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Politically Feasible Reforms of Nonlinear Tax Systems[†]

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We study reforms of nonlinear income tax systems from a political economy perspective. We present a median voter theorem for monotonic tax reforms, reforms so that the change in the tax burden is a monotonic function of income. We also provide an empirical analysis of tax reforms, with a focus on the United States. We show that past reforms have, by and large, been monotonic. We also show that support by the median voter was aligned with majority support in the population. Finally, we develop sufficient statistics that enable to test whether a given tax system admits a politically feasible reform. (*JEL* D72, H21, H24)

This paper presents a new approach for a political economy analysis of nonlinear tax systems. It develops a theory of tax reforms that are politically feasible in the sense that a majority of individuals prefers the reform over the status quo. The theory gets traction from focusing on monotonic tax reforms, i.e., reforms so that changes in the tax burden are a monotonic function of income. We investigate empirically to

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what extent this premise is satisfied in actual tax policy. We also investigate to what extent past reforms were, through the lens of our framework, politically feasible.

The previous literature has focused on models of voting over tax schedules. The set of nonlinear tax policies is a multidimensional policy space. Thus, the median voters' preferred policy is not a Condorcet winner. This complicates any analysis of voting over nonlinear tax schedules. One way of dealing with this complication is to restrict attention to a subset of tax systems for which a median voter theorem applies.[1] These restrictions, however, limit the scope for a comprehensive political economy analysis of top tax rates, earning subsidies for the "working poor," or taxes for the middle class.

One advantage of our approach is that restrictions on marginal tax rates are not needed. Another advantage is that it allows for an easy connection between a normative perspective and a political economy perspective on tax reforms. Normative analyses frequently analyze the welfare implications of raising or lowering the marginal tax rates in a narrow bracket of incomes. These tax perturbations satisfy the monotonicity assumption on which our political economy analysis is based. Thus, we can also analyze whether a given tax system can be reformed in a way that is both politically feasible and welfare-improving, or whether the tax system is efficient in the sense that the scope for politically feasible welfare improvements has been exhausted.

Theorem I (*A Median Voter Theorem for Monotonic Tax Reforms*).—Monotonic tax reforms play an important role both in our theoretical and in our empirical analysis. To fix ideas, we give two stylized examples of monotonic tax reforms: a reform that involves tax cuts for all incomes, with larger cuts for larger incomes is a monotonic tax reform. Another type of monotonic reform is one that involves higher taxes, with increases that are larger for "the rich." Theorem 1 is a median voter result for such tax reforms: a monotonic tax reform is supported by a majority of the population if and only if the person with median income is among the beneficiaries.

We prove this result in the context of a basic model of income taxation: individuals derive utility from consumption and the generation of income requires costly effort. A nonlinear tax system is in place and we analyze whether it can be reformed so that a majority of individuals is in favor of the reform. We consider budget-balanced reforms and assume that changes in tax revenue are rebated lump sum.[2]

At the heart of the median voter result is an application of the envelope theorem. Accordingly, whether a person is beneficiary of a reform depends on how the change in tax revenue relates to the change in the person's tax bill. A person benefits if there is a revenue gain that outweighs higher taxes, or if there is a tax cut that outweighs a loss of revenue. With a monotonic tax reform, there is a single cutoff level of income dividing the proponents and the opponents of the reform. For instance, with a reform that involves tax cuts that are larger for richer people and which causes a loss of revenue, individuals with an income below the cutoff are harmed and individuals with

[1] For instance, the well-known prediction due to Meltzer and Richard (1981) that tax rates are an increasing function of the difference between median and average income is obtained by focusing on linear income taxes.

[2] We discuss extensions of this basic setup in the online Appendix.

an income above the cutoff are made better off. In any case, the group that includes the person with median income forms a majority.

Empirical Analysis I.—Theorem 1 guides our empirical analysis of tax reforms: we investigate to what extent past tax reforms were monotonic. We also look into whether the median voter actually was a beneficiary, and whether there was support for the reform in the population at large. Ultimately, we check whether majority support and support by the median voter are not just aligned in theory, but also in the data. To answer these questions we provide a detailed analysis of the postwar federal income tax reforms in the United States, using NBER's TAXSIM microsimulation model and tax return microdata from the Internal Revenue Service (IRS).[3]

In studying the extent to which reforms of the federal income tax in the United States were monotonic reforms, we take account of the fact that tax reforms often times involved not only a change of tax rates, but also a change in the definition of the tax base. We moreover do justice to the fact that several reforms were gradually phased in over several years. Finally, we document the heterogeneity in the way in which people were affected by these tax reforms (e.g., depending on the number of kids, marital status, or the mix between capital and labor income). We find that the tax reforms were, by and large, monotonic, with monotonic tax cuts, i.e., larger tax cuts for richer taxpayers, being the most prevalent reform type. There were fewer reforms leading to higher taxes on high incomes, but those were also broadly monotonic.

We also document that there was substantial individual heterogeneity in the effects of a tax reform: the correlation between taxpayers' ranks in the income distribution and the change of their tax burden is large, but not perfect. These deviations then lead to the question whether the tax reforms in the United States were monotonic enough in the sense of our theory. The answer is "yes" provided that, for these reforms, support by the median voter was aligned with majority support in the population at large.

In answering this question, we deal with various challenges: for any taxpayer in our data, we need an assessment of whether she was a beneficiary of a reform. Thus, we develop a measure of the effects of a reform on individual welfare. Using this measure, we prove a median voter theorem that applies to large reforms, transcending the analysis of local effects based on the envelope theorem. We address the heterogeneity in the effects of a reform on people with close to median incomes, which complicates the analysis of whether "the median voter" gained or lost from a particular reform. Finally, we don't observe the taxpayers' post-reform incomes, complicating the analysis of the behavioral responses to a reform and of its revenue implications. One of this paper's contributions is to outline an approach that deals with all these issues. Its overall logic is to relate an estimate of the change in total tax revenue to an estimate of how a taxpayer's specific tax burden changed.

The estimates of the revenue implications and of the changes of individual tax burdens that go into this analysis depend on assumptions about the elasticity of taxable income (ETI). We find that, with an ETI of zero, the reforms involving higher

[3] We complement this analysis by looking at a large set of tax reforms in OECD countries, and by looking at various reform proposals that were part of political campaigns in the United States, but which were not enacted.

taxes on "the rich" were both in the interest of the median voter and of a majority of taxpayers. The reforms involving tax cuts were neither in the median voters' interest, nor in the interest of a majority. For the latter type of reform, the overall revenue loss looms substantial so that only individuals with incomes far above the median benefited. When imputing larger ETI values, this finding is eventually reversed. The tax cuts then appear to have been close to self-financing and therefore also in the interest of most taxpayers, including those with close to median incomes. The reforms involving higher taxes on "the rich" are diagnosed as aggravating an inefficiency and as being neither in the median voter's interest, nor in the interest of a majority of taxpayers.

In any case, we find that majority support goes together with support by the median voter. This finding does not depend on any specific value of the ETI. If the median voter liked a reform, so did a majority of taxpayers. If the median voter disliked a reform, then a majority of taxpayers disliked it. The value of the ETI matters only for which of these two possibilities actually applies.

For values of the ETI that are considered plausible in the contemporaneous empirical literature, reviewed in Saez, Slemrod, and Giertz (2012), the reforms involving monotonic tax cuts seem to have made both the median voter and a majority of the population worse off. It is interesting to note, however, that much higher values of the ETI were considered plausible at times when some of the prominent tax cuts were prepared or had already been enacted; see, in particular, the seminal articles by Feldstein (1995, 1999).

Theorem II (*Political Feasibility and Welfare*).—In some of our analysis, we focus on simple reforms. Such a reform involves a small change of the marginal tax rates for incomes in a narrow bracket. Simple reforms are monotonic so that Theorem 1 applies. Moreover, they have welfare implications that are well understood.[4] Hence, by focusing on simple reforms we can provide a more detailed analysis of how the set of politically feasible reforms relates to the set of welfare-maximizing reforms.[5]

Theorem 2 provides a characterization: if the status quo is a Pareto-efficient tax system, tax cuts for below-median incomes and tax increases for above-median incomes are politically feasible. If tax rates on high incomes are revenue-maximizing in the status quo, only tax cuts below the median are politically feasible. An implication of the theorem is that a sequence of politically feasible reforms should lead to lower and lower marginal tax rates below the median and, possibly, to higher and higher marginal tax rates above the median. Moreover, such a sequence should give rise to an income range with a pronounced progression of marginal tax rates that connects the low rates below the median with the high rates above the median.[6]

[4] See Piketty (1997); Saez (2001); Golosov, Tsyvinski, and Werquin (2014); or Jacquet and Lehmann (2016).

[5] A caveat that applies to any approach based on small reforms is that it can only identify directions for reform. While this is informative, it does not extend without further assumptions to large reforms: see Kleven (forthcoming). This qualification also applies to Theorem 2 and the subsequent analysis. It identifies politically feasible reform directions.

[6] In our empirical analysis we present suggestive evidence of this pattern for the United States. In the German income tax, progression is indeed particularly pronounced for middle incomes, a phenomenon referred to as the "Mittelstandsbauch" (middle class belly). This is similar in the Netherlands: see Jacobs, Jongen, and Zoutman (2017).

As a corollary, Theorem 2 also provides an answer to the question whether a given tax system can be reformed in a way that is both welfare-improving and politically feasible. If tax rates below the median are too high from a welfare perspective, then tax cuts are both politically feasible and welfare-improving. If tax rates are too low above the median, then they can be increased in a way that is both politically feasible and welfare-improving. Otherwise, there is no simple reform that is both welfare-improving and politically feasible.

Empirical Analysis II.—We present an empirical analysis that is motivated by Theorem 2. Specifically, we check whether US tax reforms since World War II (WWII) led to lower marginal tax rates below the median, possibly, in connection with higher marginal tax rates above the median, and, in any case, more pronounced progression over a range of middle incomes. We argue that the introduction and the expansion of the Earned Income Tax Credit (EITC) indeed led to lower marginal tax rates for low incomes and more pronounced progression for incomes not quite as low. There is no move toward higher tax rates for above-median incomes.

To provide a more detailed explanation for these observations, we employ sufficient statistics that enable us to identify politically feasible reforms empirically. We derive upper and lower Pareto bounds which determine the range over which reforms toward lower marginal tax rates below the median, or toward higher marginal tax rates above the median are politically feasible. How tight these Pareto bounds are depends, again, on the behavioral responses to taxation, i.e., the ETI.

We then look at past reforms and find that the upper Pareto bound got close to the status quo schedule for values of this elasticity that are discussed in the empirical literature. Thus, the discussion about the appropriate value of the ETI has implications for whether taxes on "the rich" could be increased in a politically feasible way. Low estimates suggest that the answer is "yes," high estimates suggest that the answer is "no." The lower bound does not give rise to such controversies. It was far away from the status quo for plausible values of the ETI. Thus, marginal taxes on "the poor" could be lowered in a politically feasible way. These findings are consistent with the US reforms, as sketched in the previous paragraph, that is, with the pattern that taxes on the "working poor" were lowered, whereas taxes on "the rich" were not increased.

Outline.—The next section discusses the related literature. The formal framework is introduced in Section II. Section III presents the median voter theorem for monotonic reforms. The characterization of simple reforms that are politically feasible can be found in Section IV. Section V contains the results of our empirical analysis. The last section contains concluding remarks. Formal proofs are relegated to the online Appendix. There we also discuss extensions of the median voter theorem for monotonic reforms to models that are richer than our basic setup.[7]

[7] Specifically, we consider the possibility to mix direct and indirect taxes as in Atkinson and Stiglitz (1976) the possibility to add sources of heterogeneity among individuals such as fixed costs of labor market participation or public goods preferences, and the possibility that taxpayers seek to mitigate income differences that are due to luck as opposed to effort as in Alesina and Angeletos (2005).

I. Related Literature

Most of the previous literature on the political economy of taxation has focused on models of *voting over tax schedules.* Contributions differ in the specification of the policy domain, e.g., whether taxes are linear or nonlinear, and in the specification of the political economy model, e.g., whether there is party competition as in Downs (1957) or competition between candidates as in the citizen-candidate framework due to Osborne and Slivinski (1996) and Besley and Coate (1997). Below we explain in more detail how our work relates to this literature. An advantage of our focus on monotonic tax reforms is that it allows for a political economy analysis on a domain that is relevant for optimal nonlinear taxation. This allows to analyze the tension between what is welfare-improving and what is politically feasible. In particular, it connects with the literature on optimal taxes and/or welfare-improving tax reforms that invokes the perturbation method. Simple reforms play an important role in this literature. Simple reforms are monotonic. Hence, our political economy analysis applies to them.

Our approach is, moreover, inspired by an older literature in public finance that seeks to complement the theory of optimal taxation, which characterizes welfare-maximizing tax systems and has no role for current tax policy, by a theory of incremental changes that apply to a given status quo, see Feldstein (1976).[8] Our analysis goes beyond this earlier literature by combining results from social choice theory on the validity of median voter theorems, see in particular Rothstein (1990, 1991), with the perturbation approach to the analysis of nonlinear tax systems, see Piketty (1997); Saez (2001); Golosov, Tsyvinski, and Werquin (2014); and Jacquet and Lehmann (2016) for important references.

The seminal contribution on linear income taxation and Downsian competition is Roberts (1977). This paper is known for a median voter result. Gans and Smart (1996) note the connection between this result and the more general analysis by Rothstein. Our work is related in that we also draw on Rothstein's insight to prove a median voter theorem, albeit one that applies to tax reforms.[9] Median voter results are also established by Röell (2012), Bohn and Stuart (2013) and Brett and Weymark (2016, 2017) who study nonlinear taxes in the citizen-candidate framework.[10]

Median voter theorems for linear income taxation are known for the prediction that more inequality, measured by the gap between average and median income, leads to more redistributive taxation, see Meltzer and Richard (1981). The explanatory power

[8] Weymark (1981), for instance, studies the scope for Pareto-improving reforms of a commodity tax system. Guesnerie (1995) provides a survey of this literature and contains an analysis of tax reforms that emphasizes political economy forces, formalized as a requirement of coalition-proofness.

