is why we seek a model that allows for more endogeneity, and is thus why we make use of a dynamic panel model in this paper.

5.1.2 Dynamic Panel Model

The second type of model used in this regression analysis is a dynamic panel data model estimated with the Arellano-Bond estimator, a generalized method of moments estimator [Arellano and Bond, 1991].

Our dynamic panel model is simply:

$$y_{it} = \beta X_{it} + \rho_1 y_{it-1} + \rho_2 y_{it-2} + \alpha + u_{it}$$

y_{it} is the dependent variable. X_{it} is the matrix of regressors and β is the coefficient on each regressor. α is an unobserved effect. u_{it} is the error term. $\rho_{1,2}$ are the coefficients on the two lags of the dependent variable. Technically these lags are used as covariates in the standard fixed effects regression in this paper as well, but here they serve an additional role as instruments in the instrument matrix.

The first difference of this equation is taken to eliminate the fixed effect, and then the formula for the Efficient Generalized Method of Moments Estimator is applied incorporating the result of that difference, Δy, and an instrument matrix using the Arellano-Bond moment conditions.

5.1.3 Variables

This section describes each of the variables used in the aforementioned models, including covariates, as well as their source and justification.

The main dependent variable used in this paper is investment - more precisely, gross fixed capital formation as a percentage of GDP. The source of this variable is

the World Bank World Development Indicators. It represents acquired fixed assets minus any fixed assets that are disposed of. As measured by the World Bank, it includes land improvements, purchases of machinery and equipment, and construction of buildings and infrastructure. While not to imply that higher investment is always optimal, investment is normally associated with stronger long-term growth. This is the macroeconomic interest in choosing this as the dependent variable.

The main explanatory variable used in this paper is a relative percentage between two variables from the aforementioned International Centre for Tax and Development. Specifically, it is the relative percentage of total tax receipts from individual taxes on income to total tax receipts from taxes on goods and services. Individual taxes on income includes taxes on labor income as well as capital gains taxes levied at the individual level. It does not include corporate income taxes. Goods and services taxes include almost any consumption taxes, such as sales taxes or VATs - however, it does not include tariffs.

One set of covariates used are two lagged versions of the dependent variable, investment. These lagged variables play a special role in the Arellano-Bond estimator, but are used in the fixed effects model in this paper as well. The two lagged variables are lagged by one and two years respectively, and both have consistent and statistically significant effects. Adding a third lag does not change any variables, and the coefficient on said lag is inconsistent in whether it is positive or negative, but is consistently very close to zero and consistently statistically insignificant.

One covariate used in the models is tax revenue relative to GDP. This variable is also from the ICTD. The reason for including this variable is very closely related to

using a relative percentage between types of taxes as the primary explanatory variable. By using the relative percentage as the main explanatory variable of interest, and controlling for the overall level of taxation, theoretically the effect of different tax structures can be separated from the effect of having an overall higher or lower tax burden. Briefly consider the alternative. If the primary explanatory variable was instead a measure of one type of tax relative to GDP, then the coefficient would include the effect of generally higher taxes. If one attempted to fix this by adding tax revenue relative to GDP as a covariate, then there would be potential for a multicollinearity issue. Using the relative percentage of one tax structure to another seems to be a suitable solution.

Annual growth in GDP per capita is included as a covariate because it is a proxy for cyclical effects. One potential issue with the relative percentage between individual income taxes and consumption taxes is that income tax receipts are more cyclically volatile than consumption tax receipts. This is established in previous literature and is verified by a survey of the data I am using. By including annual GDP per capita growth as a covariate, this cyclical volatility is controlled for. This variable comes from the World Development Indicators.

GDP per capita itself is also included as a covariate. Wealth at the individual level may affect how flexible individuals are in their financial decision-making, and in turn may affect the decisions themselves.This covariate also serves as a proxy for developed versus developing countries, potentially aborbing some of the effect that economic development has on effective taxation institutions. This variable comes from the World Development Indicators.

