The Macroeconomic Effects of Flat Taxation: Evidence from a Panel of Transition Economies[1]

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Abstract: Flat taxes have been the subject of policy discussion for decades, and such discussions have often come with bold macroeconomic claims. Yet the macroeconomic effects of flat taxation remains a mostly overlooked topic in the economics literature. To guide my analysis, I construct a simple model of investment decisions under varying income tax progressivity, and I show that decreased tax progressivity increases investment, which – under standard models of economic growth – should induce a transitionary increase in GDP growth. To test these implications, I turn to a natural experiment: between 1994 and 2011, twenty post-Communist countries introduced flat taxation on personal income. Since 2011, five of these countries have reverted to progressive income taxation. Using static and dynamic difference-in-differences approaches, I find that the flat tax reforms increase annual GDP growth by 1.36 percentage points for a transitionary period of approximately one decade. These findings are robust to multiple alternative specifications designed to deal with various identification challenges, including electoral endogeneity and correlated reforms. Entirely consistent with the model, this growth effect is operationalized through increases in investment (and labor supply), and it is driven both by the decreases in the average marginal tax rate and the reductions in progressivity resulting from the tax reforms. In short, tax progressivity can have important implications for macroeconomic outcomes.

1 Introduction

The debate over tax progressivity is as old as taxation itself. Since the passage of the Revenue Act of 1913, the United States has never had a flat tax on incomes, nor have any Western European countries in recent history. However, flat taxes have frequently been proposed and debated by economists, politicians, and political parties in these countries. Advocates have suggested that flat taxes incentivize work, investment, and innovation – and

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potentially even boosts economic growth over the long-run. Detractors have argued that flat taxes lead to budget deficits, boost inequality, and have no effects on economic growth.

In order to provide a framework for assessing these claims, I set up a simple two-period model of consumption and saving decisions individuals face under flat and progressive tax codes. I show that that decreased progressivity has an effect on investment above and beyond the effect of a downward shift in the tax schedule alone (i.e., decreased average rates). Intuitively, individuals take into account not only their taxes in the current period but also the taxes they will have to pay in the future if, for example, they make a higher income in the subsequent period. Thus it is not only individuals' contemporaneous marginal tax rates that matters for their decision-making; the entirety of the tax schedule plays a role. I relate these findings to a basic Solow model, which – like more complex models of economic growth – implies that an increase in investment should produce a transitionary increase in growth over the short- and medium-run.

In the post-communist countries of Eastern Europe and Central Asia, flat taxes have gone beyond the realm of political and intellectual discussion to become reality. Between 1994 and 2011, twenty post-communist countries introduced such a tax at varying—but typically quite low—rates as a percentage of income. At their peak, nearly all Eastern European and Central Asian countries had a flat tax in effect. Since 2011, on the other hand, some of these countries have repealed their flat taxes and reverted to a progressive system of income taxation. These policy changes represent an ideal natural experiment through which to test the multitude of claims pertaining to flat taxation.

Using quarterly GDP data on this panel of flat-tax adopters and a difference-in-differences identification strategy, I find that the adoption of a flat tax structure has a strongly significant positive effect of 1.36 percentage points on GDP growth. This result is robust, remaining statistically significant under a variety of alternative specifications. Using annual data from accounting firm *Ernst & Young* on the tax schedules of the countries in my panel, I construct a variable measuring the fiscal size of each flat-tax reform – in the vein of Romer and Romer (2010) – and I control separately for this and its lags to factor out direct Keynesian stimulus

effects. I control for other (potentially-correlated) aspects of the business environment aside from the tax code, as measured by various components of the *Ease-of-Doing-Business Index.* I restrict my analysis to the subset of flat-tax reforms passed after a close electoral victory for the party advocating the reform. I vary lag length, control for convergence, run annual versions of the regression, and use various sets of fixed-effects. This multitude of specifications slightly changes the magnitude of the effect, but it remains significant in all cases.

The finding of increased GDP growth is also robust to a dynamic difference-in-differences specification, which reveals that the effect is transitionary and persists for approximately one decade, consistent with the implications of the model. Indeed, as implied by the model, it is not only decreased average marginal tax rates which are responsible for the growth effect – decreased progressivity is also responsible for it. If anything, the latter factor is more strongly significant. Also consistent with the model is the fact that the effect on growth appears to be realized through increased investment (and labor supply). Other potential competing channels that could be driving the result – such as repeated stimulatory budget deficits, reductions in structural economic distortions, and reductions in the size of the shadow economy – are found to have no significant effect. Indeed, not every effect of flat taxation suggested by advocates and detractors appears to be realized. I find no evidence of increases in inequality or budget deficits, nor do I find evidence of explosions in innovation (as measured by patenting activity) or FDI.

Finally, while the effects are sizeable, I argue that they are also sensible. The effect sizes I measure have direct implications for the elasticity of investment with respect to tax rates and the elasticity of output with respect to investment. I point out that the latter implied elasticity is well within the range uncovered by the existing literature. In the former case of the elasticity of investment with respect to tax rates, insofar as my implied elasticity is on the high side, I argue this is because the existing literature has focused primarily on the direct channel of the impact of an individual's marginal tax rate on that individual's decisions. One of this paper's key contributions is to shine light on the importance of the extent of progressivity throughout the tax schedule, and accounting for this channel should increase the elasticity of investment with respect to changes in the tax schedule.

The structure of the remainder of this paper is as follows. In Section 2, I review some background information related to flat taxation and its macroeconomic effects – both the relevant economics literature and the political-economic context of the post-communist flat tax reforms. In Section 3, I set up and solve a simple two-period model of the consumption/saving decision under flat and progressive taxation regimes, and I consider its macroeconomic implications through a standard Solow model of economic growth. In Section 4, I discuss my various data sources and the empirical framework – along with its assumptions – that I use to investigate the macroeconomic effects of flat taxation. In Section 5, I extensively cover my main empirical results, a multitude of robustness checks, and an investigation of the mechanism and its consistency with the model. In Section 6, I discuss these findings and argue their sensibility and consistency with known elasticities from the existing literature. In Section 7, I conclude.

2 Political Economic Context

2.1 Post-Communist Context

For most of the latter half of the 20th century, the economies of the Eastern European and Central Asian nations were centrally-planned in the Soviet design: fully state-owned and managed by bureaucratic commissions that mandated wages, prices, investment, and output through the auspices of Five-Year Plans. Following the disintegration of the Eastern Bloc and then the USSR itself in 1991, many of these countries thoroughly embraced market-based reforms, which brought the economic systems of the region into greater consonance with the Western European norm. Indeed, many of these countries have gone even further than that in terms of reducing the role of government in economic life.

One key example of this fact is the introduction of flat income taxation. Between 1994 and 2011, twenty countries in Eastern Europe introduced such a tax, at varying—but typically quite low—rates as a percentage of income. Since 2011, on the other hand, five of these countries have repealed their flat taxes and reverted to a progressive system of income taxation. Table 1 lists the countries and the associated year of introduction/repeal of a flat income tax, along with the flat rate itself (upon introduction). Figure 1 shows these countries on a map. All of the

introductions and repeals were made effective on January 1st of the stated year[3].

To some extent, the blanket term "flat tax" hides the richness in variation amongst the reforms that occurred in these countries. For example, in some cases, only the income tax schedule was modified, with all other taxes in the economy remaining unchanged; in other cases, the entire system of taxation (including corporate taxes, payroll taxes, VAT, etc.) was overhauled. In some cases, the tax reform was a reduction in the general level of taxation; in other cases, it was budget-balanced—a "tilting" of the income tax schedule—or even constituted an increase in the general level of taxation. In some cases, the standard deduction (i.e., the minimum level of income subject to taxation) was increased; in other cases, it was reduced or abolished entirely.

In all cases, the advocates for the reform indicated that they expected it to attract more foreign direct investment and reduce tax evasion. Many were also influenced by the conjecture that such reforms would stimulate economic growth and thus more than pay for themselves in short order. Tax competition was another substantial motive, with Ukraine, for example, choosing its 13% rate to match that of its neighbor Russia in order to avoid being undercut and Belarus, a few years later, choosing a 12% rate in order to undercut them both. Macedonia, in 2007, chose a 10% rate in order to be the lowest in the region. The next year, its immediate neighbors Albania and Bulgaria followed at 10%. Somewhat further east, Turkmenistan introduced a 10% flat tax in 2005. Neighbors Kyrgyzstan and Kazakhstan followed at 10% in the next several years.

Fundamentally, however, the decision to introduce flat taxation in these countries was an ideological one, often implemented after the victory of center-right coalitions. One potential motive of tax/expenditure changes is to use a well-defined fiscal instrument—such as a tax cut on high earners or an increase in government expenditure on infrastructure—in order to offset expected business-cycle fluctuations on the horizon. As argued by Romer and Romer (2010) and much of the subsequent literature on the macroeconomic effects of tax shocks, such endogenous tax changes are unsuitable for studying the effect of tax changes on output. But the very fact that

[3] The sole exception is Montenegro, which made its newly-introduced flat tax effective on July 1st, 2007.

the flat tax was implemented in so many countries with such bewildering rapidity meant that the full extent of its effects was unknown and could not yet have been satisfactorily studied. As such, the proponents of the flat tax had expectations as to what its effects would be, but it would have made a blunt and unlikely fiscal policy instrument. Rather, it was considered an end in itself.

Furthermore, just as the implementation of such flat taxes was typically undertaken by a center-right coalition shortly after an electoral victory, their repeal typically occurred after the victory of center-left coalitions. Again, parties and individuals advocating for repeal did not make arguments based on offsetting expected forthcoming economic fluctuations. Rather, the emphasis was ideological: concerns about fairness and disproportionate burdens on the working-class.