[9] Gans and Smart (1996) also show that the median voter result due to Roberts (1977) extends to a set of nonlinear tax systems, namely those that can be ordered according to their degree of progressivity; among them tax schedules with a constant rate of progressivity, see Heathcote, Storesletten, and Violante (2017). Bénabou (2000) uses this framework for a dynamic political economy analysis of redistributive taxation.

[10] There are also political economy approaches to nonlinear taxation that do not give rise to median voter results. Nonlinear taxation has, for instance, been squared with probabilistic voting, political agency models, or pork-barrel spending: see Farhi et al. (2012); Scheuer and Wolitzky (2016); Acemoglu, Golosov, and Tsyvinski (2008, 2010); or Bierbrauer and Boyer (2016). Saez and Stantcheva (2016) study generalized welfare functions with weights that may reflect such political equilibrium outcomes. Our approach differs in that we do not solve for an equilibrium policy in a game of political competition. Instead, we provide a characterization of a set of politically feasible reforms. The more specific models of political competition can be used to select an equilibrium policy from this set.

of this framework was found to be limited, see, for instance, the review in Acemoglu et al. (2015), and has led to analyses in which the preferences for redistributive tax policies are also shaped by prospects for upward mobility or a desire for a fair distribution of incomes.[11] In the online Appendix, we extend our basic analysis and prove a median voter theorem for reforms of nonlinear tax systems that takes account of such demands for fairness.

Pareto bounds for nonlinear taxes play an important role in our characterization of politically feasible tax reforms. This links our analysis to work on Pareto-efficient taxation, see Stiglitz (1982), Werning (2007) or Lorenz and Sachs (2016). We complement this literature by characterizing a lower Pareto bound for marginal tax rates on top of the classical upper Pareto bound, and we provide an application of these Pareto bounds to the data.

The empirical analysis in this paper makes use of tax return microdata and of NBER's TAXSIM microsimulation model. In terms of research methodology, we build on and extend work by Eissa, Kleven, and Kreiner (2008) and Bargain et al. (2015). Similar approaches have also been used for the purpose of ex ante policy evaluation: see Immervoll et al. (2007) for a prominent example. Our analysis makes use of these tools for a political economy analysis, and, at the same time, for an analysis of how various aspects of US tax policy have evolved since WWII.[12] Our empirical analysis focuses on questions that have not been addressed in the previous literature: to what extent are tax reforms monotonic? To what extent is support by people with close to median income aligned with majority support in the population? To what extent are lower taxes on "the poor" and higher taxes on "the rich" politically feasible? Our answers also take account of the behavioral responses to taxation.

In answering these questions we also extend existing literature on tax reforms in the United States.[13] Eissa, Kleven, and Kreiner (2008) analyze four tax reforms of 1986, 1990, 1993, and 2001 using survey data from Current Population Survey (CPS) and focus on single mothers. Bargain et al. (2015) also include the reforms of 1981 and 2003. We complement their analysis by also investigating the five additional reforms of 1964, 1969, 1978, 2012, and 2017.

II. The Model

We study the political economy of tax reforms through the lens of a generic Mirrleesian model of income taxation: individuals value consumption and the generation of income requires costly effort. They maximize utility, subject to a budget constraint that is shaped by a nonlinear income tax system. We begin with a

[11] See, for instance, Piketty (1995); Bénabou and Ok (2001); Alesina and Angeletos (2005); Bénabou and Tirole (2006); or Alesina, Stantcheva, and Teso (2018).

[12] Broadly related, but with a difference in focus, are Piketty and Saez (2007) and Roemer (2011). Piketty and Saez (2007) analyze changes in the progressivity of the US federal income tax over time. Roemer (2011) looks at five US tax income reforms (1981, 1986, 1993, 1997, 2001) with data assembled by Piketty and Saez (2007) and the Tax Policy Center. He focuses on the hypothesis that the tax policy proposed by leftist and rightist parties has similar implications for the middle class. See, also, Egger, Nigai, and Strecker (2019) who analyze the development of labor income in many countries around the world from 1980 to 2007.

[13] Several policy studies by the Joint Committee on Taxation, the Congressional Budget Office, or the Tax Policy Center analyze single reforms: see online Appendix Section H.

specification of preferences and then describe how individual choices as well as measures of tax revenue, welfare, and political support are affected by reforms of the tax system.

Preferences.—There is a continuum of individuals of measure 1. Individuals have a utility function u that is increasing in private goods consumption, or after-tax income, c, and decreasing in earnings or pretax income y. Individuals differ in their willingness to work harder in exchange for increased consumption. To formalize this we distinguish different types of individuals. The set of possible types is denoted by Ω with generic entry ω. The utility that an individual with type ω derives from c and y is denoted by $u(c,y,\omega)$.[14] For ease of exposition, we assume that preferences are quasilinear in private goods consumption and that the effort costs are isoelastic,[15]

$$u(c,y,\omega) = c - \frac{1}{1+\frac{1}{\varepsilon}}\left(\frac{y}{\omega}\right)^{1+\frac{1}{\varepsilon}}.$$

With this utility function, preferences satisfy the Spence-Mirrlees single crossing property. This implies that higher types choose higher incomes than lower types, and, in particular, that this ordering does not depend on the tax system. The set Ω is taken to be a compact subset of the nonnegative real numbers, $\Omega = [\underline{\omega},\bar{\omega}] \subset \mathbb{R}_+$. The cross-section distribution of types in the population is represented by a cumulative distribution function F with density f. We denote the median of this distribution by ω^M.

Tax Reforms.—Individuals are confronted with a predetermined income tax schedule T_0 that assigns a (possibly negative) tax payment $T_0(y)$ to every level of pretax income $y \in \mathbb{R}_+$. Individuals with no income receive a transfer equal to $c_0 \geq 0$. A reform induces a new tax schedule T_1 that is derived from T_0 so that, for any level of pretax income y, $T_1(y) = T_0(y) + \tau h(y)$, where τ is a scalar and h is a function. We represent a reform by the pair (τ,h) where τ measures the size the reform.

A tax reform is said to be monotonic over a range of incomes $\mathcal{Y}$ if $T_1(y) - T_0(y) = \tau h(y)$ is a monotonic function for $y \in \mathcal{Y}$. Given a cross-section distribution of income, we say that a reform is monotonic above (below) the median if $T_1 - T_0$ is a monotonic function for incomes above (below) the median income. As will become clear, monotonicity at least above or below the median is key for our median voter results.

A reform induces a change in tax revenue denoted by $R(\tau,h)$. For now we assume that this additional tax revenue is used to increase the basic consumption level c_0. Alternative uses of tax revenue are considered in the online Appendix.

Simple Reforms.—Some of our results follow from looking at a special class of reforms that we refer to as *simple* in what follows. Simple reforms play a prominent

[14] The literature often interprets ω as an hourly wage and $l = y/\omega$ as the time that an individual needs to generate a pretax-income of y, see, e.g., Mirrlees (1971) or Diamond (1998).

[15] A generalization that allows for income effects can be found in Bierbrauer and Boyer (2018).

role in the literature, see, e.g., Saez (2001) and Piketty and Saez (2013). Such a reform involves a change of marginal tax rates for incomes in a given bracket. More formally, there exists a threshold level of income y_a, so that the new and the old tax schedule coincide for all income levels below the threshold, $T_0(y) = T_1(y)$ for all $y \leq y_a$. For incomes in the bracket, marginal tax rates change by τ. Let ℓ be the length of the bracket, and $y_b = y_a + \ell$ be the end of the bracket. Then, $T_0'(y) + \tau = T_1'(y)$ for all $y \in (y_a, y_b)$. For all incomes above y_b, marginal tax rates do not change, so that $T_0'(y) = T_1'(y)$ for all $y \geq y_b$. Hence, the function h is such that

$$h(y) = \begin{cases} 0, & \text{if } y \leq y_a; \\ y - y_a, & \text{if } y_a < y < y_b; \\ \ell, & \text{if } y \geq y_b. \end{cases} \tag{1}$$

For reforms of this type we will write (τ, ℓ, y_a) rather than (τ, h), see Figure 1 for an illustration.

Notation and Terminology.—To describe the implications of reforms for measures of revenue, welfare, and political support, it proves useful to introduce the following optimization problem: choose y so as to maximize

$$c_0 + R + y - T_1(y) - \frac{1}{1 + \frac{1}{\varepsilon}} \left(\frac{y}{\omega}\right)^{1+\frac{1}{\varepsilon}}, \quad \text{where} \quad T_1(y) = T_0(y) + \tau h(y).$$

We assume that this optimization problem has, for each type ω, a unique solution that we denote by $y^*(\tau, h, \omega)$. The corresponding level of indirect utility is given by

$$c_0 + R + v(\tau, h, \omega),$$

where the function v gives indirect utility net of government transfers. We can now express the reform-induced change in tax revenue as

$$R(\tau, h) := \int_{\underline{\omega}}^{\bar{\omega}} \left\{ T_1\left(y^*(\tau, h, \omega)\right) - T_0\left(y^*(0, h, \omega)\right) \right\} f(\omega)\, d\omega.$$

We assume that $R(\cdot, h)$ is a differentiable function of τ and denote the derivative by R_τ. The reform-induced change in indirect utility for a type ω individual is given by

$$V(\tau, h, \omega) := R(\tau, h) + v(\tau, h, \omega) - v(0, h, \omega).$$

Pareto-Improving Reforms.—A reform (τ, h) is said to be Pareto-improving if, for all $\omega \in \Omega$, $V(\tau, h, \omega) \geq 0$, and if this inequality is strict for some $\omega \in \Omega$.

Welfare-Improving Reforms.—Consider a social welfare function with welfare weights $g : \omega \mapsto g(\omega)$ that are non-increasing. The welfare change that is induced by a reform is given by

$$W(\tau, h) := \int_{\underline{\omega}}^{\bar{\omega}} g(\omega) V(\tau, h, \omega) f(\omega)\, d\omega.$$

A reform (τ, h) is said to be welfare-improving if $W(\tau, h) > 0$.

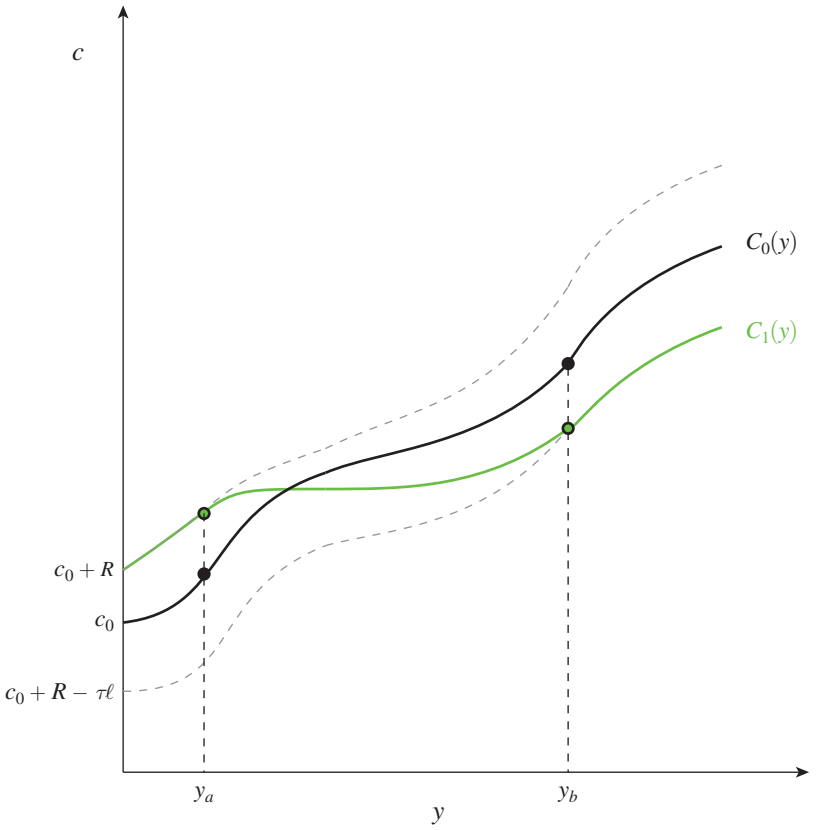

FIGURE 1. A SIMPLE REFORM

Notes: Figure 1 shows how a simple reform that generates positive tax revenue, $R > 0$, affects the combinations of consumption c and earnings y that are available to individuals. Specifically, the figure shows the curves $C_0(y) = c_0 + y - T_0(y)$ and $C_1(y) = c_0 + R + y - T_0(y) - \tau h(y)$. For incomes below y_a and above y_b the curves have the same slopes. The basic transfer increases by R so that more consumption is available at income levels smaller than y_a. Less consumption is available at income levels larger than y_b: in Figure 1 we assume that, at these income levels, the loss from the additional tax payment $\tau\ell$ exceeds the gain from the increase of the basic transfer. Otherwise the reform would be Pareto-improving, leading to additional consumption at all levels of income. Between y_a and y_b the increased marginal tax rate implies that the consumption schedule becomes flatter.

Political Support for Reforms.—Political support for the reform is measured by the mass of individuals who are made better off if the initial tax schedule T_0 is replaced by T_1,

$$S(\tau, h) := \int_{\underline{\omega}}^{\bar{\omega}} \mathbf{1}\{V(\tau, h, \omega) > 0\} f(\omega)\, d\omega,$$

where $\mathbf{1}\{\cdot\}$ is the indicator function. A reform (τ, h) is supported by a majority of the population if $S(\tau, h) \geq 1/2$. We call such reforms politically feasible.

III. Median Voter Theorems for Monotonic Reforms

The focus on monotonic reforms enables a characterization of reforms that are politically feasible. As we show in this section, checking whether a reform is

supported by a majority of individuals is, with some qualifications, the same as checking whether the taxpayer with median income is a beneficiary of the reform. We begin with an analysis of small reforms and turn to large reforms subsequently.