Total population is included as a covariate, as well as the percentage of the population between the ages of 15 to 64. Enormous populations pose challenges to tax institutions that should be controlled for, and the age balance of a population may very well affect the saving behavior in said population for a number of reasons - for example, an age imbalance towards the elderly may affect the expections of young people with regard to how much support they can expect from the government. Both of these variables are from the World Development Indicators.

The final covariate used is trade openness, the sum of exports and imports of goods and services measured as a share of GDP. This variable is also from the World Development Indicators. In an open economy, the extent to which a nation is trading with the rest of the world is meaningful in light of the fact that the dependent variable is investment. Trade with foreign nations creates a source of investment entirely external to traditional closed economy models, and it is important to account for that.

Other variables whose relationships to these models were explored were the size of the agricultural sector and the total natural resource rents. Both of these variables have theoretical connections to both tax institutions as well as investment. In practice, whether due to a lack of actual causal connection to the other variables or due to data issues, these variables did not have a consistent nor statistically significant effect when incorporated into the models. Thus, they have been excluded.

5.1.4 Panels

Five main panels are used to illustrate robustness and possible heterogeneity in the coefficient of interest. The first is all countries for which generally reliable data

is available for at least some years, which is 120 countries. This panel is highly unbalanced, but it is not a violation of any of the assumptions of the econometric models used for the panel to be unbalanced. Just in case, the result is verified with a second panel, a balanced panel of 28 countries with complete data between 1980 and 2015. This panel, as would be expected, is biased towards the developed world. Some may question the consistency of international tax statistics - for this reason, a panel of 28 OECD countries has been included. Member countries of the OECD work under what is known as the OECD Quality Framework to synchronize and improve their quality and consistency of country-level data. If measurement error is causing a consistent bias in the data, such error should disappear when this panel is used.

Two regional panels are also used to identify possible heterogeneity in the results and as a further robustness check. The first is a panel of 19 European countries. This panel does not include a number of Eastern European countries due to data availability issues in the earlier part of the sample years. The second panel is of 59 countries in Africa, South America, and Central America. Tax institutions in developing countries have their own unique challenges, and so even with controlling for something like GDP per capita, we could see unobserved effects present as heterogeneity in the results for this panel when compared with the others.

5.1.5 A Note on Interaction Terms

It is worth discussing one choice in the model that may seem counterintuitive - why is there no interaction term between tax revenue and the IIGST relative percentage? Theoretically, an interaction term makes sense, for the same reason that we want to

use tax revenue relative to GDP as one of our covariates in the first place. We would expect the relative percentage to have a different effect on investment depending on whether we're talking about $2 and $1 of different tax receipts versus $10,000 and $5,000. While this makes theoretical sense, it makes the actual effects of including an interaction term all the more surprising. When the term is included, the coefficient seems to be virtually zero. For example, in the full unbalanced panel under the standard FE regression, the 95% confidence interval of the coefficient of the interaction term is roughly -0.0004 to 0.0010. For the balanced panel, this interval is between -0.0011 and 0.0004. For the Arellano-Bond estimation on the full unbalanced panel, this interval is -0.0003 to 0.0011. Of course, the coefficient on this interaction term is never even close to statistical significance.

I argue that the most plausible reason for this is not that, at the fundamental level, there is no difference whether we're talking about $2 and $1 of different tax receipts versus $10,000 and $5,000. It is that due to data availability, this is not the kind of range of values in the domain we're investigating. In short, there are not any countries actually only bringing in a single dollar of tax receipts, for example. The lack of significance of any interaction term suggests that within the range of different tax revenue levels in the countries we're examining, there is not a meaningful difference between how tax structure affects investment in modestly taxed countries versus those that are highly taxed. Then we can meaningfully use the coefficient on the IIGST relative percentage variable as the average effect that a change in said percentage will have on investment relative to GDP.