2.2 Literature Review

Arguably the most influential case for flat taxation was made by Hall and Rabushka (1983), who advocated for a broad-based reform to the US tax code. Their basic proposal centered on eliminating exclusions, deductions, or credits to any individual or organization and using the revenue gained to reduce marginal tax rates to a 19% flat tax on wages and business income. Notably, Hall and Rabushka propose not an income tax but a wage tax. Critics suggested that, because the Hall-Rabushka proposal was a wage tax and the vast majority of income from top earners is capital income, functionally the reform would constitute a transfer from middle- and working-class individuals to wealthier individuals, with those making under $50,000 per year at 1983 prices (equivalent to approximately $125,000 per year in 2017) experiencing an increase in taxation, according to Pechman (1984). Additionally, Auerbach and Kotlikoff (1987), using tax simulation models, find that a shift from an income tax to a wage tax would actually reduce economic efficiency, suggesting that the touted efficiency gains of a flat tax on wages may not be met.

Perhaps as a result of such considerations or perhaps as a result of the anticipated political difficulties of implementing a wage tax, the Hall-Rabushka flat wage tax proposal is not

precisely what has been implemented in any of the Eastern European countries. They instead feature more traditional income taxation, except at flat rates, with a standard personal deduction. As such, the above critiques do not directly apply.

There are a number of theoretical benefits of flat income taxation at low rates. First, there is a large body of evidence suggesting that there are indeed behavioral responses to income taxation, with higher rates inducing lower labor supply. The general consensus is that, for the majority of prime-age males in the United States, the earnings elasticity is rather low (in the neighborhood of 0 to 0.1), and that it has declined substantially over time for prime-age females as well (now in the neighborhood of 0.2) as they have become more attached to the labor force (Pencavel 1986, Pencavel 2002, Blau and Kahn 2007). Higher earners, however, from whom the majority of tax revenue in most systems originates, tend to be more sensitive to changes in marginal tax rates, and estimates of their earnings elasticity tend to be in the neighborhood of 0.5 to 0.8 (Saez, Slemrod, and Giertz 2012). This suggests significant benefits vis-à-vis labor supply and economic output in response to a cut in top tax rates, and it also suggests that making up some or most of the lost revenue by increasing the tax burden on low income individuals would not significantly offset those gains .

As a cautionary note, though, Romer and Romer (2014) find an elasticity of 0.2 for the top 1% of earners in the interwar-era U.S., suggesting that—across time and space—high earnings elasticities amongst high-earners are not inevitable. Furthermore, Rebelo and Stokey (1995) explictly investigate the theoretical growth effects of flat-taxation by calibrating an endogenous growth model to the U.S. data. They find that flat-tax reform would have little or no effect on the U.S. growth rate. On the other hand, they do note that factor shares, depreciation rates, the elasticity of intertemporal substitution, and the elasticity of labor supply are crucial parameters to which this result is sensitive, suggesting it is possible that countries with different parameter values may indeed enjoy economic growth effects as a result of a flat-tax reform.

Another potential benefit of a flat tax with low rates—the one cited most often by flat-tax proponents in Eastern Europe—is a reduction in tax evasion, a prediction borne out by many models of tax evasion. Although it may seem strange to think that anyone would increase tax

payments as a result of reduced rate, if one models evasion as a costly activity (perhaps consuming time and requiring payments to a team of "creative" accountants), then the reasoning becomes straightforward. Having said that, the effects of a flat tax on evasion are not theoretically unambiguous. Low-income individuals actually experience an increase in rates under most flat-tax proposals; as such, if the majority of evasion comes from low-income individuals, there is no reason to believe that a flat-tax system would ameliorate this issue. If instead most evasion comes from individuals with high incomes, a flat-tax system would indeed be expected to reduce tax evasion, and in their micro-level study of the Russian flat-tax reform, Gorodnichenko, Martinez-Vasquez, and Peter (2009) find exactly such a result.

On the whole, though, there has been relatively little research on the macroeconomic effects of the Eastern European flat tax reforms, a surprising fact given how politically-charged the surrounding debate can be. Right-wing and left-wing commentators alike have made known their strong, even fiery, opinions on the matter[4]. However, this debate has been remarkably unquantified, excepting a spattering of reports and white papers that, for example, attempt to identify the effect of flat taxation on growth rates by comparing the mean growth rate in one given flat-tax-adopting country to the mean growth rates in a set of (often questionably-selected) other countries. As a result of this shortage of well-identified evidence, even a review paper on flat taxation by Keen, Kim, and Varsano (2008) is light on empirical evidence, instead focusing primarily on theoretical implications.

There are a handful of exceptions. Ivanova, Keen, and Klemm (2005) examine micro-level labor-supply responses to the Russian flat tax reform using panel data from the Russian Longitudinal Monitoring Survey, finding little to no evidence of enhanced labor-supply but substantial reductions in evasion (as measured by the gap between household expenditure and reported income). They note, however, that changes in tax enforcement accompanied the flat-tax reform, and it is difficult to decompose how much of the reduced evasion is due to this versus the flat-tax reform.

[4] See, for example, Mitchell (2007), which rails against an IMF report asserting that the flat-tax reforms – given their specific parameters – were unlikely to have an impact on labor-supply or tax compliance, and Bashevska (2014), which brands Macedonia a "workers' hell" and charges its flat-tax reform with increasing poverty.

Mentioned previously, Gorodnichenko, Martinez-Vasquez, and Peter (2009) go a step further. They first supplement the Ivanova, Keen, and Klemm analysis by using the same data source but with a few extra years of data (more than the first two years after the reform), confirming the lack of any significant labor-supply/productivity response to the tax reform. However, they are able to isolate the effect of the reform on evasion from the effect of increased enforcement by using a difference-in-difference design which takes advantage of the fact that some income brackets did not experience a marginal rate change as a result of the reform (and hence would only have experienced an enforcement change) while others did, restricting the sample to those near the marginal rate discontinuity for robustness. They find that there was indeed a strong and significant impact of the flat-tax reform on evasion, although 30% smaller than implied by the approach of Ivanova, Keen, and Klemm.

Easterbrook (2008) delves into the tax code data for eight of the countries that implemented flat tax reforms and uses said data to calculate the actual change in average marginal income tax rates. She uses these calculations to calibrate the Prescott (2004) model of labor supply for each of the countries, finding that the model predicts a substantial labor-supply increase in most of the countries—excepting two that actually experienced increased average marginal income tax rates as a result of the reform. However, when she compares the predictions of the model to actual labor supply changes (using data on hours worked from the International Labor Office), true responses appear negligible in most cases.

Adhikari and Alm (2016) use the synthetic control method to study the effect of the flat-tax reforms on the *level* of GDP in the case of 8 specific flat-tax reforms, finding effects in each country that are positive, albeit not strongly significant[5]. Theirs is the closest existing work to this paper. However, the fact that Adhikari and Alm examine only a selection of 8 of the 25 flat-tax reforms/repeals in Eastern Europe means that it is difficult to regard any pooled estimates of the GDP effects as comprehensive. Also, Adhikari and Alm do not use data on the tax code of the countries they study, nor on the fiscal size of any of the reforms, and hence they do not separate the effects of a tax-cut-induced stimulus from a decrease in the average marginal tax

[5] It is worth noting that these are not all the same countries as examined by Easterbrook (2008).

rate (shifting downward of the tax schedule) from that of flat taxation per se (flattening of the tax schedule). Furthermore, the application of a data-driven big-data methodology to a decidedly small empirical macroeconomic dataset means, concretely, that Adhikari and Alm are assuming that a synthetic Kazakhstan (for example) which captures all of the *time-varying unobservable* characteristics of real Kazakhstan can be created from a data-driven weighted-average of the observables of mostly non-transition economies (since nearly all transition economies were flat-tax adopters), a bold assumption. In short, there is plenty of room for a further contribution to this topic.

World Bank (2005) examines the effects of the Slovak flat tax reform on inequality by simulating tax payments under the pre- and post-reform tax systems using household survey data. They curiously find that the Kakwani index of tax progressivity (in terms of pre-tax incomes) actually increased substantially, while the Reynold-Smolensky index (relevant for post-tax incomes) did not increase[6]. As such, while the tax reform made the distribution of tax payments more unequal—in that sense increasing progressivity—the reduction in overall revenue meant that the impact of the tax system on equalizing after-tax incomes was not affected. These results suggest flat tax reforms may have complex and by no means unambiguous distributional effects.

No paper has yet either (i) examined the effect of the flat-tax reforms on longer-term economic growth, (ii) used the full panel flat-tax implementing countries, (iii) studied the outcomes of a flat-tax repeal, or (iv) conducted a systematic (i.e., more than single-country) examination of the mechanism of any such effect – particularly vis-à-vis the relative importance of reduced average tax rates and reduced tax progressivity. I hope to fill these gaps in the literature.

3 A Simple Model of Flat Taxation

To provide some intuition for the plausible effects of flat taxation, I present a simple two-

[6] This is made less counterintuitive when one notes that Slovakia is one of the countries identified by Easterbrook as having had effectively no change in average marginal tax rates as a result of the reform.

period model of investment under varying tax progressivity. Individuals are endowed with wealth ω and live for two periods. They obtain utility from consumption and, consequently, decide how much of their wealth to consume in the first period and how much to invest in a (risk-free) asset with return R which allows them to transfer their wealth to the next period. In other words, any endowment not consumed, c_1, in the first period will be consumed in the second period, such that $c_2 = (1 + R)(\omega - c_1)$. They must pay income tax on their investment income, where the tax rate is given by

$$\tau(y) = \alpha + \beta y$$

for any level of income, y. Notice that, for any $\beta > 0$, the income tax rate is increasing in income – the standard definition of a progressive tax schedule. When $\beta = 0$, the income tax rate reduces to the flat base rate of α (the standard setup in models of investment under taxation). It can be shown that, with a very weak assumption on the form of the utility function, decreased tax progressivity decreases investment.

Proposition: Consider a two-period model of investment wherein individuals are endowed with wealth ω and choose how much of that wealth to consume, c_1, in the first period and how much to invest in an asset with return R for consumption in the next period. Investment income, y, is taxed at the rate $\alpha + \beta y$. In this framework, for any utility function u satisfying $u'(c) > 0$ and $u''(c) > 0$, the individual's chosen level of investment, $s = \omega - c_1$,

(i) declines, if risk aversion is sufficiently low, as the flat base rate α increases (holding constant progressivity) OR

(ii) declines *unambiguously* as the progressivity of the tax schedule increases (holding constant the average tax rate).