We say that an individual of type ω benefits from a small reform if, starting from some reform intensity τ', the reform intensity is increased at the margin, i.e., if

$$V_\tau(\tau', h, \omega) \coloneqq \frac{d}{d\tau} V(\tau, h, \omega)|_{\tau=\tau'} > 0.$$

If this derivative is negative, the individual benefits from a reduction of the reform intensity. For a simple reform, an increase of τ simply means that marginal tax rates in the given bracket are increased.

THEOREM 1: *Let h be a monotonic function. The following statements are equivalent:*

(*i*) *The median voter benefits from a small reform.*

(*ii*) *There is a majority of voters who benefit from a small reform.*

The proof in online Appendix Section A makes use of the envelope theorem:[16]

$$V_\tau(\tau, h, \omega) = R_\tau(\tau, h) - h\big(y^*(\tau, h, \omega)\big). \tag{2}$$

For concreteness, consider a reform that involves tax cuts for everybody and that the cuts for richer people are larger than the ones for poorer people. Also suppose that the median voter supports the reform; that is, from the median voter's perspective, the gain from the tax cut outweighs the loss of tax revenue. For taxpayers with above-median incomes, the gains are even larger. Hence, everyone who is richer than the median will also support the reform. The same logic applies if the median voter opposes the reform. Then everyone who is poorer than the median will oppose it, too. Thus, support of the median voter is both necessary and sufficient for political feasibility.

The median voter result in Theorem 1 exploits the Spence-Mirrlees single crossing condition.[17] In the online Appendix we also consider extensions where the Spence-Mirrlees single crossing condition does not hold.[18] In such a setting, the taxpayer with median income under the initial tax system T_0 may be different from the taxpayer with median income under the new tax system, T_1. The median voter theorem then only holds for small reforms in a neighborhood of the status quo; that is, such a small reform is politically feasible if and only if it is in the interest of the

[16] The validity of the Envelope Theorem follows from the analysis of Milgrom and Segal (2002). This theorem does not require differentiability of the status quo schedule T_0, the direction of the reform h, or continuity of the behavioral responses y^*. It only requires that utility functions satisfy continuity and differentiability assumptions that are fulfilled in our case.

[17] For a discussion of how the Spence-Mirrlees single crossing condition relates to single crossing conditions that are used in social choice theory to prove median voter theorems, see Bierbrauer and Boyer (2018).

[18] For instance, we consider a setup where individuals differ in their variable effort costs as in the Mirrlees model and in their fixed costs of labor market participation, as in Saez (2002) or Jacquet, Lehmann, and Van der Linden (2013).

taxpayer with median income in the status quo. Technically, we need to add a qualification to Theorem 1: it only holds locally, at $\tau = 0$.

Non-Monotonic Reforms.—Not all conceivable reforms are such that h is monotonic for all levels of income. The following Proposition gives conditions under which support of the median voter is a sufficient condition for political feasibility.

PROPOSITION 1:

(*i*) *Let h be nondecreasing for $y \geq y^*(\tau, h, \omega^M)$. If the median voter benefits from a small reform with $\tau < 0$, then it is politically feasible.*

(*ii*) *Let h be nondecreasing for $y \leq y^*(\tau, h, \omega^M)$. If the poorest voter benefits from a small reform with $\tau < 0$, then it is politically feasible.*

The first part of Proposition 1 covers reforms that are monotonic and involve tax cuts that are larger for richer individuals. We present empirical examples of tax reforms with this property below. A way of making sure that such a reform is appealing to a majority of voters is to have the median voter among the beneficiaries. If, from the median voter's perspective, the reduced tax burden outweighs the loss of tax revenue, then everybody with above-median income benefits from the reform.

The second part applies the same logic to tax cuts for low incomes. If the poorest individuals benefit from a tax cut and h is nondecreasing for below-median incomes, then individuals with incomes closer to the median benefit even more. Individuals with below-median incomes then constitute a majority in favor of the reform. This case applies, in particular, to reforms so that $T_1 - T_0$ is negative and decreasing for incomes below a threshold $\hat{y}$, see below for empirical examples. In this case, political feasibility is ensured by putting the threshold (weakly) above the median, so that everybody with below-median income is a beneficiary of the reform.

Large Reforms.—The results in Theorem 1 can be easily extended to large reforms. Say that an individual of type ω benefits from a reform (τ, h) if $V(\tau, h, \omega) > 0$ and note that the gains or losses from the reform can be written as

$$\begin{aligned} V(\tau, h, \omega) &= \int_0^\tau V_\tau(s, h, \omega)\, ds \\ &= R(\tau, h) - \int_0^\tau h\big(y^*(s, h, \omega)\big)\, ds \\ &=: R(\tau, h) - H(\tau, h, \omega). \end{aligned}$$

Also note that $H(\tau, h, \cdot)$ is a monotonic function of ω if h is a monotonic function. Thus, upon replacing h by H in the proof of Theorem 1 we obtain the following corollary.

COROLLARY 1: *Let h be a monotonic function. The following statements are equivalent:*

(*i*) *The median voter benefits from a reform* (τ, h).

(*ii*) *The reform* (τ, h) *is politically feasible*.

Proposition 1 also extends to large reforms with the appropriate qualifications.

In our empirical analysis that is based on Theorem 1 (see Section V) we investigate to what extent past reforms were monotonic and also whether the taxpayer with median income was a beneficiary of the reform. When bringing the theory to data, we will make use of the following insight: suppose that the function h is nondecreasing and that median income $y^*(s, h, \omega^M)$ is a monotonic function of the reform intensity s.[19] Also, for concreteness, suppose that the reform involves an increase of the marginal tax rate for the median income. Then, using the shorthand $y_1^M := y^*(\tau, h, \omega^M)$ for median income after the reform,

$$\tau h\big(y_1^M\big) \leq H(\tau, h, \omega) \leq \tau h\big(y_0^M\big)$$

or, equivalently,

$$T_1\big(y_1^M\big) - T_0\big(y_1^M\big) \leq H(\tau, h, \omega) \leq T_1\big(y_0^M\big) - T_0\big(y_0^M\big). \tag{3}$$

As a consequence,

$$\begin{aligned} R(\tau, h) - \Big(T_1\big(y_0^M\big) - T_0\big(y_0^M\big)\Big) &\leq V\big(\tau, h, \omega^M\big) \\ &\leq R(\tau, h) - \Big(T_1\big(y_1^M\big) - T_0\big(y_1^M\big)\Big). \end{aligned} \tag{4}$$

Thus, when the median voter experiences an increase of the marginal tax rate, we underestimate her utility gain when we compare the overall revenue effect to the change of the tax burden and thereby take account only of the mechanical effect. By contrast, we overestimate her utility gain, when we base the change of her tax burden on the post-reform income.[20] This pattern is reversed when there is a decrease of the marginal tax rate at the median level of income. In this case,

$$\begin{aligned} R(\tau, h) - \Big(T_1\big(y_1^M\big) - T_0\big(y_1^M\big)\Big) &\leq V\big(\tau, h, \omega^M\big) \\ &\leq R(\tau, h) - \Big(T_1\big(y_0^M\big) - T_0\big(y_0^M\big)\Big). \end{aligned} \tag{5}$$

[19] Substantively, this requires that there is an unambiguous effect on the marginal tax rate faced by the median voter, i.e., this tax rate increases or decreases in the reform intensity. The assumption is satisfied with simple reforms.

[20] The lower and the upper bound coincide when there are no behavioral responses, so that $y_1^M = y_0^M$.

In the light of (4) and (5), a sufficient condition under which the median voter is a beneficiary of a tax reform is

$$R(\tau,h) - \max\left\{T_1\left(y_1^M\right) - T_0\left(y_1^M\right), T_1\left(y_0^M\right) - T_0\left(y_0^M\right)\right\} \geq 0. \tag{6}$$

Analogously, the median voter is worse off if

$$R(\tau,h) - \min\left\{T_1\left(y_1^M\right) - T_0\left(y_1^M\right), T_1\left(y_0^M\right) - T_0\left(y_0^M\right)\right\} < 0. \tag{7}$$

We will make use of these conditions in our empirical analysis in Section V when we check whether past reforms were in the median voter's interest.

IV. Detecting Politically Feasible Reforms

By the median voter theorem, in order to understand whether a given tax system can be reformed in a politically feasible way, we need to understand whether it can be reformed in a way that makes the voter with median income better off. But how do we tell whether that's the case? In this section, we focus on simple reforms.[21] Theorem 2 provides a characterization of the conditions under which such a reform is politically feasible. Based on this characterization we develop sufficient statistics that make it possible to identify politically feasible reforms empirically. By squaring this approach with sufficient statistics for the welfare implications of reforms, we finally obtain conditions under which welfare improvements are politically feasible.

A. *Pareto-Efficient Tax Systems and Politically Feasible Reforms*

A tax schedule T_0 is Pareto-efficient if there is no Pareto-improving reform. If it is Pareto-efficient, then for all y_a and ℓ,

$$\ell \geq R_\tau(0,\ell,y_a) \geq 0,$$

where $R_\tau(0,\ell,y_a)$ is the marginal change in tax revenue that results as we slightly rise τ above 0, while keeping y_a and ℓ fix. This follows from equations (1) and (2): if we had $R_\tau(0,\ell,y_a) < 0$, a small reform (τ,ℓ,y_a) with $\tau < 0$ would be Pareto-improving: all individuals would benefit from increased transfers and individuals with an income above y_a would, in addition, benefit from a tax cut. With $\ell < R_\tau(0,\ell,y_a)$, a small reform (τ,ℓ,y_a) with $\tau > 0$ would be Pareto-improving. All individuals would benefit from increased transfers. Individuals with an income above y_a would not benefit as much because of increased marginal tax rates. They would still be net beneficiaries because the increase of the tax burden was dominated by the increase of transfers. Under a Pareto-efficient tax system there is no scope for such reforms. We say that T_0 is an *interior Pareto-optimum* if, for all y_a and ℓ,

[21] Simple reforms induce discontinuities in marginal tax rates. For ease of exposition, the formal proofs for this section use smooth approximations of simple reforms that avoid these discontinuities. Thereby we follow Golosov, Tsyvinski, and Werquin (2014). Working directly with simple reforms is possible and yields the same conclusions, but at the cost of longer and more detailed derivations, see Bierbrauer and Boyer (2018).

$$\ell > R_\tau(0, \ell, y_a) > 0.$$

THEOREM 2: *Suppose that T_0 is an interior Pareto-optimum.*

(*i*) *For any $y_a < y_0^M$, there is a simple reform with $\tau < 0$ that is politically feasible.*

(*ii*) *For any $y_a > y_0^M$, there is a simple reform with $\tau > 0$ that is politically feasible.*

According to the theorem, one can find a politically feasible reform for any level of income $y_a \neq y_0^M$ if the status quo is an interior Pareto optimum. Specifically, reforms that involve a shift toward lower marginal tax rates for below-median incomes and reforms that involve a shift toward higher marginal tax rates for above-median incomes are politically feasible. A lowering of marginal taxes comes with a loss of tax revenue. For individuals with incomes above $y_b = y_a + \ell$, the reduction of their tax burden outweighs the loss of transfer income so that they benefit from such a reform. If y_b is smaller than the median income, this applies to all individuals with an income (weakly) above the median. Hence, the reform is politically feasible. By the same logic, an increase of marginal taxes for incomes between y_a and y_b generates additional tax revenue. If y_a is chosen so that $y_a \geq y_0^M$, only individuals with above-median income have to pay higher taxes with the consequence that all individuals with below-median income, and hence a majority, benefit from the reform.

Proposition 2 presents sufficient statistics that characterize upper and lower Pareto bounds for marginal tax rates. Given data on the distribution of incomes, the current tax system and the behavioral responses to taxation, these sufficient statistics provide an answer to the question, whether the status quo is an interior Pareto-optimum. We can then apply Theorem 2 to see what types of reforms are politically feasible. Upon combining these insights with a characterization of welfare-improving reforms we finally obtain sufficient statistics formulas for politically feasible welfare improvements (see Corollary 3). Table 1 provides both a preview and a summary of this analysis.

The table refers to three functions that can be used to diagnose, $\mathcal{D}$, whether marginal taxes rates in the status quo are inefficiently low or inefficiently high, or whether a change of marginal tax rates would be politically feasible and/or welfare-improving. Formally, they are defined by

$$\mathcal{D}^{low}(y) := -\frac{F\big(\omega_0(y)\big)}{f\big(\omega_0(y)\big)\,\omega_0(y)}\left(1 + \frac{1}{\varepsilon}\right),$$

$$\mathcal{D}^{up}(y) := \frac{1 - F\big(\omega_0(y)\big)}{f\big(\omega_0(y)\big)\,\omega_0(y)}\left(1 + \frac{1}{\varepsilon}\right),$$

and

$$\mathcal{D}^{W}(y) := \frac{1 - F\big(\omega_0(y)\big)}{f\big(\omega_0(y)\big)\omega}\left(1 + \frac{1}{\varepsilon}\right)\Big(1 - \mathcal{G}\big(\omega_0(y)\big)\Big),$$

Table 1—Detecting Politically Feasible and Welfare-Improving Reforms

	Income (y) below median			Income (y) above median		
	Pareto	Political	Welfare	Pareto	Political	Welfare
$\frac{T_0'(y)}{1-T_0'(y)} > \mathcal{D}^{up}(y)$	↓	↓	↓	↓	↓	↓
$\mathcal{D}^{up}(y) > \frac{T_0'(y)}{1-T_0'(y)} > \mathcal{D}^{W}(y)$	—	↓	↓	—	↑	↓
$\mathcal{D}^{W}(y) > \frac{T_0'(y)}{1-T_0'(y)} > \mathcal{D}^{low}(y)$	—	↓	↑	—	↑	↑
$\frac{T_0'(y)}{1-T_0'(y)} < \mathcal{D}^{low}(y)$	↑	↑	↑	↑	↑	↑

where $\omega_0(y)$ is the type with an income of y in the status quo and $\mathcal{G}(\omega_0(y)) \coloneqq E[g(s) \,|\, s \geq \omega_0(y)]$ is the average welfare weight associated to individuals with types above ω_0. These expressions are related to $T_0'(y)/(1 - T_0'(y))$, i.e., to an increasing function of the marginal tax rate $T_0'(y)$. An inequality such as $\mathcal{D}^{W}(y) > T_0'(y)/(1 - T_0'(y))$ indicates that the marginal tax rate at income level y is below a threshold, and hence that an increase would be welfare-improving. More generally, an arrow pointing upward (resp., downward) indicates that raising (resp., lowering) marginal tax rates for incomes in a neighborhood of y is Pareto-improving, politically feasible, or welfare-improving. The symbol "—" indicates that changes of marginal tax rates are neither Pareto-improving nor Pareto-damaging.