5.2 Results

The following table shows two tables of the results of ten regressions total utilizing the two different models and five different panels described previously in this paper.

Both the standard FE regression and the Arellano-Bond estimation are more accurate in the samples with more countries. This is for methodological reasons. For the standard FE regression, a larger sample size means smaller standard errors. For the Arellano-Bond estimation, a lower number of instruments relative to the number of groups (in this case, countries) leads to more accurate results.

Table 3: Effect of Tax Structure on Investment, Regression Results

	Investment over GDP				
	(1)	(2)	(3)	(4)	(5)
IIGST Relative Percentage	-0.007*	-0.009*	-0.009*	-0.006	-0.007*
	(0.003)	(0.004)	(0.004)	(0.005)	(0.003)
Tax Revenue over GDP	0.163**	0.297**	0.129**	0.141**	0.117
	(0.046)	(0.060)	(0.031)	(0.037)	(0.030)
Annual GDP per Capita Growth	0.095**	0.043*	0.277**	0.278**	0.255**
	(0.022)	(0.020)	(0.027)	(0.019)	(0.020)
GDP per Capita (Thousands)	-0.151**	-0.399**	0.093**	0.033	0.099**
	(0.042)	(0.051)	(0.027)	(0.019)	(0.026)
Population (Millions)	0.014*	0.013	-0.006	-0.018	-0.016
	(0.007)	(0.013)	(0.012)	(0.017)	(0.010)
Percent Population between 15 - 64	0.006	-0.141	0.020	-0.006	0.112*
	(0.061)	(0.084)	(0.040)	(0.052)	(0.043)
Trade Openness	0.063**	0.142**	-0.015**	-0.009	-0.020**
	(0.006)	(0.007)	(0.005)	(0.062)	(0.005)
GFCF $(t-1)$	0.388**	0.285**	0.927**	0.960**	0.942**
	(0.021)	(0.020)	(0.034)	(0.033)	(0.036)
GFCF $(t-2)$	0.290**	0.218**	-0.140**	-0.158**	-0.153**
	(0.021)	(0.019)	(0.034)	(0.033)	(0.035)

Note: (1) is the standard FE regression with all countries. (2) is the Arellano-Bond estimation with all countries. (3) is the standard FE regression on the balanced panel. (4) is the Arellano-Bond estimation on the balanced panel. (5) is the standard FE regression on the OECD countries panel. * indicates p-value of less than 0.05, ** indicates p-value of less than 0.01.

Table 4: Effect of Tax Structure on Investment, Regression Results (cont.)

	Investment over GDP				
	(6)	(7)	(8)	(9)	(10)
IIGST Relative Percentage	-0.003	-0.005	-0.004	-0.002	-0.007
	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)
Tax Revenue over GDP	0.102**	0.082*	0.048	0.256*	0.270**
	(0.033)	(0.035)	(0.035)	(0.106)	0.099
Annual GDP per Capita Growth	0.241**	0.213**	0.250**	0.035	0.002
	(0.017)	(0.032)	(0.024)	(0.039)	0.034
GDP per Capita (Thousands)	0.062**	0.115**	0.055**	-0.765**	-0.897**
	(0.017)	(0.033)	(0.020)	(0.229)	(0.243)
Population (Millions)	-0.022	0.099	-0.003	0.143	0.122
	(0.014)	(0.067)	(0.066)	(0.111)	(0.145)
Percent Population between 15 - 64	0.177**	0.047	0.073	-0.291	-0.095
	(0.049)	(0.062)	(0.068)	(0.248)	(0.242)
Trade Openness	-0.019**	-0.016**	-0.014**	0.150**	0.198**
	(0.005)	(0.005)	(0.004)	(0.015)	(0.015)
GFCF $(t-1)$	0.976**	0.880**	0.952**	0.204**	0.143**
	(0.033)	(0.047)	(0.043)	(0.038)	(0.034)
GFCF $(t-2)$	-0.204**	-0.103*	-0.146**	0.249**	0.183**
	(0.034)	(0.048)	(0.046)	(0.038)	(0.034)

Note: (6) is the Arellano-Bond estimation on the OECD countries panel. (7) and (8) are the FE model and Arellano-Bond estimation respectively on the European countries panel. (9) and (10) are the FE model and the Arellano-Bond estimation respectively on the developing countries panel. * indicates p-value of less than 0.05, ** indicates p-value of less than 0.01.