This proposition is proven in Appendix A of the paper. In short and intuitive terms, it says that while shifting the tax schedule vertically may only lead to boosted investment under certain circumstances, changing its slope (even conditional on the average tax rate) *unambiguously* boosts investment. This result is important because it indicates that progressivity of the tax

schedule has implications above and beyond simple changes in the base average marginal tax rate. If changes in the income tax schedule have any effect on investment, this result suggests that flat-tax reforms are precisely where we would be most likely to detect them.

But what are the implications for economic growth, if any? To answer this question, I consider a simple Solow (1956) growth model. In the Solow model, net investment in a period is equal to output in that period times the saving rate minus any depreciation of the pre-existing capital stock. That is, $\dot{K}_t = sY_t - \delta K_t$, where Y_t denotes aggregate output in period t, K_t denotes the capital stock, s denotes the saving rate, and δ denotes depreciation. In the steady-state of the model net investment is zero, as $sY_t = \delta K_t$. Increased savings on the part of the populace lead to positive net investment and movement to a higher steady-state level of the capital stock. Since output in the Solow model is produced according to the aggregate production function $Y_t = K_t^{\alpha}(AL_t)^{1-\alpha}$, this translates to a higher level output. This higher level of output, however, is not realized instantaneously. In each period, the new, higher level of investment expands the capital stock slightly, expanding productive capacity and thus output along with it. As the capital stock continues to expand, total depreciation in each period also increases. Eventually, the higher level of depreciation catches up with the higher level of investment and the economy settles at its new steady-state. In this manner, there is a *transitionary*, non-permanent increase in economic growth as a result of the tax reform. Figure 2 plots a graphical example of this dynamic.

It should be noted that this framework is relatively broad in its applicability. That is, while literal financial investment in an asset which pays some return is the most obvious form of investment, a broad class of actions fit under the umbrella of sacrificing utility in the present period in order to obtain an improved payoff in the latter period. To the extent that working harder at a job increases one's future income (through promotions) or to the extent that getting a higher education improves one's future income, the above framework is applicable with only mild adjustment. These, too, are "investments", and while financial investment may be the foremost amongst them, the takeaway is that a broad set of economic activities may be affected by tax progressivity. And to the extent this broad class of additional variables affect economic growth – through endogenous growth models in the case of increased labor or human capital

models in the case of improved education – limiting one's viewing lens to standard investment through the Solow model may yield but a lower bound on the importance of tax progressivity.

4 Data and Empirical Framework

4.1 Data

To conduct my analysis, I acquire quarterly GDP data from the Economist Intelligence Unit (EIU), which has collected said data from the Central Statistical Bureaus of the respective countries. For a few of the countries, the data are not available from the EIU, so I obtain it directly from the nation's Central Statistical Bureau[7]. In some cases, the data do not come seasonally-adjusted. As such, I apply the standard x13 seasonal adjustment procedure to these series. For many of the countries in my panel, quarterly GDP data are not available before 1995, so I supplement this with interpolated annual data from the Penn World Table where said quarterly data are missing.

From the World Income Inequality Database (WIID), I obtain data on income share by decile of population and the Gini coefficient at repeated cross-sections. The WIID collates this data from numerous sources, but one source that attempts to measure such indicators in a consistent manner across almost all countries is the World Bank, so I use the World Bank estimates within the WIID. For many countries, the World Bank has annual estimates of Gini and population-by-income stretching back for decades. For other countries, the frequency is less regular. In these cases, I use the estimate from closest year.

Also from the World Bank, I obtain the World Development Indicators (WDI) dataset, which includes data on foreign direct investment, sectoral shares in the economy, population growth, and many other useful indicators. I obtain data on patents from the World Intellectual Property Organization (WIPO). From the IMF Government Financial Statistics (GFS) dataset, I obtain data on tax revenue by source. Again from the Penn World Table, I obtain data on employment and annual average hours worked.

With regard to legislated changes in the tax code, I refer to and digitize information in the

[7] I do this for Albania, Kyrgyzstan, Turkmenistan, Bosnia and Herzegovina, and Montenegro.

annual international tax guides published by Ernst & Young (*Worldwide Personal Income Tax Guide, Worldwide Corporate Income Tax Guide,* and *Worldwide VAT, GST, and Sales Tax Guide*), which detail the tax code in each country for each year since 2006. For the earlier reforms, I obtain this information from the data appendix in Easterbrook (2008), where it was collected from analogous annual tax-code reports that PricewaterhouseCoopers published at the time[8]. In a procedure described in the appendices of this paper, I pair the tax code data with the data on income distributions in order to compute measures of the average marginal tax rate, tax progressivity, and the fiscal size of each flat-tax reform.

4.2 Empirical Framework

The fact that the timing of flat-tax adoption varied substantially across countries suggests a difference-in-differences identification strategy. As discussed extensively above, this series of tax changes consists of policies adopted for ideological reasons, rather than for other factors likely to influence output in the near future. This reduces concerns of systematic correlation between these tax changes and other determinants of output growth. Regardless, it could possibly be the case that individuals are more likely to vote for the center-right parties advocating flat tax reforms at certain points in their local business cycle. Adding lags of output growth controls for the state of the economy and helps to address this possibility of policy endogeneity. As such, the main regression specification is a difference-in-differences approach which controls for lags of output growth[9].

$$\Delta Y_{t,j} = \alpha + \phi F_{t,j} + \sum_{i=0}^{M} \beta_i \Delta T_{t-i,j} + \sum_{j=1}^{J} \gamma_j + \sum_{y=1}^{Y} \psi_y + \theta n_{y,j} + \varepsilon_{t,j},$$

where $\Delta Y_{t,j}$ denotes quarter-over-quarter real GDP growth (calculated using , ΔT is the measure of tax changes associated with the flat-tax reform (assigned to the quarter of its implementation), $F_{t,j}$ is an indicator variable equal to 0 when country j does not have a flat tax system in effect and

[8] For Albania, which is missing information on its pre-reform tax code, I supplement this with IMF (2005), which provides said information. Similarly, for Macedonia before its reform, I refer to OECD (2003). I am unable to find the tax code for the year immediately before the reform in each of these two countries, so I must assume that they did not change in the couple of years leading up to the reform—an assumption that holds true for the other countries in the panel.

[9] Such controls are the norm in the literature pertaining to the macroeconomic effects of tax changes. See, for example, Romer and Romer (2010).

equal to 1 when it does, γ_j is the fixed-effect for country j, ψ_y is the fixed-effect for year-quarter yq, and $n_{y,j}$ is population growth for country j in year y. Standard errors are clustered at the level of treatment: the country level. X denotes a vector of control variables.

It is worth taking a moment to reflect upon the identification assumptions implicit in this approach. This difference-in-differences specification relies on a parallel trends assumption – that, conditional on a set of controls, if a country which implemented a flat tax in year t had, counterfactually, not done so, then its economic growth would have evolved along the same trajectory as those countries which actually had not implemented a flat tax reform by t. Without controlling for lagged growth, this assumption may have been relatively unpalatable, but doing so helps address the key reverse endogeneity concern described above. Even after this, however, there may remain some additional concerns. Correlated policymaking is one other particular concern: what if the flat taxes tended to be passed simultaneously with other major economic reforms? To deal with these concerns and others, I conduct a number of robustness checks that account for various potential confounds.

Econometricians have recently raised concerns about the reliability of results from static difference-in-difference specifications which are run in fundamentally dynamic settings. Consequently, I also run an analogous dynamic difference-in-differences specification. The second main specification adds lagged output growth to this setup.

$$\Delta Y_{t,j} = \alpha + \phi F_{t,j} + \sum_{i=0}^{N} \beta_i \Delta T_{t-i,j} + \sum_{i=0}^{N} \rho_i \Delta Y_{t,j} + \sum_{j=1}^{J} \gamma_j + \sum_{y=1}^{Y} \psi_y + \theta n_{y,j} + \varepsilon_{t,j}$$

5 Empirical Results

5.1 Main Results

Table 2 shows the results of the baseline regression and various modifications thereof. Column (1) corresponds directly to the baseline specification, which finds that adopting a flat tax leads to an increase in economic growth of 1.36 percentage points annually. While sizeable, it is worth noting that average annual GDP growth during the 2000s in the countries in my panel was over 5%. Consequently, a boost of 1.36% is large but not unthinkable. Compounded over the course of 10 years, this corresponds to a roughly 3-year boost in growth due to flat tax adoption.

Column (2) drops the controls for lagged GDP growth and population growth to show that the result is not being driven by the inclusion of specific controls. The results are only strengthened (albeit non-significantly so).

Column (3) addresses the concern of correlated policymaking. The idea here is that the party introducing the flat-tax reform may also introduce correlated reforms, which could be what are actually responsible for the growth. It is worth noting that, in most all of the countries in my panel, the flat tax has been (or was) in effect for a sufficiently long time such that a different party led the government for at least as many years as the party which introduced the flat tax, somewhat reducing the magnitude of this concern. Still, in order to deal with it, I turn to the Ease-of-Doing Business Index. The Ease-of-Doing-Business Index is compiled annually by the World Bank for a panel of nearly all countries in the world. Its aim is to capture the institutional quality of the environment for starting and operating a business with 10 sub-indices[10]. I find no evidence for this conjecture, as the growth effect actually becomes somewhat *larger* (though the difference is not significant) once these controls are added[11].

Column (4) restricts the sample to those countries wherein the flat tax reform was implemented after the close election victory of the party advocating flat taxation. The idea here is that a country where 80% of the populace favors a flat tax and 20% is against is plausibly a quite different place than one where support was 50/50 when the issue came up for debate, and differences in outcomes amongst the latter group are more likely to reflect differences in policy adoption rather than idiosyncratic factors correlated with high enthusiasm for center-right policies. In other words, any policy endogeneity still left over after controlling for lagged GDP growth is likely to be further ameliorated or eliminated by such a strategy. Here, too, the effect remains strongly significant and of a similar magnitude.