According to the first line of Table 1, if a tax system is such that the marginal tax rate at income y exceeds the upper Pareto bound, then lowering marginal tax rates for incomes in a neighborhood of y is Pareto-improving, welfare-improving, and politically feasible. Analogously, according to the last line, if tax rates are inefficiently low in the status quo, then increased rates are Pareto-improving, welfare-improving, and politically feasible. The second and third line consider tax reforms that are not Pareto-improving. For below-median incomes, only tax cuts are politically feasible. If marginal tax rates are too high according to a given welfare function, then there is scope for a politically feasible welfare-improvement. Otherwise, there is a conflict between what is politically feasible and what is desirable from a welfare perspective. For above-median incomes, only higher tax rates are politically feasible. Thus, there is scope for a politically feasible welfare improvement if and only if moving toward higher rates is also welfare-improving.

B. *Pareto Bounds for Marginal Tax Rates*

According to the following Proposition 2, if the status quo tax schedule is Pareto-efficient, then marginal tax rates are bounded from above by an upper Pareto bound and from below by a lower Pareto bound. Formally, for any income level y',

$$\mathcal{D}^{up}(y') \geq \frac{T_0'(y')}{1 - T_0'(y')} \geq \mathcal{D}^{low}(y').$$

PROPOSITION 2: *Suppose that income in the status quo* $\omega_0 : y \mapsto \omega_0(y)$ *is a strictly monotonic and continuous function.*[22] *Also suppose that income in the status quo satisfies the first-order conditions of utility-maximization.*

(*i*) *Suppose that the status quo schedule* T_0 *is such that, at income level* y',

$$\frac{T_0'(y')}{1 - T_0'(y')} > \mathcal{D}^{up}(y') := \frac{1 - F\big(\omega_0(y')\big)}{f\big(\omega_0(y')\big)\,\omega_0(y')}\Big(1 + \frac{1}{\varepsilon}\Big), \tag{8}$$

then there is a simple Pareto-improving reform (τ, ℓ, y') *that involves a decrease of the marginal tax rate at* y'.

(*ii*) *Suppose that the status quo schedule* T_0 *is such that, at income level* y',

$$\frac{T_0'(y')}{1 - T_0'(y')} < \mathcal{D}^{low}(y') := -\frac{F\big(\omega_0(y')\big)}{f\big(\omega_0(y')\big)\,\omega_0(y')}\Big(1 + \frac{1}{\varepsilon}\Big), \tag{9}$$

then there is a simple Pareto-improving reform (τ, ℓ, y') *that involves an increase of the marginal tax rate at* y'.

The Upper Pareto Bound.—The right-hand side of equation (8), $\mathcal{D}^{up}(y')$, is a product of two terms, an inverse hazard rate and an inverse elasticities term. To see the role that they play, consider a reform that involves an increase of marginal tax rates for incomes in a small neighborhood of y': the inverse hazard rates relates the number of people who pay higher taxes and show no behavioral response, $1 - F(\cdot)$, to the number of people who show a behavioral response and choose to earn less, $f(\cdot)$. The smaller this ratio, the smaller is the revenue effect of the tax reform. The elasticity ε measures the size of this behavioral response. Thus, a larger behavioral response and a larger hazard rate make it more difficult to raise revenue with such a simple reform at y'. If these terms exceed critical values, then there is a loss rather than a gain of revenue. Tax cuts are then Pareto-improving.

We can relate Proposition 2 also to the tax policy that maximizes tax revenue, or, equivalently, a Rawlsian social welfare function. As we show in online Appendix Section B, under such a tax policy,

$$\frac{T'\big(y^R(\omega)\big)}{1 - T'\big(y^R(\omega)\big)} = \frac{1 - F\big(\omega^R(y)\big)}{f\big(\omega^R(y)\big)\,\omega^R(y)}\Big(1 + \frac{1}{\varepsilon}\Big), \tag{10}$$

where $y^R(\omega)$ is the income realized by type ω under the Rawlsian tax policy. Thus, under the Rawlsian tax policy marginal tax rates are equal to the upper Pareto bound $\mathcal{D}^{up}$.

[22] The assumption that income in the status quo is a strictly monotonic function avoids complications due to bunching. Bunching would arise at points at which marginal tax rates jump upward. Downward jumps, by contrast, would give rise to discontinuities in the function y_0. Modifying the analysis so as to allow for these phenomena is not difficult, see Bierbrauer and Boyer (2018). It merely requires additional case distinctions that we omit here for ease of exposition.

The Lower Pareto Bound.—Equation (9) provides a lower bound for marginal tax rates. Consider a reform that involves an increase of marginal taxes at y'. As we argued above, the revenue that is thereby raised is larger the larger is the inverse hazard rate and the smaller is the elasticity ε. To be Pareto-improving the revenue effect must be so strong that even those who are hit hardest by the tax increase are compensated by the additional transfers that are financed with this revenue. The right-hand side of (9), $\mathcal{D}^{low}(y')$, has a negative sign. This shows that such a situation can only occur if the status quo involves earning subsidies, or, equivalently, negative marginal tax rates. A situation in which the lower Pareto bound is violated indicates that these subsidies are excessive: a move toward lower subsidies would then be Pareto-improving.

The smaller the elasticity ε the more negative is the right-hand side of (9) and the more difficult it is to have a Pareto-improving tax increase. Thus, a small behavioral response implies a more permissive Pareto bound: the set of efficient tax policies is larger in this case.

We have argued above that there is close connection between the upper Pareto bound and the tax schedule that maximizes a Rawlsian social welfare function. There is an analogous connection between the lower Pareto bound and the tax schedule that maximizes the well-being of the richest taxpayer, the maxi-max tax schedule. As we show in online Appendix Section B, the maxi-max schedule is such that

$$\frac{T'\big(y^X(\omega)\big)}{1 - T'\big(y^X(\omega)\big)} = -\frac{F\big(\omega^X(y)\big)}{f\big(\omega^X(y)\big)\,\omega^X(y)}\Big(1 + \frac{1}{\varepsilon}\Big), \tag{11}$$

where $y^X(\omega)$ is the income earned by type ω under the maxi-max schedule.

C. *Politically Feasible Reforms*

According to Theorem 2, tax cuts are politically feasible for below-median incomes and tax increases are politically feasible for above-median incomes, provided that the status quo is an interior Pareto optimum. Proposition 2 provides a characterization of Pareto bounds that make it possible to check whether this condition is fulfilled. The following Corollary combines these insights and thereby provides a characterization of politically feasible tax reforms.

COROLLARY 2: *Suppose that income in the status quo is a strictly monotonic and continuous function of ω. Also suppose that income in the status quo satisfies the first-order conditions of utility-maximization.*

(*i*) *Let $y' < y_0^M$. There is a politically feasible reform, involving a decrease of marginal tax rate at y', if $T_0'(y')/(1 - T_0'(y')) > \mathcal{D}^{low}(y')$.*

(*ii*) *Let $y' > y_0^M$. There is a politically feasible reform, involving an increase of marginal tax rate at y', if $T_0'(y')/(1 - T_0'(y')) < \mathcal{D}^{up}(y')$.*

Corollary 2 involves a discontinuity at the median level of income. Below, tax cuts are politically feasible. Above, higher taxes are politically feasible. Thus, if the status quo indeed is an interior Pareto-optimum, a sequence of politically feasible reforms should give rise to lower and lower tax rates below the median and to higher and higher tax rates above the median. If the status quo schedule hits the upper bound above the median, then only a lowering of marginal tax rates below the median is to be expected. There must also be a transition from the low rates below the median to the high rates above. If the tax schedule is continuous, this necessitates pronounced progression at some middle income range. We get back to these predictions in our empirical analysis.

Brett and Weymark (2016, 2017) provide a characterization of the tax schedule that the median voter would choose if she could dictate tax policy. Specifically, they show that the median voter's preferred schedule coincides with the Rawlsian one for above-median incomes, and with the maxi-max schedule for below-median incomes. In between is a region of transition that gives rise to bunching. As we discussed before, the maxi-max schedule coincides with the lower Pareto bound and the Rawlsian schedule with the upper Pareto bound. Thus, outside the bunching region, a politically feasible reform can also be viewed as one that brings the status quo closer to the median voter's preferred tax policy.

D. *Politically Feasible Welfare Improvements*

Diamond's (1998) formula provides a characterization of a welfare-maximizing tax system:

$$\frac{T'\big(y^W(\omega)\big)}{1 - T'\big(y^W(\omega)\big)} = \frac{1 - F\big(\omega^W(y)\big)}{f\big(\omega^W(y)\big)\,\omega^W(y)}\Big(1 + \frac{1}{\varepsilon}\Big)\Big(1 - \mathcal{G}\big(\omega^W(y)\big)\Big), \tag{12}$$

where $\mathcal{G}(\omega) \coloneqq E[\,g(s)\,|\,s \geq \omega]$ is the average welfare weight among those with a type above ω and $y^W(\omega)$ is the income earned by type ω under the welfare-maximizing tax system. As we show formally in online Appendix Section A, a simple reform is welfare-improving if it brings marginal tax rates closer to the ones stipulated by Diamond's formula. Together with Corollary 2 this insight yields a characterization of politically feasible welfare improvements.

COROLLARY 3: *Suppose that income in the status quo is a strictly monotonic and continuous function of ω. Also suppose that income in the status quo satisfies the first-order conditions of utility-maximization.*

(*i*) *Consider an income level $y' < y_0^M$. Suppose that*

$$\frac{T_0'(y')}{1 - T_0'(y')} > \mathcal{D}^W(y') \coloneqq \frac{1 - F\big(\omega_0(y')\big)}{f\big(\omega_0(y')\big)\omega}\Big(1 + \frac{1}{\varepsilon}\Big)\Big(1 - \mathcal{G}\big(\omega_0(y')\big)\Big),$$

then a simple reform that leads to lower marginal tax rates at y' is both politically feasible and welfare-improving.

(*ii*) *Consider an income level* $y' > y_0^M$. *Suppose that* $T_0'(y')/(1 - T_0'(y')) < \mathcal{D}^W(y')$ *then a simple reform that leads to higher marginal tax rates at* y' *is both politically feasible and welfare-improving*.

Tax cuts are welfare-improving if taxes in the status quo exceed the level stipulated by Diamond's formula. The marginal tax rates according to Diamond's formula lie above the lower Pareto bound. Thus, for below-median incomes, if a tax cut is welfare-improving, then it is also politically feasible. This is the first statement in the Corollary. The second statement applies the same logic to above-median incomes. Higher tax rates are welfare-improving if they fall short of the level prescribed by Diamond's formula, in which case they are also below the upper Pareto bound. Consequently, for above-median incomes, welfare-improving tax raises are also politically feasible.

Corollary 3 states sufficient conditions for the existence of welfare-improving and politically feasible reforms. This raises the question of necessary conditions. The corollary has been derived from focusing on "small" reforms, i.e., on small increases of marginal tax rates applied to a small range of incomes. The arguments in the online Appendix, more specifically in proof of Proposition 2 and in the derivation of $\mathcal{D}^W$, imply that these conditions are also necessary in the following sense: if either

$$y' < y_0^M \quad \text{and} \quad \frac{T_0'(y')}{1 - T_0'(y')} \leq \mathcal{D}^W(y'),$$

or

$$y' > y_0^M \quad \text{and} \quad \frac{T_0'(y')}{1 - T_0'(y')} \geq \mathcal{D}^W(y'),$$

then there is no "small" reform for incomes close to y' that is both welfare-improving and politically feasible.[23]

The analysis suggests that existing tax schedules might be viewed as resulting from a compromise between concerns for welfare-maximization on the one hand, and concerns for political support on the other. If the maximization of political support was the only force in the determination of tax policy, we would expect to see tax rates close to the revenue-maximizing rate $\mathcal{D}^{up}$ for incomes above the median and negative rates close to $\mathcal{D}^{low}$ for incomes below the median. Concerns for welfare dampen these effects. A welfare-maximizing approach will generally yield higher marginal tax rates for incomes below the median and lower marginal tax rates for incomes above the median.

Our analysis also raises a question. Diamond (1998) and Saez (2001) have argued that, for plausible specifications of welfare weights, existing tax schedules have marginal tax rates for high incomes that are too low. Corollary 3 shows that an increase of these tax rates is not only welfare-improving but also politically feasible. Why don't we see more reforms that involve higher tax rates for the rich? Proposition 1 provides a possible answer to this question: reforms that involve

[23] We omit a more formal version of this statement that would require ϵ-δ-arguments.

tax cuts that are larger for richer taxpayers may as well prove to be politically feasible.

V. Empirical Analysis

In our empirical analysis, we proceed in four steps. First, guided by Theorem 1, we check to what extent past tax reforms were monotonic. Second, we investigate whether the median voter was a beneficiary of these reforms. Moreover, we check whether support of a reform by the median voter goes together with majority support in the population at large, i.e., we check whether the "median voter theorem holds in our data." Third, guided by Theorem 2, we check whether we can observe a trend toward steeper progressivity at or below the median. Fourth, we compute upper and lower Pareto bounds which determine the range over which reforms are politically feasible. Extensive sensitivity checks are provided in online Appendix Section F.

A. *Are Tax Reforms Monotonic?*

We look at this question from three different angles. First, we take a broad overview look at the annual changes of statutory tax rates in 33 OECD countries for the years 2000–2016. This leads to the conclusion that a large fraction of these "reforms" were monotonic, but there were exceptions. Second, we take an in-depth look at 11 major reforms of the federal personal income tax in the United States since WWII using tax return microdata and microsimulation tools. This provides insights on the heterogeneity in the reform induced change of individual tax burdens accounting not only for statutory tax rate changes but also changes in the tax base. We find that the rank correlation between individual incomes and the changes of individual tax burdens is large, but not perfect. Finally, we look at tax reform proposals that were part of political campaigns, but which were not enacted. This reinforces the previous conclusion that tax reforms, whether implemented or just debated, are usually monotonic. The conclusion that tax reforms are, by and large, monotonic leads to the question whether they are monotonic enough for our theory to apply, i.e., whether majority support and support by the median voter are aligned. We get to this question in Section VB.