The most important feature of the coefficients on the key explanatory variable, of course, is their consistency. They are all negative and within a range of 0.007 of each other. Particularly compelling is the fact that what I will argue are the two most accurate structures - the standard FE regression on the balanced panel and the Arellano-Bond estimation on the unbalanced panel - yield the same result, and with statistical significance. Of course, this risks a self-serving bias - this coefficient, -0.009,

is the largest one of any statistical significance. For this reason, any time I discuss the implications of this coefficient, I will also discuss how those implications change if the actual effect is on the lower end, at -0.003. The interpretation of this coefficient is as follows - for every one percentage point increase in the IIGST relative percentage (normalized to 100 - that is, 100 to 101 for example) we predict that on average investment relative to GDP will decrease by 0.009 percentage points (normalized to 100 - that is, a decrease from 20 to 19.991.)

While the heterogeneity in these results is fairly minor, it is worth addressing it to the extent that it exists. Coefficients estimated using the Arellano-Bond estimator seem to have greater variability. This may be because, when it comes to the smaller panels, the number of instruments relative to the number of groups (countries) is becoming excessive and harming precision. It may be the case that, due to this, the Arellano-Bond estimation is a more reliable model for the largest panel, but that the fixed effects regression is more appropriate for the smaller panels.

The results for both the European countries and the Africa/Americas panel are less statistically significant than the results of the other panels. This makes sense. These panels are much smaller and contain less data than the panel of all countries, but without the data rigor benefit of the OECD panel or the self-evident benefit of the perfectly balanced panel. Another potential issue with the European countries is that because the tax systems of these countries are so similar in many cases, there may not be enough variability for the models to exploit. Still, it is worth returning to and appreciating the consistency of the results. Even for these regional panels, the results are reliably negative and of comparable magnitude to the rest of the results.

Finally, in the context of these results it is worth emphasizing that these coefficients reflect a change in tax structure while holding overall tax revenue relative to GDP constant. For example, decreasing this relative percentage and reaping the investment gains indicated by a given coefficient assume that the country is not only increasing consumption tax revenue, but simultaneously decreasing individual income tax revenue by an equivalent amount, holding overall tax revenue constant. In reality, tax reform may not necessarily take this form. However, the justification for viewing tax changes in such a way is that it allows us to entirely separate the issue of overall tax burden from specific tax structure. In addition, the coefficients from these regressions still offer a way to derive the independent effect on investment from a change in consumption tax revenue relative to GDP, described in the following subsection.

5.3 Deriving Effect of a Change in Consumption Tax Revenue

Holding all other variables constant, an increase in consumption tax revenue *without* a proportional decrease in individual income tax revenue as described in the previous section, is related to two coefficients in the previously described results. It is related to the coefficient on the tax relative percentage as well as the coefficient on total tax revenue relative to GDP. By decomposing both the relative percentage of individual income taxes to goods and services taxes, as well as total tax revenue relative to GDP, we can derive a formula for the effect of such a change.

This formula can be described as follows:

$$\delta = \beta_1 \frac{ic - ic'}{cc'} + \beta_2(c' - c)$$

In this formula, δ is the effect on investment relative to GDP of a change in consumption tax revenue relative to GDP from c to c'. The variable i represents individual income tax revenue relative to GDP, β_1 is the regression coefficient on the relative percentage of individual income tax revenue to consumption tax revenue, and β_2 is the regression coefficient on total tax revenue relative to GDP.