Column (5) asks whether the effects are truly an enduring consequence of the flat-tax policy itself or simply a short-term Keynesian stimulus effect that has far more to do with deficit spending from any source than the particulars of a flat tax. Using the procedure described in

[10] These are starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency.
[11] Note that the sample size is noticeably lower for this column. That is because the Ease-of-Doing-Business Index did not exist prior to 2004, limiting the sample somewhat.

Appendix B, I compute a measure of the fiscal size of each tax reform a la Romer and Romer (2010), and I add as controls to the main specification this variable and 20 of its lags. Statistical significance is retained, and the magnitude of the effect barely budges.

Column (6) adds a control for the log of GDP, in acknowledgement of the existence of convergence effects and the fact these countries tended to have less developed economies when they had progressive taxes than when they had flat taxes (since the latter is the more recent system in most of these countries). It should be noted that any bias induced by this factor should bias the effect in the main specification toward zero – downward, not upward. Regardless, the inclusion of this control does not substantially change the situation. In acknowledgement of the finding of Barro (2015) that effect sizes in regressions such as this with convergence terms may actually be biased by the inclusion of country fixed-effects, I run a version without said FEs and, in column (7), again find a significant (albeit non-significantly smaller) effect size.

Column (8) runs the regressions at the annual level using the Penn World Table data. To the extent that the quarterly data released by these countries are less reliable than the annual data or that the seasonal-adjustment process induces any oddities, annual data from a highly standard source should abstract from such concerns. Here too I drop the fixed-effects in column (9). In both cases, again, the result remains statistically-significant.

In Table 3, I re-run the baseline specification with a varying lag length – 4 lags, 8 lags, 12 lags, 16 lags, 20 lags, 24 lags, and 28 lags. In each case, the result remains statistically significant and the magnitude is little changed. This demonstrates that it is not a specific lag length driving the results.

The fact that the effect remains strongly statistically significant (and barely reduced in magnitude) even with a full set of country fixed-effects, a full set of year fixed-effects, varying lags of GDP growth, and a restriction to the countries that experienced flat-tax reform implementation after a close election is a strong statement indeed, made even stronger by the aforementioned robustness checks. Regional business-cycle fluctations, within-country fluctuations, national idiosyncracies, the potential presence correlated pro-growth developments, and concerns related to electoral endogeneity are all addressed—the latter in multiple ways.

However, a substantial concern remains. The relative paucity of clusters (i.e., 17) leads to the concern that clustered standard errors may lead be inaccurately narrow and consequently be over-reject the null hypothesis. To answer this concern, one can run a permutation test which generates p-values within-sample. I randomly re-assign the timing of treatment across countries in my sample 2000 times and run regressions on these placebo treatment variables, plotting the resulting coefficients in Figure 3. As can be seen, the implied p-value is less than 0.001 – the result is just as strongly significant as the clustered standard errors would imply.

As pointed out by recent applied econometrics papers such as Borusyak and Jaravel (2017), coefficients from static difference-in-difference regressions may be unreliable if dynamic coefficients exhibit little stability over time. Fortunately, as can be seen in Figure 4, the effect is quite stable for about a decade, and its magnitude during that time period is stable and consistent with the static specification. It is also worth highlighting that the fact the effect is not permanent but rather transitionary is exactly as predicted by the model discussed in Section 3.

Next, I run a year-level specification analogous to the main specification, except with the change in the Gini coefficient as the dependent variable. The results are displayed in Table 4. As seen in column (1), I find no statistically-significant evidence of any effect on inequality as measured by the Gini coefficient. Even if I drop the right-hand-side control variables – which dramatically increased the measured effect on the GDP growth outcome – I still find no evidence of an effect on inequality, as seen in column (2). One potential reason for this puzzling result is the fact that tax compliance was known to be very low in Eastern European and Central Asian countries prior to the flat tax reforms. If the reforms substantially boosted compliance, it would not necessarily be surprising to find a lack of any significant effect on inequality. While this cannot be verified with macro data, the micro-level exploration conducted by Gorodnichenko, Martinez-Vasquez, and Peter (2009) found strong evidence in favor of an effect of this sort in the Russian case, so it is not at all a stretch of the imagination to expect this to happen in these other similar settings.

5.2 Mechanism – Channel of the Effect

Thus flat taxation on income in Eastern Europe appears to have had a positive, robust, and rather large effect on economic growth. A key question remains: through what economic channel(s) was this effect realized? Theory and the assertions of Eastern European flat-tax proponents suggest a few possibilities:

- Domestic Investment: This is the primary channel suggested by the model. Reduction of the tax on high incomes should motivate individuals to re-allocate their income toward saving/investment.
- Labor Supply: Reduction of the income tax on high-income individuals should motivate said individuals (and individuals who might believe they could potentially be high-income in the future) to supply more of their own labor and thus generate more economic output. While such a level effect is theoretically straightforward and well-founded, an effect on economic growth rates through this channel could only be realized through an endogenous growth framework, if perhaps high-income individuals are more likely to work in professions that would contribute to such endogenous growth. Admittedly, this is considerably less straightforward and well-founded than the preceding channel.
- Foreign Direct Investment: Eastern European proponents of flat-taxation suggested it would attract foreign investors to their countries, persuading said individuals to invest, start a business, and move there, bringing themselves along with their financial interests. Such investment could spur economic growth.
- Systematic Budget Deficit: Most of the reforms represented a reduction in the general level of taxation. If government expenditure was not reined in by a commensurate amount, it could be the case that the flat-tax reforms have represented systematic budget deficits, which—viewed as repeated Keynesian stimuli—could result in debt-fueled (and likely unsustainable) economic growth.
- Shadow Economy Size: A notable characteristic of the Eastern European economies is the extremely large size of their underground/shadow sectors, estimates of which tend to be in the range of 40-50%, depending on the country. If the crucial effect of reducing marginal tax rates on high-income individuals in these countries was to make it cheaper

and easier to simply report one's income and pay one's taxes than to hire a team of "creative accountants", then it may in fact be the case that the measured economic growth is actually movement of the shadow sector out of the shadows.

- Removal of Sectoral Distortions: A key feature of the Communist-era Eastern European economies was an inordinately high share of heavy industry in the overall economy. Furthermore, member states of the CMEA—the Communist equivalent of the EEC—were strongly encouraged to specialize in certain areas (e.g., Romania was directed to specialize in agriculture, East Germany in tech, etc.). If an environment of high taxes and subsidies in the aftermath of this period kept sectors distorted in such a way that that the economies were not attaining allocative efficiency, transition to a low, flat-tax regime could induce economic growth.

All of the aforementioned hypotheses have testable implications and can be addressed here. I run difference-in-differences regressions precisely analogous to the main specification, albeit with differing left-hand-side variables. First, with regard to labor supply, the flat-tax reforms could potentially have had an effect on the extensive margin or the intensive margin. As can be seen in columns (1) and (2) of Table 5, there is no significant evidence of an effect on the extensive margin, but there is some significant evidence of an effect on the intensive margin – the flat-tax reform is associated with an increase of 13.45 hours in the growth of annual hours worked.

Column (3) examines the effect on investment growth. Here, too, there is a significant increase – to be specific, an increase of 4.9 percentage points. This finding – and the preceding one on labor supply – are consistent with the implications of the simple model discussed earlier in this paper. It was precisely these variables through which the flat tax effects on output were mediated. Column (4) examines foreign direct investment (FDI). No significant effect is found here. Although a potential effect on FDI was much-touted by Eastern European flat-tax advocates, such an effect would have to occur through a much more circuitous pathway. For example, US citizens who invest money in an Eastern European country would still need to pay some US taxes on any income resulting from such investments, unless they became a resident of

the country in which they are investing – a very hefty and costly decision.

Column (5) turns to the budget balance. No evidence is found of any effect on the budget balance resulting from the flat tax reforms. Budgetary concerns were cited by some Eastern European flat-tax opponents, but these do not appear to have been borne out. The increased labor supply and investment resulting from the reforms likely ameliorated direct revenue decreases, and given the findings of Gorodnichenko, Martinez-Vasquez, and Peter (2009), increased tax compliance may also be partially responsible for the lack of budget deficits. In any case, this finding makes it unlikely that repeated Keynesian stimuli induced by budgetary shortfalls are responsible for the boost in growth.

Column (6) turns to the matter of the shadow economy. I use estimates of shadow economy size from Hassan and Schneider (2016). Schneider has produced the most well-recognized, well-cited estimates of shadow economy size in the literature, and the most recent update of this dataset covers the period 1999 – 2013 for nearly all countries, which fortunately overlaps with the adoption (and repeal) of the vast majority of flat taxes in my panel. These estimates are imperfect, but for countries where more accurate estimates based on the tax gap can be calculated, they match very closely with the Schneider data. In column (6), shadow economy share – the fraction of economic activity esimated to be due to the shadow sector – is used as the outcome variable. I find no statistically-significant effect, which suggests the flat-tax reforms neither significantly shrunk or grew the shadow economy.

Column (7) analyzes the WIPO data on patenting. While the point estimate suggests a 6% increase in the amount of patents filed due to the flat tax reforms, the result is not remotely statistically-significant, and thus it cannot be said that the flat tax reforms are leading to an explosion of innovation, at least as measured by patent data[12].

Columns (8) and (9) examine the sectoral distortion hypothesis, its implication is that the introduction of flat taxation would result in systematically higher structural change. The canonical method for measuring structural chance is to use the Lilien Index, named for Lilien (1982), which measures structural change by summing squared changes in the output (or

[12] An alternative specification which analyzes patents which were granted, not merely patents which were filed similarly yields a non-significant positive coefficient.

employment) share of each sector, weighted by that sector's size as a fraction of total output (or employment). Applying this technique to three-sector (agriculture, industry, services) data on employment and GDP shares, respectively, in columns (7) and (8), no statistically-significant effect of flat taxation on either measure of structural change is found. It is worth noting that if the structural change is occurring at a finer level (e.g., workers in the chemical industry becoming workers in the metal industry), it would not be detected by these measures. Regardless, the key distortion of the Communist-era economies was excessive industry and insufficient services, so one might expect movement along that margin, which would indeed be picked up by these measures.