Tax Reforms in OECD Countries.—The OECD provides annual data on the statutory tax systems of its member countries. In particular, for singles without dependents, it documents tax brackets and tax rates for labor income, see online Appendix Section D for a more detailed description. We use this information to construct a tax function.[24] A reform takes place when this tax function changes from one year to the next. It is classified as monotonic when the change of the tax burden is a monotonic function of income.

[24] The OECD also reports personal allowances and tax credits. We incorporate this information.

Table 2—Monotonic Tax Reforms in a Panel of 33 OECD Countries, 2000–2016

Total number of possible reforms (number of years × number of countries)	528	
Total number of reforms	394	
Number of monotonic reforms	309	(78%)
Number of non-monotonic reforms	85	(22%)

Notes: See online Appendix D for a list of the countries that we cover.

Source: Table 2 is based on the OECD database (Table I.1. Central government personal income tax rates and thresholds: accessible on http://stats.oecd.org/Index.aspx?DataSetCode=TABLE_I1).

Table 2 shows that 78 percent of the reforms in the sample were monotonic.[25] The complementary set includes reforms that are monotonic either above or below the median. It also includes reforms with non-monotonicities that seem economically negligible. We provide more specific examples of such reforms in the supplementary material.

Tax Reforms in the United States.—There were 11 major reforms of the US federal personal income tax between 1964 and 2017: see online Appendix Section H for details. As documented in online Appendix Table H.1, some of these reforms were phased in over several years and we account for this in our analysis.

Methodology.—Our analysis is based on NBER's microsimulation model TAXSIM and (tax return) microdata. Specifically, we use the public use files (IRS-SOI PUF) of tax return microdata from the Statistics of Income (SOI) division of the IRS (IRS 1962–2012) provided by the NBER (Feenberg 2012). These data include all information reported on tax returns of individuals (the number of observations varies between 90,000–200,000 across years) and are available biannually for the years 1960–1966 and annually for the years 1966–2012.[26] We use TAXSIM to calculate income and payroll taxes as well as tax credits.[27]

For now, the question is whether tax reforms are monotonic. To answer it in line with our theory, we construct a (counterfactual) measure of the change in a taxpayer's tax burden that is only due to the reform, holding all individual characteristics, including the person's income, fixed.[28] Take the example of TRA86 which was phased in between 1985 and 1988. Let T_0 be the tax system in 1985 and T_1 be the

[25] Not all countries have a fraction of monotonic reforms close to the average of 78 percent. For instance, the fraction of monotonic reforms is much smaller in Israel and Italy, and much larger in Belgium and Sweden. Summary statistics for all OECD countries can be found in the online Appendix. The online Appendix also reports on findings obtained from additional sources for the United States, the United Kingdom, and France. The share of monotonic reforms is 80 percent for the United States (1981–2016), 84 percent for France (1916–2016), and 77 percent for the United Kingdom (1981–2016).

[26] For the years after 2012, we use the uprated data for each year available on the NBER's server. This only affects the analysis of TCJA17 which should therefore be treated with a bit more caution compared to the other reforms as our analysis for this reform is not based on the actual tax return microdata as of 2017. See https://www.nber.org/taxsim-notes.html for details on the data.

[27] See Feenberg and Coutts (1993) and http://www.nber.org/taxsim/ for more information on TAXSIM. To be precise, we use the TAXPUF version of TAXSIM which is designed to run on the IRS-SOI PUF data. Note that the focus of TAXSIM is on modeling the personal income tax. It includes all transfers that are paid in the form of tax credits including the EITC or the child tax credit, but omits other welfare programs such as TANF or food stamps.

[28] For a more extensive discussion of this counterfactual simulation approach, see, e.g., Eissa, Kleven, and Kreiner (2008) or Bargain et al. (2015).

tax system in 1988. We observe an individual i's pretax income y_0^i, and all further characteristics relevant to compute the individual's tax burden in the year 1985. We then use TAXSIM to calculate the person's tax payment $T_0(y_0^i)$.[29] To account for the fact that T_1 becomes effective three years later, we compute an inflation-adjusted version of y_0^i that we denote by $\hat{y}_0^i$.[30] Our measure of the reform induced change of the person's tax burden is then $T_1(\hat{y}_0^i) - T_0(y_0^i)$. In the literature, this also known as the *direct policy effect*. To see whether TRA86 was a monotonic tax reform we then rank individuals according to pretax income[31] and investigate to what extent tax units with higher incomes experience larger changes of their tax burden than individuals with lower incomes.

We have to take some modeling choices on the way and follow the literature, especially Piketty and Saez (2007) and Eissa, Kleven, and Kreiner (2008) in doing so. In our baseline, we determine a tax unit's rank in the income distribution based on pretax incomes excluding capital gains as they are not a regular stream of income. For the calculation of tax payments capital gains are included. For couples filing jointly, we allocate to each spouse 50 percent of the couple's incomes and taxes ("equal-split couples"). We check the sensitivity of our results with respect to these (and other) choices in online Appendix Section F.

We explore whether tax reforms are monotonic over the whole income distribution, or possibly only above or below the median. For robustness, we invoke alternative ways of determining the median in the income distribution. First, there is the median position in the tax return data we are using. Second, we make a correction for nonfilers, i.e., low-income households who do not submit a tax declaration. The median is then poorer than the one in the data.[32] Third, for a political economy analysis, the median income among voters is relevant. Since richer individuals are more likely to turn out, the median voter is richer than the median taxpayer in our data.[33] Taking account both of nonfilers and of differential turnout brings us coincidentally back to the median position in our data, i.e., these effects are neutralizing each other.

Results.—For each reform, Figure 2 shows, separately for each decile of the income distribution, the average value of $T_1(\hat{y}_0^i) - T_0(y_0^i)$.[34] Of these reforms,

[29] We also observe the actual tax payment of the person. It coincides with the calculated tax payment in more than 99 percent of the cases, and there is no systematic pattern in the few cases with no coincidence.

[30] We use the Consumer Price Index research series using current methods (CPI-U-RS) as an uprating factor to inflate/deflate incomes.

[31] Our income measure includes all sources of market income which are reported on tax returns, i.e., wages and salaries; bonuses and exercised stock-options; employer and private pensions; self-employment income; business income; dividends, interest, and rents; and realized capital gains.

[32] To give an example, this shifts the median to the forty-fourth percentile in 2016 in the IRS-SOI PUF data. To be precise, we use data from Piketty and Saez (2007) to assess the share of nonfiling tax units: it varies between 4–8 percent in the period of our analysis.

[33] For turnout rates by income we rely on data from the US Census: https://www.census.gov/topics/public-sector/voting/data/tables.html. This shifts the median to the fifty-seventh percentile in the 2016 IRS-SOI PUF data.

[34] To check the sensitivity of our results with respect to the choices made, we replicate Figure 2 in online Appendix Section F using (i) tax units (instead of equal split couple, see online Appendix Figure F.1); (ii) statutory tax rates (instead of effective tax rates, see online Appendix Figure F.2); (iii) different bin sizes (50 instead of 10, see online Appendix Figure F.3); (iv) different income definitions: gross income including capital gains (see online Appendix Figure F.4) and adjusted gross income (see online Appendix Figure F.5); and (v) including state-level and payroll taxes (see online Appendix Figure F.6). Results are robust across different specifications and the most noticeable changes affect the three oldest reforms.

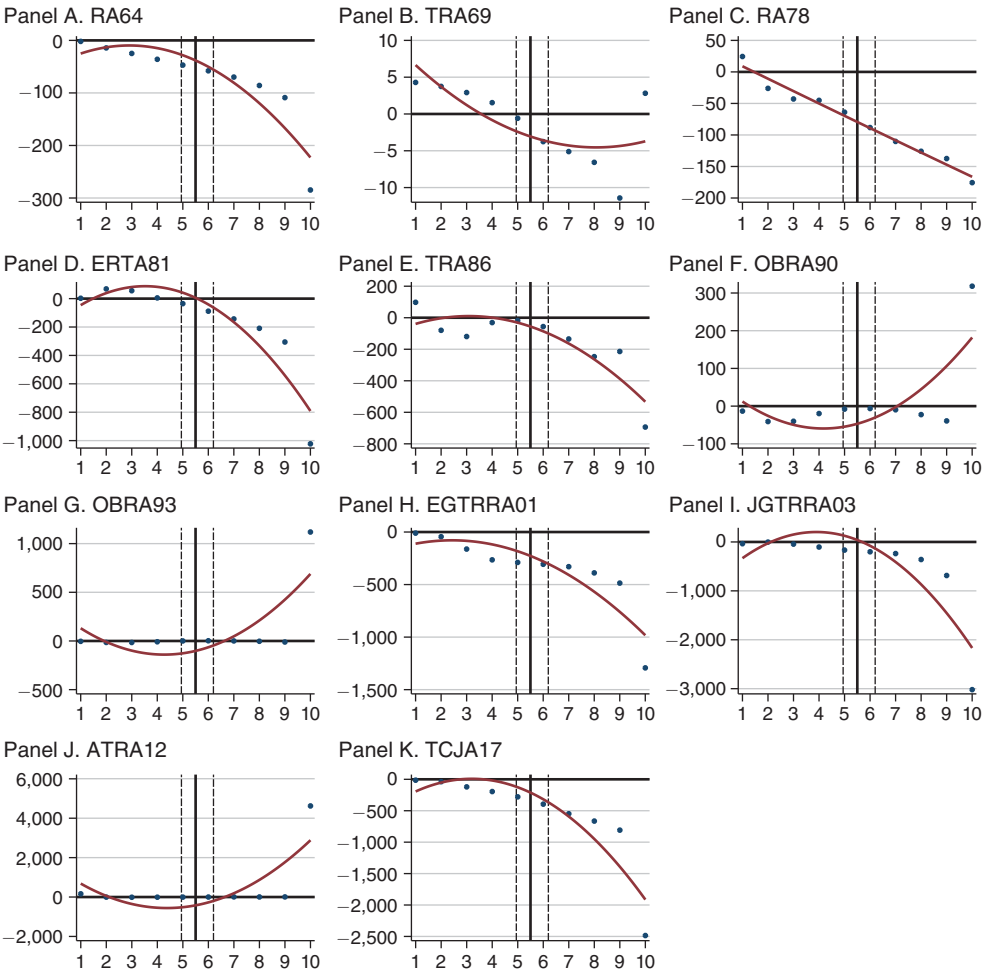

FIGURE 2. CHANGES IN TAX LIABILITY: AVERAGE VALUES PER DECILE

Notes: Figure 2 shows the average value of the counterfactual change in tax liability $T_1(\hat{y}_0^i) - T_0(y_0^i)$ for reforms of the US federal personal income tax (see online Appendix Table H.1 for details on the reforms and online Appendix Table E.1 for some summary statistics on $T_1(\hat{y}_0^i) - T_0(y_0^i)$) by income decile. The red line represents a quadratic fit based on the underlying microdata. Deciles are computed based on pretax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments $T_1(\hat{y}_0^i)$, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor. The vertical lines show different locations for the median voter: the dashed line to the left imputes non-filers to the tax return data while the dashed line to the right accounts for differential turnout by income. The solid line in the middle represents both the original median in the data as well as the one accounting for both modifications simultaneously.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

seven can be broadly classified as tax cuts that are larger for richer taxpayers (RA64, RA78, ETRA81, TRA86, EGTRRA01, JGTRRA03, TCJA17). Three reforms involve higher taxes on the top decile (OBRA90, OBRA93, ATRA12). TRA69 is a hybrid with tax cuts for the middle class, and higher taxes at the top and bottom deciles. Broadly speaking, the figure shows a monotonic pattern, but there are also deviations from monotonicity. ERTA81 has a non-monotonicity for low incomes, but is monotonic above the median. TRA69 is monotonic below the median. TRA86

and OBRA90 have non-monotonicities both below and above the median. As we will argue in Figure 6, these non-monotonicities are small in the sense of our theory: they do not upset the alignment of support by the median voter and majority support in the population.

Figure 3 provides additional information on the underlying heterogeneity by means of box plots. Several insights can be taken away from this. First, looking at the monotonicity of decile medians gives a similar picture as looking at the monotonicity of decile averages: by and large, the changes are monotonic. Second, there is significant heterogeneity, despite this general pattern and non-monotonicities can be found all over the place. To see this, pick a reform and consider a pair of neighboring deciles: the minimum in the lower decile is usually lower than the minimum in the next higher decile, but not lower than the maximum. Still, the overall (rank) correlation is high for all reforms (see online Appendix Table F.1) but the ultimate question is whether there is enough monotonicity for our theory to apply, i.e., so that support by the median voter is aligned with support in the population at large. We get to this question below. Third, for the reforms that involve higher taxes on the rich, the box plots make apparent that only a very small group of taxpayers was actually hit by higher taxes. For OBRA90, OBRA93 and ATRA12, the top 10 percent pay higher taxes on average as shown by Figure 2, but the box plots reveal that most taxpayers in this decile still experienced a tax cut.

Reform Proposals.—Does the finding that tax reforms are, by and large, monotonic, extend to tax reforms proposals which are publicly debated, but not enacted? Providing an answer faces the challenge that such reform proposals often remain vague, so that researchers have to make assumptions on the missing details.[35] To avoid own judgment calls, we invoke the systematic analysis of reform proposals in the United States that is provided by the Tax Policy Center. Their analysis covers 69 reform proposals for the federal personal income tax that were made in the period 2003–2019: some proposals were made during presidential campaigns and primaries, others were proposed by the Administration during the legislative process. The methodology and data used are described in the Tax Policy Center's documentation, see also online Appendix Section G for details. Figure 4 illustrates the results for four proposals made during the 2016 US presidential campaign. Note that the Tax Policy Center's analysis provides only information for quintiles and not deciles. The proposals by the two Democratic candidates were of the "tax increase on the rich" type while the Republican proposals were of the "tax cuts for everybody" type. Online Appendix Figures G.1–G.8 and Tables G.1–G.8 summarize our findings for all 69 proposals: the large majority of tax reform proposals are monotonic. The two reform types observed during the 2016 US presidential campaign are prevalent with the qualification that the "tax increase on the rich" type is often combined with tax cuts for low incomes.[36]

[35] The Netherlands are a notable exception: see Jacobs, Jongen, and Zoutman (2017).