As an example of using this formula, consider an increase in consumption tax revenue relative to GDP of 1 percentage point. Let β_1 and β_2 be the respective coefficients from the regression using the standard fixed effects model and the balanced panel. And let individual income and consumption tax revenue be their median values within the balanced panel, which are 8.4 percentage points and 10.4 percentage points respectively. Including these parameters in the formula described above, we would predict, for a typical country, that an increase in consumption tax revenue relative to GDP of 1 percentage point will increase gross fixed capital formation relative to GDP by approximately 0.13 percentage points.

6 Discussion and Conclusions

The empirical results displayed in the previous section have two main implications. The first implication is that for most countries, the potential benefits (in terms of increasing investment) of shifting to a system more reliant on consumption taxes over income taxes are relatively modest. In short, most countries cannot increase investment dramatically simply by relying more on consumptions taxes. However, this may be because these countries are already incredibly reliant on such taxes, and thus

have already reaped their benefits. The second implication is that for outlier countries, like the United States, the potential benefits of a shift to consumption taxation may be large and meaningful. I will now discuss each of these implications in greater depth.

In this discussion section, I will use several countries as benchmarks and examples for both the IIGST (individual income to goods and services taxation) relative percentage and for gross fixed capital formation (investment). The goal of these benchmarks is to provide intuitive perspective in what certain policy changes could mean in practice. All benchmarks are in terms of most recent data - that is, 2015. Our benchmarks for discussion of the IIGST relative percentage are Paraguay, Greece, and the United States. Paraguay has an IIGST relative percentage (again normalized to 100) of just over 1. Paraguay serves as our benchmark for a hypothetical most extreme shift towards consumption taxation. Greece has a relative percentage of roughly 38 - this is 10 points below our median and serves as a benchmark for more "realistic" reform towards consumption taxes. South Korea has a relative percentage slightly over our 2015 median, at approximately 51. Finally, Denmark and the United States are our upper-end benchmarks with the highest two percentages for 2015 - approximately 167 and 255 respectively.

Consider South Korea implementing reforms to its tax system to spur investment. If South Korea were able to drop its IIGST relative percentage down to that of Greece, we would expect investment (normalized to 100, relative to GDP) to increase by about 0.12 percentage points. If South Korea were able to drop its percentage all the way down to that of Paraguay without adverse consequences in other areas, then we would predict investment to increase by about 0.45 percentage points. If the -0.003 coefficient

is the correct one, then of course each of these predictions would be cut down to a third of each number. For perspective, this 0.45 percentage point maximum increase is the 2015 difference in investment between Belgium and Canada. Even in a best case scenario, the potential for a median IIGST percentage country like South Korea to spur investment by changing its tax structure seems extraordinarily minimal.

Now consider the United States, an extreme outlier in its tax structure. If the United States were able to drop its relative percentage down to that of Denmark, the second highest country in 2015, then we would predict an increase in investment of 0.79 percentage points. If the United States were able to drop its relative percentage down to that of Greece, we would expect a 1.95 percentage point increase in investment. Given that current US investment is at roughly 20 percentage points relative to GDP, this would represent a nearly 10% increase in investment. While no claims are made here regarding the political feasability of such a drastic reform, it at least appears to be logistically feasible given that other developed countries have maintained such a percentage. It is, of course, worth noting that if the lower bound of our range of coefficients is correct, then such reform in the US would lead a more modest (but still meaningful) 3% increase in investment.

These benchmark examples bring us back to the original argument of this section - tax reform that changes tax structure to prioritize consumption taxes more and individual income taxes less does not present a meaningful opportunity to increase investment for the median country. But for outliers like Denmark and the United States, such reform could present a way to do exactly that - increase investment sharply.