5.3 Mechanism – AMTR, SDMTR, or Both?

The model has another important implication – that the increased economic growth is a result not merely of the fact that the flat-tax reforms reduced tax rates but of the fact that they flattened the whole tax schedule. To this end, I use the *Ernst & Young* data on annual tax schedules and the WIID data on income distributions in a procedure described in Appendix C to compute the change in the average marginal tax rate (a measure of the average level of the tax schedule) and the change in the standard deviation of the marginal tax rate (a measure of the progressivity of the tax schedule) associated with each flat-tax reform. The former measure is quite standard and has a long history in the literature on taxation, dating back to Barro and Sahasakul (1983, 1986). The latter is a natural extension which measures progressivity – a country with a standard deviation of the marginal tax rate equal to zero is a country with a flat tax. The higher the value of this standard deviation, the more the marginal tax rate varies across individuals – i.e., the more progressive the tax schedule[13].

I regress GDP growth on these two measures in order to identify the effect of a downward shift in the tax schedule and the effect of a change in its slope. As in the baseline specification, I

[13] In theory, a non-zero standard deviation of the marginal tax rate could represent either a progressive tax schedule wherein low-income individuals pay a lower tax rate than high-income individuals *or* regressive tax schedule wherein low-income individuals pay a higher tax rate than high-income individuals. In the case of every single country in my panel, tax rates are monotonically increasing in income. As such, a higher value of the standard deviation of the marginal tax rate can only represent a higher level of progressivity.

include lags of GDP growth, country fixed-effects, and year-quarter fixed-effects. The results are given in column (1) of Table 6. It can be seen that decreasing AMTR and decreasing SDMTR both increase GDP growth. In other words, consistent with the model, the flat-tax reforms induce growth not only through their impact on shifting the tax schedule downward and reducing the AMTR – a subject much-discussed in the existing literature on taxation. They also matter in that they reduce progressivity, itself evidently an important and understudied factor. Columns (2) and (3) repeat this regression for the investment growth and labor supply growth outcomes, again finding that both factors are significant.

6 Effect Size and Elasticities

Surveying these results, the bulk of the effect of flat taxation on economic growth in Eastern Europe appears to go through a boost in domestic investment. It is thus worthwhile to consider whether the magnitudes of the effect are reasonable and gel with existing macro estimates. First, with regard to the elasticity of output with respect to investment, the regressions suggest that an annual 4.9 percentage-point increase in investment is responsible for a 1.36 percentage-point annual increase in output – i.e., capital elasticity of output of 0.27. Across countries and time, published estimates of capital elasticity range from 0.2 to 0.4[14]. Thus the implied elasticity here is well within this range.

Second, with regard to the elasticity of investment with respect to the marginal tax rate, the average change in average marginal tax rate resulting from the reforms is approximately -5%. The average change in top marginal rate is -15%. The average change in after-tax income of top-bracket individuals is around +10%. Saving is disproportionately undertaken by high-income individuals; such individuals saving 50 cents out of each additional dollar of income they receive is not at all unreasonable and would yield a 5% increase in investment. Indeed, for the U.S. (c. 1990s), Dynan, Skinner, and Zeldes (2004) find that the top quintile of earners have an average MPS of 0.43. The figure should be even higher for the top decile, top 5%, and top 1% – and these categories of individuals make up the vast majority of saving in the economy. However,

[14] See, for example, Boskin and Lau (1990), Levy (1990), and Berndt and Hansson (1992).

these estimates pertain to effects on the level of investment, whereas I find evidence of increased growth of investment. It is certainly true that the GDP growth resulting from the increase in the level of investment leads to additional knock-on effects – further increased after-tax income, which will again lead to higher investment. However, even using estimates of the capital elasticity near the top of the aforementioned range, the total effect I estimate – cumulated over 10 years – of the flat tax reform on growth is 2 to 4 times the size of the total effect one would anticipate from the elasticities previously found in the literature[15].

Having said this, as was pointed out in the context of the model, the existing literature has focused on tax changes that induced a change in the AMTR without a major change in the SDMTR – i.e., tax changes that were not flat-tax reforms. As my model reveals, there are reasons to believe that an additional effect an investment would result from the reduced AMTR. Furthermore, as also hinted at in the model section, the effect through the capital investment channel is only one plausible avenue through which the growth effects of flattening the tax schedule may be realized. Similar logic works for any costly investment which yields a future payoff greater than the initial investment. As seen above, some evidence was found of an effect on the labor-supply channel. Increased schooling leading to a higher-quality, more productive workforce could potentially be another. On the whole, the point is that while increases in the capital stock may explain the largest share of growth effect, there are a multitude of other small channels through which the effect may be operating.

7 Conclusion

Between 1994 and 2011, the spectre of flat-taxation haunted Eastern Europe and Central Asia — and, despite flat-tax repeals in several countries, flat income taxation remains in effect in most of the countries that introduced it during that era. The results of the analysis here demonstrate that flat income taxation had significant, robust, and economically large effects on

[15] After the initial 5% increase in investment yields a 2.5% expansion in output/income, this should again yield a 1.25% increase in investment, which yields a 0.625% expansion in output/income, which yields a 0.2% expansion in income, and so on. The series sums to a cumulative effect of 3.3%. This is one-quarter the cumulative effect over a decade that I find of the flat-tax reforms in my main specification (one-half the effect in the specifications that find the smallest effect sizes).

GDP growth — an annualized 1.3 percentage-point effect in the main specification, which controls for lags of GDP growth, population growth, country fixed-effects, and year fixed-effects. Although the effect varies somewhat depending on the precise specification used, it is always strongly significant, and it is found to endure for approximately one decade. Robustness checks aimed at controlling for the possibility that parties which introduce flat taxes are conceivably more likely to foster a pro-growth environment in other ways, controlling for electoral endogeneity with a restriction of the panel to countries where the flat-tax was introduced (repealed) after a close electoral victory, and combating potential econometric bias all retain strong significance of the aforementioned effect. Finally, deeper analysis of the channels through which the growth rate effect could possibly proceed reveals that domestic investment is the key element. A moderate effect on intensive-margin labor supply is also uncovered. However, no evidence is found for increased FDI, systematic budget deficit, or removal of sectoral distortions as a result of the flat-tax reforms.

Decomposing the flat-tax reforms into a reduction in the average marginal tax rate and a reduction in progressivity (the standard deviation of the marginal tax rate), I find that both of these play a statistically-significant role. In other words, in terms of boosting investment and (transitionary) economic growth, tax progressivity matters above and beyond simply the average level of the tax rate, consistent with the implications of my simple model of consumption and saving under varying tax rates and progressivity.

The extent to which these findings have applicability outside of Eastern Europe is certainly open to discussion. On the one hand, all of these countries have very similar shared histories over the course of the past three-quarters of a century – being devastated by World War II, then transformed into a Communist-led planned economy, and finally beginning a turmoil-ridden transition to market economics in the early 1990s. Because developed Western countries did not suffer from massive amounts of capital depreciation in the 1990s, they may not necessarily have quite as much to gain from boosts to capital accumulation. On the other hand, one could argue that the developing world does indeed have much to gain from such a boost. As such, a potential avenue for fruitful future research could be examining the effects of flat income taxation (and

other types of flat taxation) in the developing countries of Latin America and Africa where such taxes have recently begun to be adopted.

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Tables and Figures

Table 1: Flat Tax Timing and Rates

Country	Year of Introduction (Repeal)	Flat-Tax Rate
Estonia	1994	26%
Lithuania	1994	33%
Latvia	1997	25%
Russia	2001	13%
Serbia	2003	12%
Slovakia	2004 (2013)	19%
Ukraine	2004 (2011)	13%
Georgia	2005	20%
Romania	2005	16%
Turkmenistan	2005	10%
Kazakhstan	2007	10%
Macedonia	2007	10%
Montenegro	2007 (2013)	15%
Albania	2008 (2014)	10%
Bulgaria	2008	10%
Czech Republic	2008 (2013)	15%
Belarus	2009	12%
Bosnia & Herzegovina	2009	10%
Kyrgyzstan	2009	10%
Hungary	2011	15%

Table 2: Main Specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Main	Controls Dropped	*Doing Business*	Close Elections	Fiscal Size Controls	Converg-ence	No Country FEs	Annual	Annual, No FEs
Dependent Variable:	ΔY	ΔY	ΔY	ΔY	ΔY	ΔY	ΔY	ΔY	ΔY
Flat Tax indicator, *F*	1.362***	2.860***	1.904**	0.900**	1.291**	1.488***	0.765***	2.508***	1.619***
	(0.424)	(0.746)	(0.754)	(0.415)	(0.501)	(0.410)	(0.233)	(0.744)	(0.509)
Observation Frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Annual	Annual
Lags of GDP Growth	Yes; 20	No	Yes; 20	Yes; 20	Yes; 20	Yes; 20	Yes; 20	Yes; 20	Yes; 20
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1288	1288	608	432	1288	1288	1288	322	322

Note: * $0.05 < p \leq 0.1$, ** $0.01 < p \leq 0.05$, *** $p \leq 0.01$

Table 3: Varying Lag Lengths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	4 Lags	8 Lags	12 Lags	16 Lags	20 Lags	24 Lags	28 Lags
Dependent Variable:	ΔY	ΔY	ΔY	ΔY	ΔY	ΔY	ΔY
Flat Tax indicator, *F*	1.042***	0.809***	1.237***	1.216***	1.362***	1.326**	1.260***
	(0.315)	(0.249)	(0.394)	(0.392)	(0.424)	(0.477)	(0.420)
Observation Frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Lags of GDP Growth	Yes; 4	Yes; 8	Yes; 12	Yes; 16	Yes; 20	Yes; 24	Yes; 28
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1560	1492	1424	1356	1288	1224	1156