[36] The exceptions are proposals made by Cain (presidential campaign 2012: see online Appendix Figure G.2), Bowles-Simpson Plans (bipartisan presidential commission created in 2010: see online Appendix Figure G.4) and the Working Families Tax Relief Act (a 2019 proposal initiated by Democratic senators: see online Appendix Figure G.4).

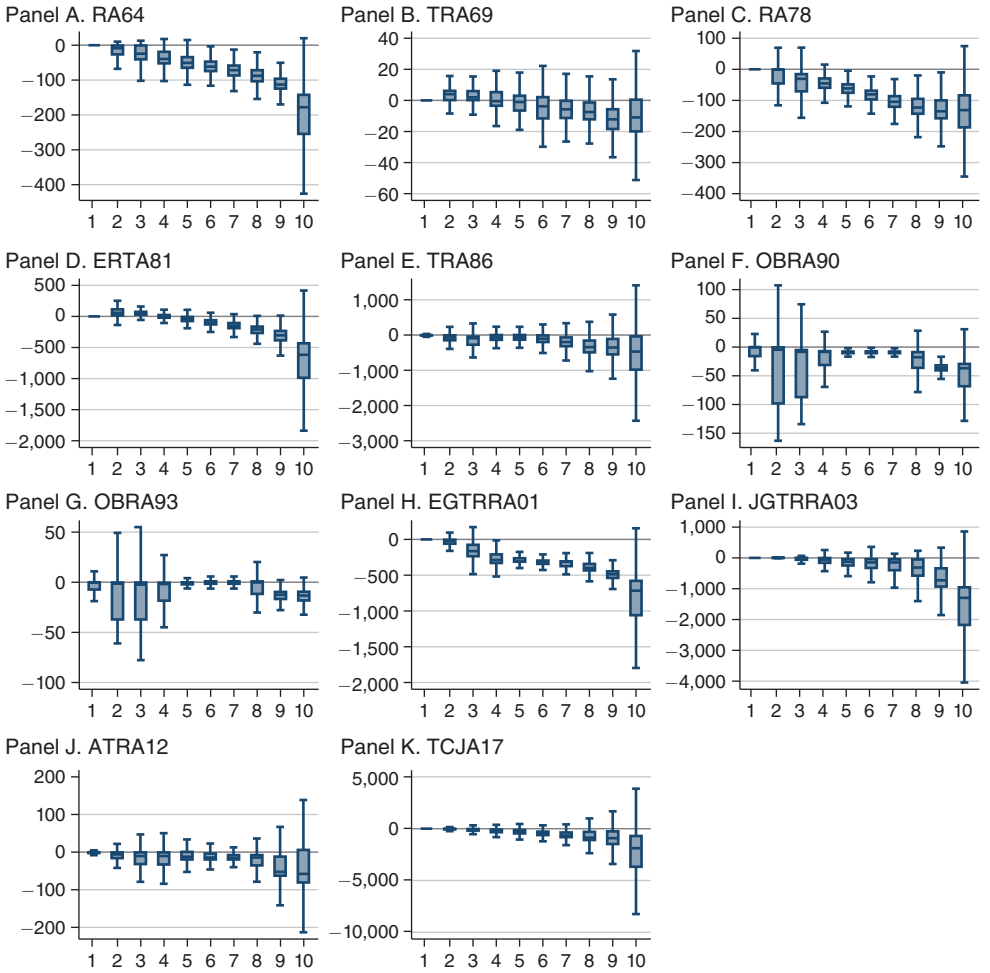

Figure 3. Changes in Tax Liability: Heterogeneity within Deciles

Notes: Figure 3 illustrates, for each decile, the cross-sectional distribution of the counterfactual change in tax liability $T_1(\hat{y}_0^i) - T_0(y_0^i)$ for reforms of the US federal personal income tax (see online Appendix Table H.1 for details) by means of a box plot. Deciles are computed based on pretax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments $T_1(\hat{y}_0^i)$, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

Summary.—Our analysis of reforms of the federal income tax in the United States and the analysis of tax reforms in OECD countries in the online Appendix show that two types of tax reforms are particularly frequent: first, reforms that involve monotonic tax cuts, i.e., tax cuts which are larger for higher incomes. Second, reforms that lead to higher taxes on high incomes, possibly in combination with tax cuts for low incomes. In the latter case, monotonicity holds only above or below the median. In the United States, the monotonic tax cuts are more prevalent for the reforms of the federal income tax after WWII. Fewer reforms led to higher taxes on top incomes.

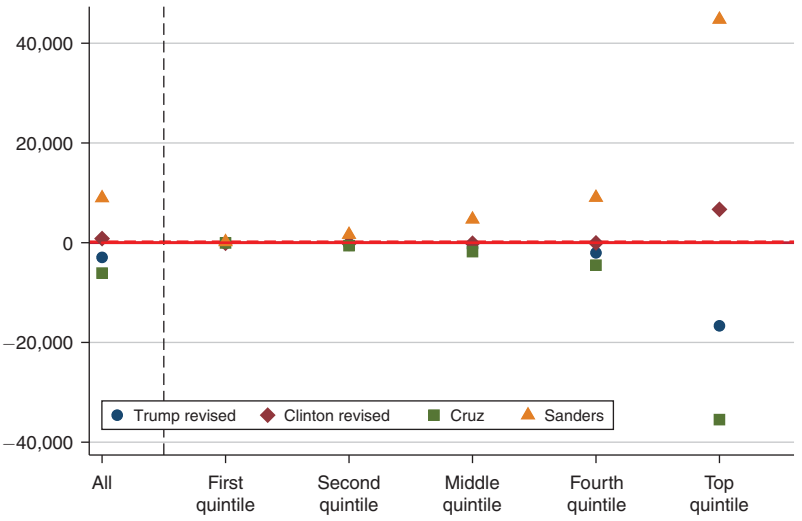

FIGURE 4. CHANGES IN TAX LIABILITY BY QUINTILE, 2016 US PRESIDENTIAL CAMPAIGN

Notes: Figure 4 shows the average value of the counterfactual change in tax liability $T_1(\hat{y}_0^i) - T_0(y_0^i)$ for reform proposals made during the 2016 presidential campaign for the US federal personal income tax by income quintile. The first column shows the overall counterfactual tax change. The data are taken from the Tax Policy Center's ex ante analysis of each reform proposal (see online Appendix Figure G.1 and online Appendix Table G.1 for details).

Source: Authors' calculations based on Tax Policy Center

B. *Did the Median Voter Gain? Was There Majority Support?*

We return to the reforms of the US federal income tax after WWII. We first analyze whether the median voter was a beneficiary of these reforms.

Inequality (6) provides a sufficient condition under which the median voter gains from a reform. Remember that the condition relates the change in overall tax revenue to the change in the median voter's tax burden, both according to the pre-reform income and according to the post-reform income.[37] The median voter is better off if there is a loss of overall revenue and her tax cut is even larger, or if there is a revenue gain exceeding the increase of her tax bill.[38] We extend this analysis to see whether there was majority support for tax reforms. Any taxpayer i in our data is a reform beneficiary if

$$R(\tau, h) - \max\left\{T_1\left(y_1^i\right) - T_0\left(y_1^i\right), T_1\left(y_0^i\right) - T_0\left(y_0^i\right)\right\} \geq 0. \tag{13}$$

Thus, there is majority support for a reform if this inequality holds for at least one-half of the population.

[37] Online Appendix Table E.1 summarizes the revenue effects $R(\tau, h)$ for each reform in the absence of behavioral responses.

[38] As discussed in Section III, with these conditions we can remain agnostic on whether the median voter's marginal tax rate increased or decreased. In Section VA we documented that there is substantial heterogeneity in the effects of a reform. Thus, an advantage of our approach is that it does not require a specific assumption on the change of marginal tax rates for close to median incomes.

A detailed explanation of how we bring inequalities (6) and (13) to the data can be found in online Appendix Section C. Assumptions about the ETI play a role for our estimate of the revenue effect, $R(\tau, h)$. For large elasticities, the revenue gains from higher taxes and the revenue losses from reduced taxes appear small. The pattern is reversed for low elasticities. We also simulate counterfactual post-reform incomes for individuals in our dataset, again using assumptions about the ETI.

Benchmark: ETI of Zero.—If there are no behavioral responses to taxation, inequality (13) simplifies. In this case, an individual i gains from a tax reform if the revenue effect $R(\tau, h)$ exceeds $T_1(y_0^i) - T_0(y_0^i)$, where y_0^i is the individual's pre-reform income, and loses otherwise.

Figure 5 is an adaptation of Figure 2. Recall that the latter shows, for each decile, the average value of $T_1(\hat{y}_0^i) - T_0(y_0^i)$. Figure 5 now shows, again for each decile, $T_1(\hat{y}_0^i) - T_0(y_0^i) - R(\tau, h)$, where $R(\tau, h)$ is calculated assuming an ETI of zero (blue dots). Thus, positive values in Figure 5 indicate an overall loss, an increase of the tax burden that is not compensated by the revenue implications of the reform. Negative values, by contrast, correspond to an overall gain, i.e., a reduction in tax payments.

Some of these reforms appear to be perfectly in line with our theory. For instance, RA78 is a monotonic reform with tax cuts above the median, and the median being among the beneficiaries. OBRA90, OBRA93, and ATRA12 have higher taxes on the rich so that the bottom 90 percent and hence also the median are made better off. Other reforms with, by and large, monotonic tax cuts (RA64, ERTA81,TRA86, EGTRRA01, JGTRRA03, TCJA17) are qualitatively similar to RA78, but, for an ETI of zero, do not include the median voter in the set of reform winners. For TRA69, depending on the exact definition of the median voter, the median voter either gains from the reform, or is close to being indifferent.

Alternative Assumptions on the ETI.—Figure 5 also shows that alternative assumptions about the ETI affect who was a reform winner, or a reform loser, and hence also whether the median voter was a beneficiary. The reforms involving tax cuts were in the median voter's interest for high values of the ETI, but not for low ones. By contrast, the reforms involving higher taxes on "the rich" were in the median voter's interest for low values of the ETI, but not for high ones.

We have seen before that there is substantial heterogeneity in the way in which individuals were affected by a tax reform. Online Appendix Figure E.2 therefore supplements Figure 5 by showing, for each decile, the fractions of winners and losers, respectively. The figure shows that support for tax cuts gets larger with income, and that, for an ETI of zero, there are only few supporters with close to median income. The reforms involving higher taxes on high incomes, by contrast, receive more support than opposition.

Majority Support and Support by the Median Voter.—According to Theorem 1, for monotonic tax reforms, there is an equivalence of support by the person with median income and majority support. We have seen in Section VA that tax reforms are broadly monotonic. We also saw, however, that numerous deviations from this broad pattern can be found. This raises the question whether there is enough monotonicity for our

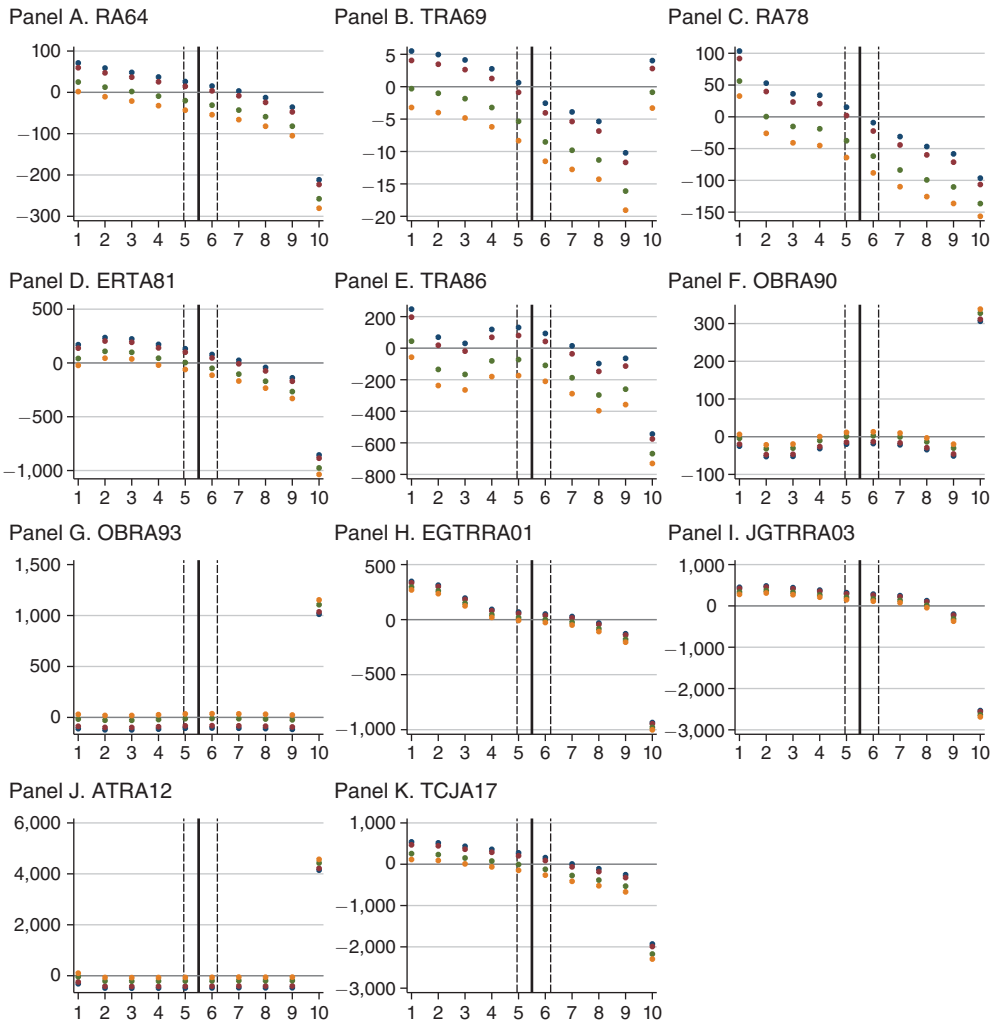

FIGURE 5. WINNERS AND LOSERS OF MAJOR US TAX REFORMS

Notes: Figure 5 shows the average of the counterfactual change in tax liability net of tax revenue $\max\{T_1(y_1^i) - T_0(y_1^i), T_1(\hat{y}_0^i) - T_0(y_0^i)\} - R(\tau, h)$ (see online Appendix Section C for details) for reforms of the US federal personal income tax (see online Appendix Table H.1 for details) by income decile for four different ETI values: 0 (blue), 0.25 (red), 1 (green) and 1.5 (orange). Deciles are computed based on pretax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor. The vertical lines show different locations for the median voter: the dashed line to the left imputes non-filers to the tax return data while the dashed line to the right accounts for differential turnout by income. The solid line in the middle represents both the original median in the data as well as the one accounting for both modifications simultaneously. See online Appendix Figure E.1 for the cross-sectional heterogeneity within each decile.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

theory to apply. To provide an answer, we check whether majority support and support by the median voter are aligned. If this is indeed the case, majority support fails whenever the median voter is made worse off by a reform, and majority support holds, whenever the median voter is made better off.