That said, it is worth noting that investment is not the only potential macroeconomic outcome of interest. As mentioned at the beginning of this thesis, many see the issue of consumption versus income taxes as yet another example of the macroeconomic tradeoff between equality and efficiency. The empirical literature on the effects of different tax structures on income inequality is fairly sparse and developing (and indeed that question may present a logical continuation of this very paper) but we can imagine a scenario in which a choice to prioritize income taxation may reflect not economic illiteracy, but on the contrary a well-informed decision to "purchase" equality with a cost to efficiency. There may also be administrative or even political benefits to income taxation over consumption taxation that are not considered in this thesis. Nonetheless, the hope is that this paper can contribute to the existing empirical literature by giving perspective and precision to the magnitude of the efficiency effects stemming from different tax structures at an international level.

7 Appendix

7.1 Selected Additional Descriptive Statistics

Table 5: Summary Statistics for Relative Percentage of Individual Income Taxes to Goods and Services Taxes, Observations from 1980 - 2015

Statistic	All	OECD	Europe	Africa	South & Central America
Mean	58.5	96.4	87.2	55.2	19.1
Median	41.5	88.2	82.0	34.3	11.5
95th Percentile	156.3	192.7	158.7	138.9	63.4
5th Percentile	1.9	12.1	24.8	11.4	0.0

Table 6: Summary Statistics for Relative Percentage of Individual Income Taxes to Goods and Services Taxes, 1980

Statistic	All	OECD	Europe	Africa	South & Central America
Mean	86.5	115.6	105.5	Insufficient Data	Insufficient Data
Median	68.8	108.6	102.2	.	.
95th Percentile	268.4	232.6	268.4	.	.
5th Percentile	5.7	22.7	37.7	.	.

7.2 Alternative Regression

An alternative approach to investigating the effects of different tax structures, and one that has been used in some of the previous literature, is to use different categories of tax revenue as the primary explanatory variables, in contrast with the relative percentage used in this paper. The following table shows the results of such a regression, where

total tax revenue is split into three categories - individual income tax revenue relative to GDP, goods and services tax revenue relative to GDP, and all other tax revenue relative to GDP. Only the total panel and balanced panel are used for these results, as they are not a part of the central argument of this thesis. Both regressions use the standard fixed effects model.

Table 7: Effect of Tax Structure on Investment, Alternate Regression Results

	Investment over GDP	
	(11)	(12)
Individual Income Tax Revenue over GDP	-0.019	-0.154
	(0.055)	(0.116)
Goods and Services Tax Revenue over GDP	0.167**	0.148*
	(0.047)	(0.074)
Other Tax Revenue over GDP	0.213**	0.343**
	(0.052)	(0.066)
Annual GDP per Capita Growth	0.274**	0.088**
	(0.021)	(0.022)
GDP per Capita (Thousands)	0.084**	-0.163**
	(0.027)	(0.042)
Population (Millions)	-0.006	0.014*
	(0.012)	(0.007)
Percent Population between 15 - 64	0.016	0.014
	(0.040)	(0.061)
Trade Openness	-0.015**	0.066**
	(0.005)	(0.006)
GFCF $(t-1)$	0.926**	0.389**
	(0.034)	(0.020)
GFCF $(t-2)$	-0.141**	0.286**
	(0.034)	(0.020)

Note: (11) uses the balanced panel as described in the paper, while (12) uses the panel of all countries. * indicates a p-value of less than 0.05, while ** indicates a p-value of less than 0.01.

For the most part, the coefficients of the non-tax-related covariates are similar to the values found in the models used in the main section of the paper. It is important to note that the coefficients on the tax variables in this model do not separate tax structure fully from total revenue - they are, at least in part, reflecting both the

effects of tax structure and of total tax burden. In both regressions, the results seem to indicate that individual income taxes decrease investment in a way that neither consumption taxes nor other taxes do. Future research may gain insight by deconstructing these categories further depending on data availability, particularly the "other tax revenue" category which appears to be better for investment than either of the other two categories.

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