Note: * $0.05 < p \leq 0.1$, ** $0.01 < p \leq 0.05$, *** $p \leq 0.01$

Table 4: Gini Specifications

	(1) Gini, 1	(2) Gini, 2
Dependent Variable:	Gini Growth	Gini Growth
Flat Tax indicator, *F*	0.150	-0.855
	(0.978)	(0.918)
Observation Frequency	Annual	Annual
Lags of GDP Growth	Yes; 5	No
Country FEs	Yes	No
Year FEs	Yes	Yes
Observations	356	390

Note: * $0.05 < p \leq 0.1$, ** $0.01 < p \leq 0.05$, *** $p \leq 0.01$

Table 5: Channel-of-Effect Specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Labor Supply, Extensive	Labor Supply, Intensive	Investment	FDI	Budget Balance	Shadow Economy Share	Patents	Structural Change	Structural Change
Dependent Variable:	Empl. Growth	Δ Hours Worked	log(*I*)	log(FDI)	Budget Balance	Δ Share Shadow	Patent Growth	Lilien Index, *E*	Lilien Index, *Y*
Flat Tax indicator, *F*	0.092	13.454*	0.049**	-0.45	0.55	-0.37	0.061	-0.006	-0.057
	(0.063)	(7.226)	(0.020)	(0.56)	(0.51)	(0.63)	(0.123)	(0.050)	(0.058)
Observation Frequency	Annual	Annual	Annual	Quarterly	Annual	Annual	Annual	Annual	Annual
Lags of GDP Growth	Yes; 3	Yes; 3	Yes; 3	Yes; 12	Yes; 3	Yes; 3	Yes; 3	Yes; 3	Yes; 3
Country FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	356	188	356	815	312	327	318	295	266

Note: * $0.05 < p \leq 0.1$, ** $0.01 < p \leq 0.05$, *** $p \leq 0.01$

Table 6: AMTR & SDMTR Regressions

	(1)	(2)	(3)
	GDP Growth	Investment Growth	Hours Worked Growth
Dependent Variable:	Empl. Growth	Δ Hours Worked	log(FDI)
AMTR	-0.154***	-0.443**	-0.809*
	(0.048)	(0.173)	(0.410)
SDMTR	-0.005*	-0.020*	-0.078**
	(0.003)	(0.012)	(0.026)
Observation Frequency	Quarterly	Annual	Annual
Lags of GDP Growth	Yes; 12	Yes; 3	Yes; 3
Country FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Observations	1288	357	189