As explained above, whether the median voter, or any other person, gained depends on the ETI. Figure 6 therefore shows majority support and support by voters with close to median income for different values of the ETI. Specifically, the vertical axis measures support in the population at large and the horizontal axis measures support by people with close to median incomes (more precisely the fraction of percentiles P45–P55, i.e., the range in which the different median definitions fall). Points in the upper right quadrant indicate that there was both majority support and support by most people with close to median income. Points in the lower left quadrant indicate that there was no majority support and that most people with close to median income opposed the reform. Thus, points in the upper right quadrant and in the lower left quadrant are in line with the median voter theorem. By contrast, points in the lower right quadrant and in the upper left quadrant indicate a discrepancy between support by the median voter and majority support. The figure reveals that, whatever our assumption on the ETI, majority support and support by people with close to median incomes are (almost perfectly) aligned. We hence conclude that reforms in the United States were "sufficiently monotonic" and that the "median voter theorem holds in the data."

C. *Increased Progressivity in the Middle?*

Theorem 2 implies that a sequence of politically feasible tax reforms should push tax rates in the direction of the lower Pareto bound for below-median incomes and, possibly, in the direction of the upper Pareto bound for above-median incomes. Mechanically, this should lead to more pronounced progression over an intermediate range of incomes.

To check whether we can find this pattern in our data for the United States, we document the evolution of effective marginal tax rates T' in Figure 7 by plotting the pre- and the post-reform values of the ratio $T'/(1 - T')$.[39] The transition from RA64 to ATRA12 reveals that there was indeed a lowering of marginal tax rates for low incomes and increased progression for incomes that were somewhat higher. These changes are associated with the introduction and then the expansion of the earned income tax credit (*EITC*). The EITC led to lower, in fact negative, marginal tax rates for the working poor. Low-income households with children were the main recipients of these earnings subsidies. The negative marginal tax rates were phased out over a range of higher incomes, beginning with the income level qualifying for the maximal credit. This led to a strong increase of marginal tax rates in the next higher segment of the income distribution.

In contrast, Figure 7 does not reveal a strong tendency toward higher marginal tax rates above the median. The sufficient statistics that we present in the subsequent Section VD provide a possible explanation: the conclusion that there was room to lower marginal tax rates for "the poor," is robust to alternative assumptions about the ETI. This is not true for higher taxes on "the rich." With an ETI around 1, which has been considered plausible by scholars in the 1990s (see, in particular, Feldstein 1995, 1999), such tax increases appear Pareto-damaging.

[39] We focus on the ratio $T'/(1 - T')$ for consistency with the other figures that we present. Online Appendix Figure E.4 shows T' directly.

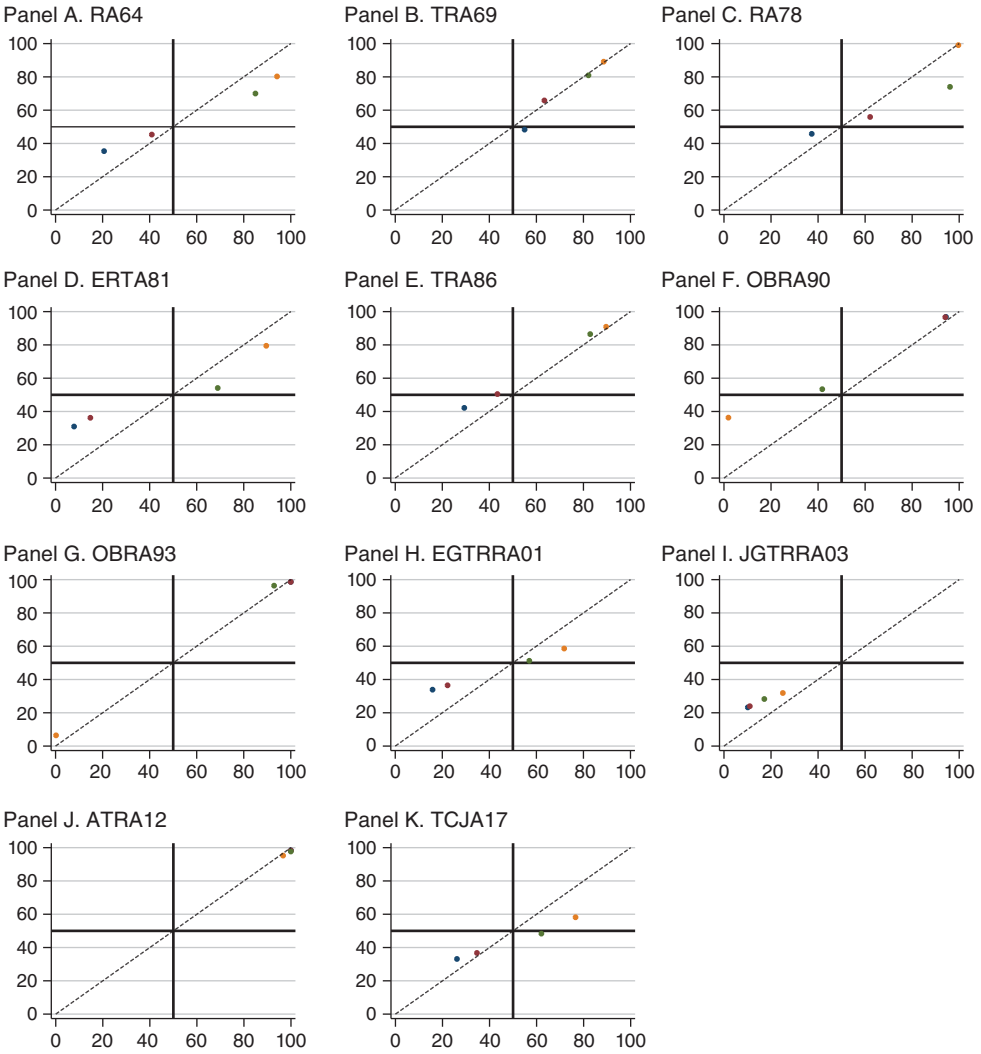

FIGURE 6. MAJORITY SUPPORT VERSUS SUPPORT BY THE MEDIAN VOTER

Notes: Figure 6 shows the shares of reform winners, i.e., of tax units i with $\max\{T_1(y_1^i) - T_0(y_1^i), T_1(\hat{y}_0^i) - T_0(y_0^i)\} - R(\tau, h) \leq 0$ (see online Appendix Section C for details) for the full population (vertical axis) and the middle of the distribution (P45–P55, horizontal axis) for major reforms of the US federal personal income tax (see online Appendix Table H.1 for details) and for four different ETI values (see Figure 5): 0 (blue), 0.25 (red), 1 (green), and 1.5 (orange). Deciles are computed based on pretax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments $T_1(\hat{y}_0^i)$, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor. See online Appendix Figures E.2 and E.3 for the shares of winners in all income deciles.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

D. *Sufficient Statistics for Politically Feasible and/or Welfare Improving Reforms*

In the following, we present an analysis of tax reforms using the upper Pareto bound $\mathcal{D}^{up}$ and the lower Pareto bound $\mathcal{D}^{low}$. We will focus on whether the tax

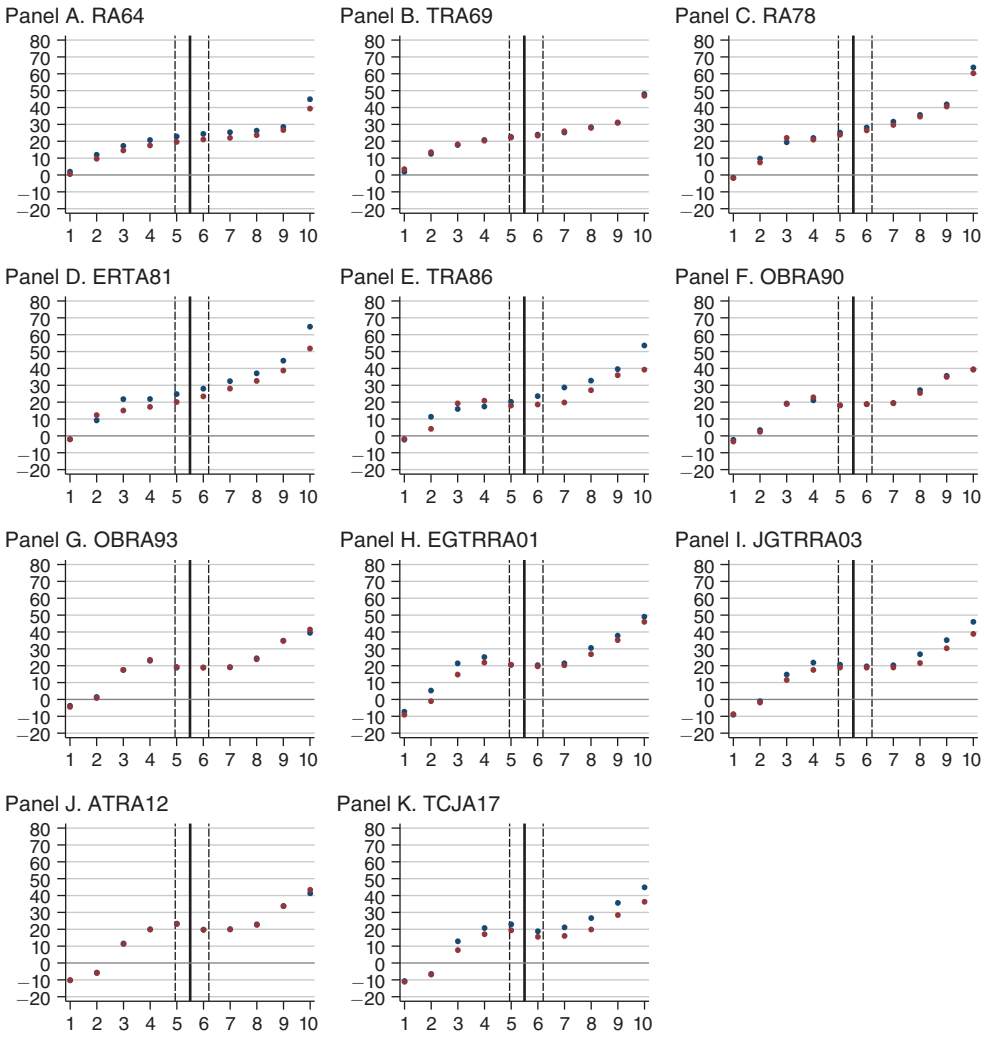

FIGURE 7. $\frac{T'}{1-T'}$ BY DECILE BEFORE AND AFTER EACH REFORM

Notes: Figure 7 shows, separately for each decile, the ratio $T'/(1-T')$ based on effective marginal tax rates (EMTRs) before (blue) and after (red) major reforms of the US federal personal income tax (see online Appendix Table H.1 for details). Deciles are computed based on pretax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments $T_1(\hat{y}_0^i)$, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor. The vertical lines show different locations for the median voter: the dashed line to the left imputes non-filers to the tax return data while the dashed line to the right accounts for differential turnout by income. The solid line in the middle represents both the original median in the data as well as the one accounting for both modifications simultaneously. See online Appendix Figure E.4 for EMTRs T'.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

reforms in the United States were Pareto-improving or politically feasible. In our data we observe the endogenous (to the tax system) distribution of incomes (instead

of the exogenous distribution of types).[40] We therefore use a representation of $\mathcal{D}^{up}$ and $\mathcal{D}^{low}$ that invokes the income distribution, as represented by the c.d.f. F_y and the density f_y:[41]

$$(16)\quad \mathcal{D}^{low}(y) \coloneqq -\frac{F_y\big(y_0(\omega)\big)}{f_y\big(y_0(\omega)\big)\,y_0(\omega)}\frac{1}{\varepsilon},\quad \text{and}\quad \mathcal{D}^{up}(y) \coloneqq \frac{1-F_y\big(y_0(\omega)\big)}{f_y\big(y_0(\omega)\big)\,y_0(\omega)}\frac{1}{\varepsilon}.$$

Upper Pareto Bound.—Figure 8 shows, for each reform of the US federal income tax, and each level of income y, the upper Pareto bound $\mathcal{D}^{up}(y)$, the pre-reform value of $T'(y)/(1-T'(y))$ (in blue) and the post-reform value (in red). The first four reforms (RA64, TRA69, RA78, ERTA81) involved tax cuts that were larger for richer taxpayers. For plausible values of the ETI, these reforms can be viewed as responses to inefficiently high tax rates on "the rich": for values of the ETI above 0.4, the pre-reform schedule crossed the upper Pareto bound. The fifth reform (TRA86) again involved tax cuts. Those can be rationalized as being Pareto-improving for an ETI above 0.5, but not for lower values of the ETI. The tax cuts in the early 2000s (EGTRRA01, JGTRRA03) and the Trump tax plan (TCJA17) are Pareto-improving for an ETI above 0.75, but not otherwise. The reforms involving higher taxes on the rich (OBRA90, OBRA93, ATRA12) appear politically feasible for ETI values below 0.75. For higher values of the ETI, the reforms led to inefficiently high tax rates.

Thus, whether higher taxes on the rich were politically feasible depends on the ETI. With an ETI of 1 or higher, as suggested, e.g., by Feldstein (1995, 1999) or more recently by Mertens and Montiel Olea (2018), higher taxes on "the rich" were Pareto-damaging and therefore not politically feasible. With an ETI around 0.25 as suggested by some of the subsequent literature, see Saez, Slemrod, and Giertz (2012) for a survey and Neisser (2017) for a meta-study, higher taxes on the rich have been politically feasible from the mid-80s onward.

Lower Pareto Bound.—Figure 9 shows, for each reform of the US federal income tax, and each level of income y, the lower Pareto bound $\mathcal{D}^{low}(y)$, and, again, the pre-reform value (in blue) and the post-reform value (in red) of $T'(y)/\big(1-T'(y)\big)$. All reforms give rise to the same conclusion: the lower bound came nowhere close to the pre- or the post-reform schedule. Hence, lower tax rates for "the poor" were

[40] The idea of identifying types by their position in the income distribution is due to Saez (2001).

[41] The characterization of $\mathcal{D}^{up}$ and $\mathcal{D}^{low}$ in Proposition 2 refers to the distribution of types F, with density f. These distributions are related to each other via

$$(14)\qquad F_y\big(y\big) = F\big(\omega_0(y)\big)\quad \text{and}\quad f_y\big(y\big) = f\big(\omega_0(y)\big)\frac{\partial\omega_0(y)}{\partial y}.$$

Moreover, for a piecewise linear tax system, i.e., one with $T''(y) = 0$, the first order conditions characterizing the function $y_0 : \omega \to y_0(\omega)$ that gives incomes in the status quo, and its inverse $\omega_0 : y \mapsto \omega_0(y)$, imply that

$$(15)\qquad \Big(1+\tfrac{1}{\varepsilon}\Big)\frac{\partial\omega_0(y)}{\partial y}\frac{1}{\omega_0(y)} = \frac{1}{y_0(\omega)}\frac{1}{\varepsilon}.$$

Using Proposition 2, (14) and (15) yield (16).

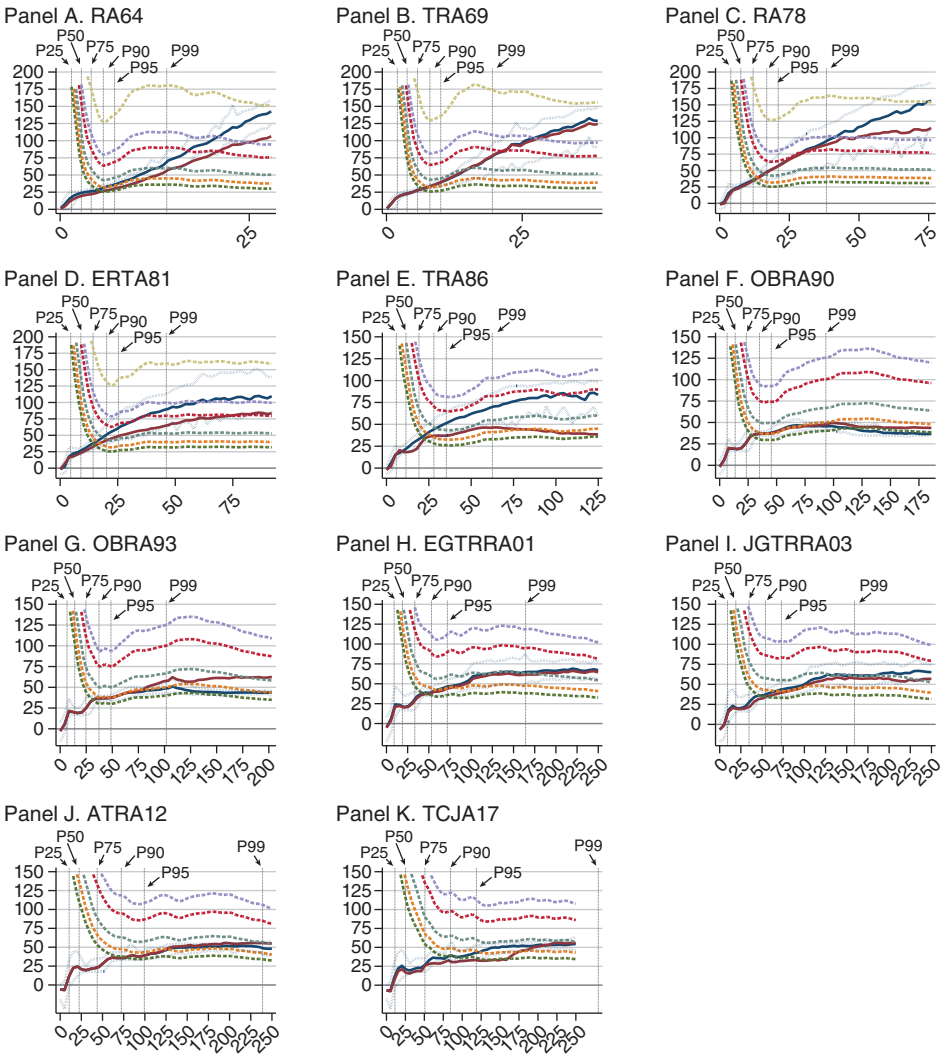

FIGURE 8. UPPER PARETO BOUNDS $\mathcal{D}^{up}$

Notes: Figure 8 shows the ratio $T'/(1-T')$ of the effective marginal tax rates (EMTRs) (y-axis) before (solid blue line; blue lines in short dashes represent, for each income level, the tenth and the ninetieth percentiles of the EMTR function) and after (solid red line) major reforms of the US federal personal income tax (see online Appendix Table H.1 for details) as well as upper Pareto bounds $\mathcal{D}^{up}$ (dashed lines) for six different ETI values: 0.25 (khaki), 0.4 (lavender), 0.5 (cranberry), 0.75 (teal), 1 (orange), and 1.25 (green). Deciles are computed based on pre-tax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments $T_1(\hat{y}_0^i)$, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor. Vertical dashed lines show different percentiles of the income distribution.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

politically feasible. The introduction and subsequent expansion of the EITC from the mid-1970s onward went in this direction. It lowered marginal tax rates, predominantly, for low-income households with children.

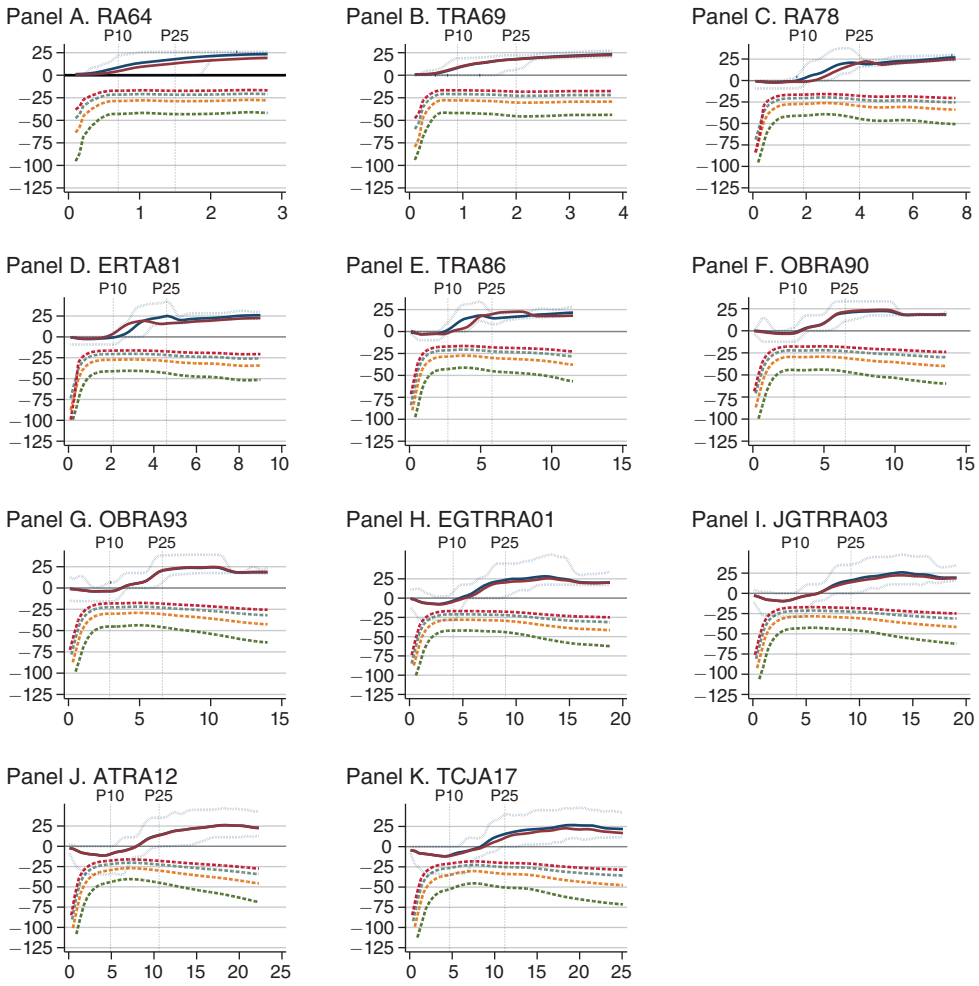

FIGURE 9. LOWER PARETO BOUNDS $\mathcal{D}^{low}$

Notes: Figure 9 shows the ratio $T'/(1-T')$ of the effective marginal tax rates (EMTRs) (y-axis) before (solid blue line; blue lines in short dashes represent, for each income level, the tenth and the ninetieth percentiles of the EMTR function) major reforms of the US federal personal income tax (see online Appendix Table H.1 for details) as well as lower Pareto bounds $\mathcal{D}^{low}$ (dashed lines) for four different ETI values: 5 (cranberry), 4 (teal), 3 (orange), and 2 (green). Deciles are computed based on pretax income without capital gains while tax base includes capital gains. All computations are on the individual level. For this, the income of couples filing jointly is allocated equally to each spouse. In order to simulate counterfactual tax payments $T_1(\hat{y}_0^i)$, income from year 0 are inflated to year 1 using the CPI-U-RS deflator as uprating factor. Vertical dashed lines show different percentiles of the income distribution.

Source: Authors' calculations based on NBER TAXSIM and IRS-SOI PUF

VI. Concluding Remarks

This paper develops a theory of politically feasible tax reforms, i.e., of reforms that are preferred by a majority of citizens over some predetermined status quo in tax policy. We also present an empirical analysis of tax reforms that is guided by this theory.

The theoretical analysis rests on the assumption that the reform-induced change in the tax burden is a monotonic function of income. With this assumption we can establish a median voter theorem for reforms of nonlinear tax systems. Accordingly, a reform is politically feasible if and only if it is preferred by the person with median income. We also clarify the conditions under which a change of the marginal tax rates for incomes in a certain range, such as higher taxes on "the rich" or larger earnings subsidies for "the poor," are politically feasible.

Our empirical analysis focuses on reforms of the US federal income tax after WWII, makes use of tax return microdata and NBER's TAXSIM microsimulation model. Even though there is heterogeneity in the effects of a tax reform on taxpayers, we find that actual tax reforms, by and large, satisfy the monotonicity property on which our theoretical analysis is based. We also find that tax reforms often look as if there had been a deliberate effort to include people with close to median income into the set of beneficiaries.

Finally, we derive sufficient statistics that make it possible to identify politically feasible reforms, given data on the distribution of incomes and the behavioral responses to taxation. Future research might use this framework to complement existing studies on the history of income taxation.[42]

The analysis in the main text is based on the workhorse of analyses of nonlinear taxation, the Mirrleesian model. In the online Appendix, we present extensions to richer models of taxation, such as models with variable and fixed costs of labor market participation, models that include heterogeneity in preferences over public goods, or models that include an investment in human capital. In the main text, we also assume that the revenue that is generated by a tax reform is rebated lump sum. In the online Appendix, we also consider that additional revenue from income taxation is used to finance public goods, or to lower other taxes, e.g., indirect taxes or taxes on capital income. We show that versions of our median voter theorem for tax reforms also hold in these settings.[43]

Real-world tax reforms often have revenue implications that are not felt in the same period in which tax rates change. For instance, tax cuts may yield budget deficits that necessitate an adjustment of public spending in later periods. Our analysis is based on a static model, and a formal treatment of the dynamic effects of tax reforms is an important topic for future research. Still, we provide some tentative remarks on how our framework might be extended: the important assumption in our baseline analysis is that the revenue implications of a reform affect all taxpayers similarly, whereas the change of the tax schedule affects people depending on their incomes. Thus, a scenario in which spending cuts in later periods hit all taxpayers in a similar fashion, should give rise to similar conclusions as our baseline analysis. A scenario where future tax cuts hit some people more than others should correspond to our extension in the online Appendix in which additional tax

[42] For instance, Scheve and Stasavage (2016) study whether tax systems have become more progressive in response to increases in inequality or in response to extensions of the franchise. Their analysis compares tax policies that have been adopted at different points in time, or by countries with different institutions. It does not include an analysis of the reforms that appear to have been politically feasible or welfare-improving in a given year, for a given country, and a given status quo tax schedule. The framework that is developed in this paper lends itself to such an analysis.

[43] A restriction that is needed in these richer models is that reforms are small, so that the people with close to median income in the status quo are also people with close to median income after the reform.

revenues are spent on public goods and preferences for public goods are heterogeneous. Thus, we conjecture that our main conclusions extend to environments with explicit dynamics or uncertainty.

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