Note: * $0.05 < p \leq 0.1$, ** $0.01 < p \leq 0.05$, *** $p \leq 0.01$

Figure 1: Flat Tax Reform Map

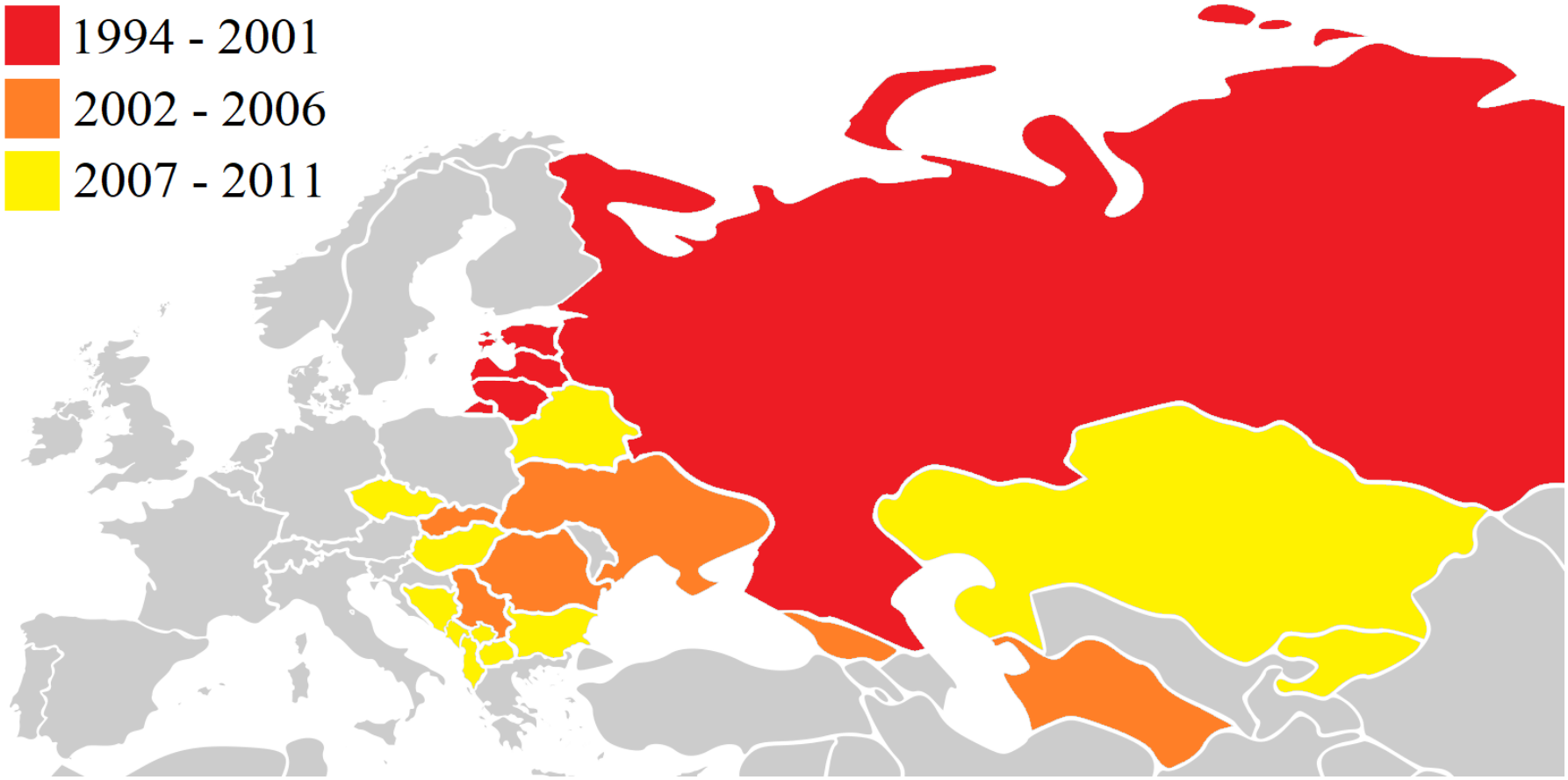


Figure 2: Solow Model Example

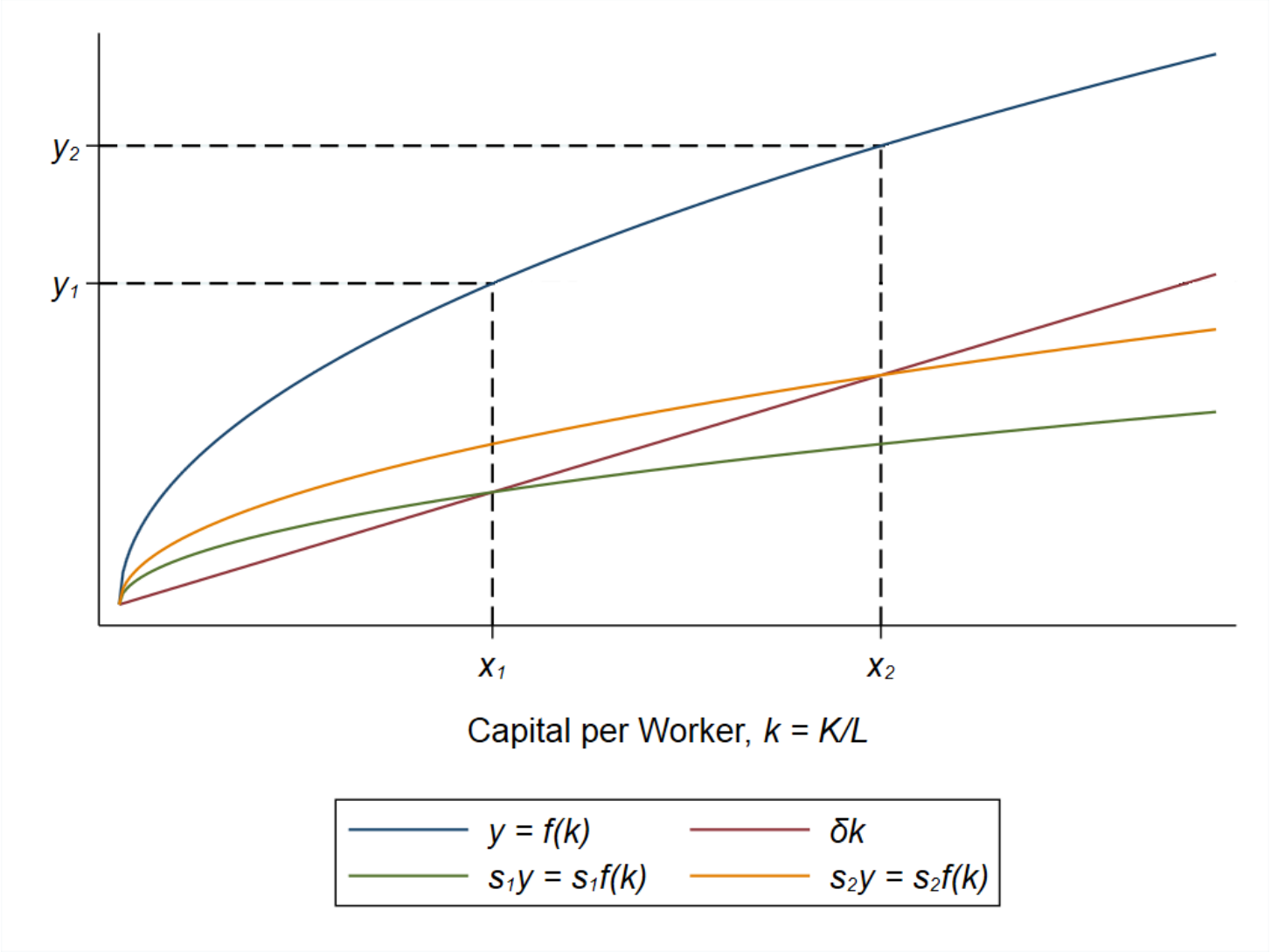


Figure 3: Permutation Test

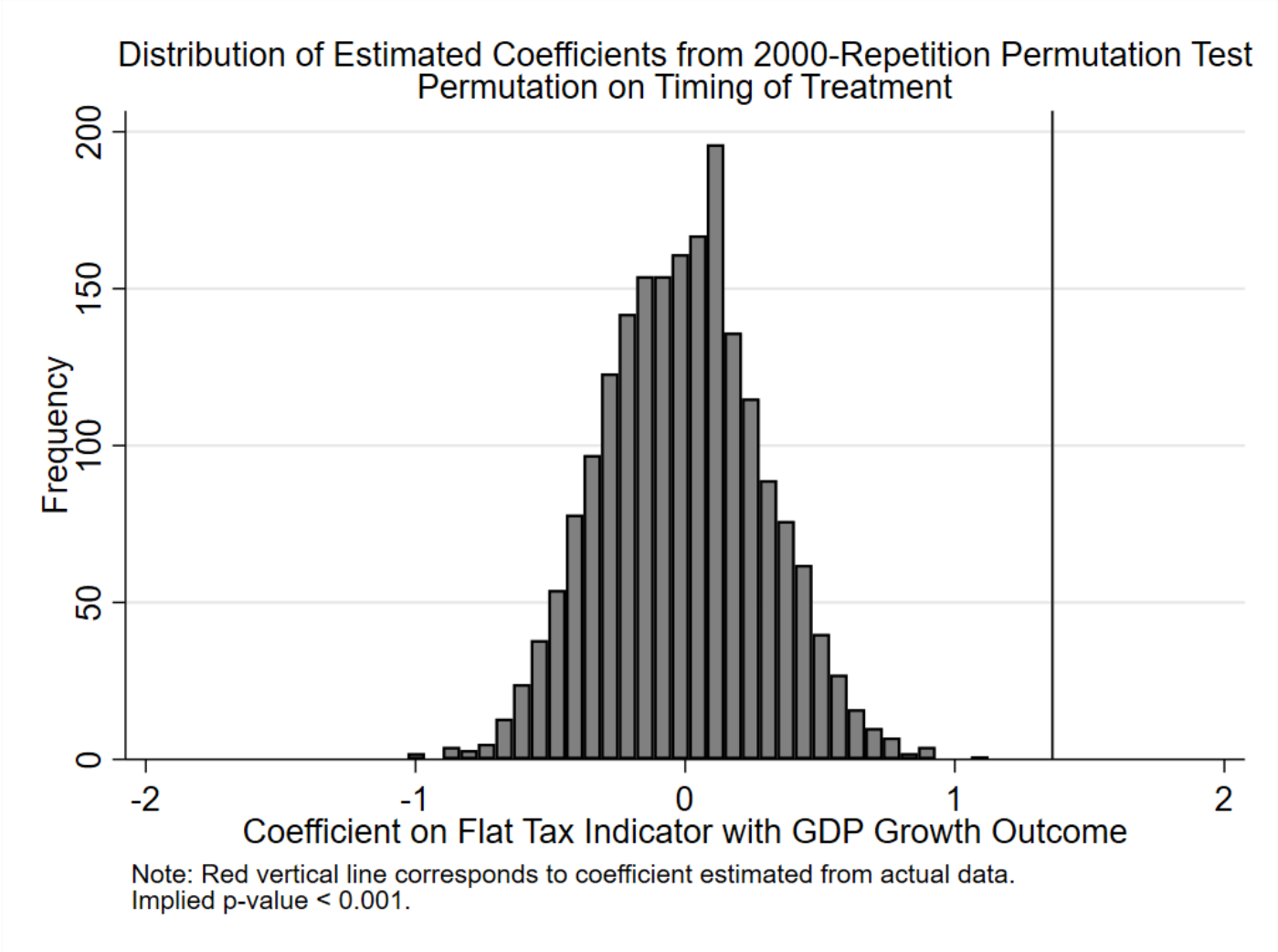
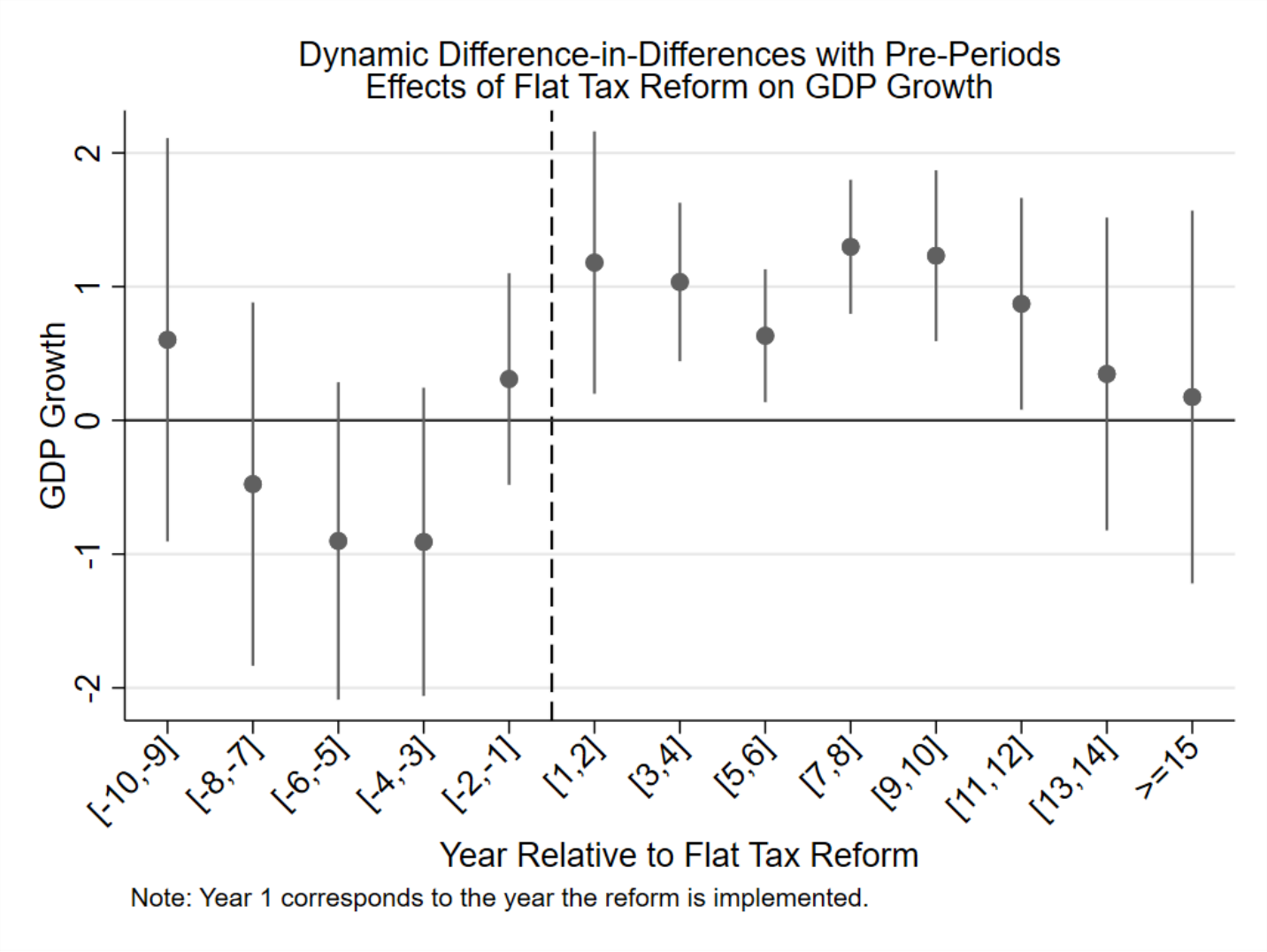


Figure 4: Dynamic Difference-in-Differences Specification



Note: Year 1 corresponds to the year the reform is implemented.

Appendix A: Proof of Proposition

Observe that the individual can spend no more than his endowment ω – plus any investment income – over the course of his life. Thus, in a setting without taxation, his budget constraint would be by $(1 + R)c_1 + c_2 = (1 + R)\omega$. However, in the present setting, the individual must pay income tax on his interest income.

By definition, the individual saves and invests $\omega - c_1$ at the end of the first period. At the start of the first period, he receives interest income of $R(\omega - c_1)$, on which he must pay total tax $\tau(R(\omega - c_1)) * R(\omega - c_1) = [\alpha + \beta R(\omega - c_1)]R(\omega - c_1)$. Consequently, his budget constraint is

$$(1 + R)c_1 + c_2 = (1 + R)\omega - \alpha R(\omega - c_1) - \beta R^2(\omega - c_1)^2 .$$

Letting the individual have a discount factor of δ, the Lagrangian for the relevant intertemporal utility maximization problem is as follows:

$$L(c_1, c_2, \mu) = u(c_1) + \delta u(c_2) - \mu\left[(1+R)c_1 + c_2 + \alpha R(\omega - c_1) + \beta R^2(\omega - c_1)^2\right].$$

Differentiating the Lagrangian with respect to c_1 and c_2 and setting these expressions equal to zero in order to obtain a maximum,

$$\partial L / \partial c_1 = u'(c_1) - \mu\left[(1+R) - \alpha R - 2\beta R^2(\omega - c_1)\right] = 0 ,$$

$$\partial L / \partial c_2 = \delta u'(c_2) - \mu = 0 .$$

This leads to the following expression:

$$g(c_1; \alpha, \beta) \equiv -u'(c_1) + \left[1 + (1-\alpha)R - 2\beta(\omega - c_1)R^2\right] \cdot \delta u'\left((\omega - c_1)\left(1 + (1-\alpha)R - \beta(\omega - c_1)R^2\right)\right) = 0 .$$

Applying the Implicit Function Theorem, we have

$$\partial c_1^* / \partial \alpha = \frac{\delta u'(c_2)R + \left[1 + (1-\alpha)R - 2\beta(\omega - c_1)R^2\right]\delta u''(c_2)(\omega - c_1)R}{-u''(c_1) + 2\beta\delta u'(c_2)R^2 - \left[1 + (1-\alpha)R - 2\beta(\omega - c_1)R^2\right]^2 \delta u''(c_2)} ,$$

Note that the denominator of this expression is unambiguously positive provided $u' > 0$ and $u'' < 0$. The numerator, however, is ambiguous. The first term is positive (for sufficiently low β), whereas the second is negative. For logarithmic utility, these two effects – the income and substitution effects – cancel each other out exactly. For linear utility, the first term dominates

and consumption increases/investment decreases in response to an increased base tax rate. More precisely, investment decreases if

$$\delta u'(c_2)R > -\left[1+(1-\alpha)R-2\beta(\omega-c_1)R^2\right]\delta u''(c_2)(\omega-c_1)R$$

$$\Leftrightarrow -\frac{c_2u''(c_2)}{u'(c_2)} < \frac{c_2}{(\omega-c_1)\left[1+(1-\alpha)R-2\beta(\omega-c_1)R^2\right]} = 1.$$

Now, again applying the Implicit Function Theorem,

$$\partial c_1^* \big/ \partial\beta = \frac{2\delta u'(c_2)(\omega-c_1)R^2+\left[1+(1-\alpha)R-2\beta(\omega-c_1)R^2\right]\delta u''(c_2)(\omega-c_1)^2R^2}{-u''(c_1)+2\beta\delta u'(c_2)R^2-\left[1+(1-\alpha)R-2\beta(\omega-c_1)R^2\right]^2\delta u''(c_2)}.$$

Note that $\partial c_1^* / \partial\beta$ is *not* the comparative static of interest when it comes to determining how consumption changes as tax progressivity changes while holding overall taxation constant. Increasing β without modifying α will increase the average tax rate at any (positive) level of income. If it was found that increasing β alone increased consumption and thus decreased saving, this would scarcely be a breakthrough, as it may simply be going through the channel of an increased average tax rate rather than the channel of progressivity in itself.

So, consider an increase in β from β_1 to β_2. In order to keep an individual's overall tax rate constant, how must α change? For a given income level y_0,

$$\alpha_1 + \beta_1 y_0 = \alpha_2 + \beta_2 y_0 \Rightarrow \alpha_2 = \alpha_1 + (\beta_1 - \beta_2)y_0 .$$

Thus, if β increments by Δ, α must decrement by Δy_0. Consequently, in order to prove the proposition, it is necessary to show that the directional derivative

$$\partial c_1^* \big/ \partial\beta - (\omega-c_1)R\,\partial c_1^* \big/ \partial\alpha > 0.$$

Substituting in the above expressions, this yields

$$\frac{\delta u'(c_2)(\omega-c_1)R^2}{-u''(c_1)+2\beta\delta u'(c_2)R^2-\left[1+(1-\alpha)R-2\beta(\omega-c_1)R^2\right]^2\delta u''(c_2)} > 0.$$

Note that, with $u' > 0$ and $u'' < 0$, this expression is unambiguously positive. Because investment $s = \omega - c_1$, this means that

$$\partial s^* \big/ \partial\beta - (\omega-c_1)R\,\partial s^* \big/ \partial\alpha < 0,$$

which proves the proposition.

Appendix B: Constructing Measures of Fiscal Size

Constructing a measure of the size of the legislated tax changes that occurred with the flat tax introduction in these countries is not an entirely straightforward process. It requires information on how the incidence of an income tax change falls on various income groups. Evidence suggests that 99% of the income distribution is well-approximated by a lognormal distribution (Clementi and Gallegati 2005). So, I begin with the data on share of total income by population decile from the WIID. These data can be fit to a lognormal distribution, with mean

$$\mu = \frac{\sum_{j=1}^{10} \ln y_j}{10}, \text{ where } y_j = \frac{s_j \cdot GNI}{POP/10}$$

and variance

$$\sigma^2 = \frac{\sum_{j=1}^{10} (y_j - \mu)^2}{10-1},$$

where s_j is the share of income accruing to population decile j (ordered by income), *GNI* is gross national income, and *POP* is national population. y_j, then, is average gross income in population decile j.

With a lognormal income distribution, the share, $S(y)$, of income accruing to people with income below y can then be calculated by integrating the income distribution up to incomes y and dividing this by the integral of said distribution over all incomes.

$$S(y) = \frac{\int_0^y 1 \Big/ \sigma\sqrt{2\pi} \cdot \exp\left(-\frac{(\log x - \mu)^2}{2\sigma^2}\right) dx}{\int_0^\infty 1 \Big/ \sigma\sqrt{2\pi} \cdot \exp\left(-\frac{(\log x - \mu)^2}{2\sigma^2}\right) dx}$$

Denoting by $P(y)$ the proportion of the population with incomes below y, it is now possible to compute the share of total income originating from each bracket—that is, the fraction exposed to each marginal income tax rate. To that end, define

$$y^i \equiv \frac{D + max\_inc^0}{1 - \tau_{ep}},$$

where D denotes the personal deduction, max_inc_i denotes the maximum income included in tax

bracket i, and τ_{ep} denotes the payroll tax paid by employees. (Note that the denominator of y^i is instead 1 if the employee's contribution to payroll tax is not deductible from income tax in the country in question.) max_inc^0 is defined to be 0. Thus y^i is a measure of adjusted gross income. Next, define

$$M(y^i) \equiv \left(S(y^i) - S(y^{i-1})\right) \cdot GNI - \left(P(y^i) - P(y^{i-1})\right) \cdot POP \cdot max\_inc^i$$
$$U(y^i) \equiv \left(max\_inc^i - max\_inc^{i-1}\right) \cdot \left(1 - P(y^i)\right) \cdot POP$$

$M(y^i)$ represents the total amount of (adjusted gross) income in the range [max_inc^{i-1}, max_inc^i] made by individuals whose total AGI is within said bracket. This is computed by subtracting the total income in the range [0, max_inc^{i-1}] of these people from their overall total income. $U(y^i)$ represents the total amount of income in the range [max_inc^{i-1}, max_inc^i] made by individuals whose gross income is *above* said bracket. This is computed simply by multiplying the number of individuals whose gross income is above said bracket by the width of the bracket.

$$\Psi(y^i) = \frac{M(y^i) + U(y^i)}{GNI}$$

The two possible sources of income in bracket [max_inc^{i-1}, max_inc^i] are then divided by total national income, yielding $\Psi(y^i)$, which measures the share of total adjusted gross income originating from bracket i.

As such, the total fiscal size of an income tax change can be computed as

$$\Delta T_{Inc} = \frac{\sum_{i=1}^{N} (\tau_i^{after} - \tau_i^{before}) \Psi(y^i)}{\sum_{j=1}^{N} \tau_j^{before} \Psi(y^j)} \cdot T_{Inc},$$

where T_{Inc} is the total income tax revenue in the economy (as a percentage of GDP), τ_i^{before} is the marginal tax rate on individuals in bracket i before the reform, and τ_i^{after} is the marginal rate on those individuals after the reform. The total fiscal size of a payroll tax/social contribution change, $\Delta T_{Payroll}$, can be computed analogously.

Much more simply, the total fiscal size of a corporate tax change and a VAT change are calculated, respectively, as

$$\Delta T_{Corp} = \frac{\tau_{Corp}^{after} - \tau_{Corp}^{before}}{\tau_{Corp}^{before}} \cdot T_{Corp}$$

$$\Delta T_{VAT} = \frac{\tau_{VAT}^{after} - \tau_{VAT}^{before}}{\tau_{VAT}^{before}} \cdot T_{VAT}$$

Note that T_{Inc}, $T_{Payroll}$, T_{Corp}, and T_{VAT} are obtained from the IMF Government Finance Statistics dataset. Combining these components, this leads to a measure of the overall fiscal size of the tax change,

$$\Delta T = \Delta T_{Inc} + \Delta T_{Payroll} + \Delta T_{Corp} + \Delta T_{VAT} .$$

Appendix C: Measuring Progressivity

The Average Marginal Tax Rate (AMTR) is a measure that has been much-used in the macro-public finance literature. It dates back to Barro and Sahasakul (1983, 1986), providing a macro-level measure of the marginal tax rates faced by a typical unit of income in the relevant country. In particular, it is calculated as follows:

$$AMTR = \sum_b ShareIncome_b \cdot MTR_b$$

That is, the AMTR is a weighted average of the individual marginal tax rates (MTRs) in a country's tax schedule, where each MTR_b is weighted by the share of total income *for which the earner is in* the corresponding tax bracket, *b*. For instance, consider a country with two tax brackets, 20% below 1000 units of currency and 30% above 1000 units of currency. If half the population makes 800 units of currency in a year and the other half makes 1200 units, the average marginal tax rate is 25%. Even though the bulk of income in this hypothetical economy was taxed at the 20% rate, half of the populace faces the 30% on *any marginal income* that they earn. This is what the AMTR measures. As discussed by Barro and Sahasakul (and a multitude of more recent papers), because individuals respond to marginal rates rather than average rates in a whole range of economic decision-making, the AMTR is a more useful concept for macro-level examination of the response of investment, labor supply, etc. to various incentive changes.

The standard deviation of the marginal tax rate (SDMTR) is a useful extension of this concept that is amenable to measuring tax progressivity.

$$SDMTR = \sum_b ShareIncome_b \cdot (MTR_b - AMTR)^2$$

Consider, for example, a pure flat tax system wherein every individual pays 20% on all income. In this case, because the MTR is equal to the AMTR throughout the tax schedule, the SDMTR will be precisely zero. The greater the commonality of deviations in the MTR from the AMTR (i.e., the higher the progressivity), the higher the value of the SDMTR. Note that, for the purposes of my empirical work, I compute the $ShareIncome_b$ in each bracket *b* using the income distributions derived in Appendix B.