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IZA DP No. 17766

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ABSTRACT

Using Tax Kinks to Estimate the Marginal Propensity to Consume*

We show how tax kinks can be used to estimate the marginal propensity to consume (MPC). Tax kinks create discrete changes in the relationship between taxable income and disposable income, which – under a set of testable assumptions – enables causal identification of the spending response to changes in disposable income. We apply our new approach using administrative data from Denmark. Using a regression kink design (RKD), we estimate a MPC of 0.6 (s.e. 0.1) for taxpayers at the top tax kink. We show theoretically the conditions under which tax kinks provide variation in transitory or permanent income and deduce that the RKD exploits predominately transitory variation in income. Our implementation addresses threats to the research design from manipulation of taxable income through labor supply and other behavioral responses. Our findings inform the targeting of fiscal stimulus and social insurance programs to high income earners.

JEL Classification: E21, H24

Keywords: marginal propensity to consume, tax kinks, regression-kink-design

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1 Introduction

The marginal propensity to consume (MPC) out of transitory income is a central parameter in the macroeconomic and public finance literatures. While there is clear evidence that MPCs are decreasing in liquid wealth (Havranek and Sokolova, 2020; Jappelli and Pistaferri, 2010), evidence on MPC heterogeneity across the income distribution is scarce. Most studies lack statistical power to accurately estimate the MPC for high income earners because they use consumption data containing few high income earners or exploit variation that affects few high income earners. This matters because fiscal stimulus and social insurance programs are typically targeted based on income rather than wealth. For example, the widely studied U.S. 2008 economic stimulus payments were phased out at higher incomes (Parker, Souleles, Johnson, and McClelland, 2013), on the presumption that MPCs are low for high earners. However, if MPCs are large for high income earners – who account for a disproportionate share of total consumption – extending stimulus measure to high income earners can have large aggregate demand effects. Furthermore, the sensitivity of consumption to transitory income changes determines the benefit of social insurance programs that buffer income risk for high income earners (Chetty and Finkelstein, 2013).

We propose a new methodology using tax kinks, which provides a potentially wide source of variation to estimate MPCs, including for high income earners. In a piece-wise linear income tax system, disposable income is a kinked function of taxable income: the rate at which disposable income rises with taxable income drops by the increase in the marginal tax rate at kinks in the tax schedule. Our method applies a regression kink design (RKD) to kinks in tax schedules and estimates the MPC by taking the ratio of the change in the slope of consumption to the change in slope of disposable income at the tax kink. We show theoretically that the estimated MPC is a weighted sum of MPCs out of contemporary and future disposable income and that we can estimate the weights and decompose the MPC into its transitory and permanent components from the data. We show theoretically that, in the absence of mass points in the distribution of innovations to income, the RKD exploits transitory variation in income, and verify this case empirically.

We address identification challenges associated with the use of tax kinks to estimate

MPCs. A RKD requires the running variable – taxable income in our case – to be non-manipulable (Card, Lee, Pei, and Weber, 2015). This rules out deterministic labor supply responses to the change in marginal tax rate at kinks. While a large literature has identified bunching at kink points, and used this to estimate labor supply elasticities, responses are overwhelmingly driven by evasion and avoidance behavior. We restrict our analysis to wage and salary earners with third-party reported income, who have limited ability to engage in evasion or avoidance and face frictions to precisely adjust their real earnings. While restricting our attention to this sample removes any sharp bunching in the data, we do find evidence of statistically significant kinks in the density of taxable income and some covariates around the tax kink. However, placebo analyses suggest that these violations are caused by non-linearities unrelated to the tax kink.

Using full-population administrative data for Denmark, we estimate the MPC for households around the top tax kink. Over our 2000-2016 sample period, top tax kink is located on average at the 75th percentile in the income distribution and implies a jump in the marginal tax rate of 15 percentage points. Consumption is imputed from administrative data on income and wealth holdings, as in Browning and Leth-Petersen (2003) and Leth-Petersen (2010). A potential concern is that measurement error in consumption causes a positive correlation between measured income and imputed consumption (Baker, Kueng, Meyer, and Pagel, 2022). Our methodology minimizes this concern because we exploit variation in tax payments, which are observed in the administrative data. Measurement error in other (non-taxed) components of income (or wealth) only affect our results in the unlikely situation that the measurement errors have a kink coinciding with the tax kink.

Figure 1 provides clear graphical evidence of a kink in consumption corresponding to the kink in disposable income for taxpayers at the top tax kink. This translates to an MPC of 0.6 (s.e. 0.1) in our formal econometric framework. Estimated kinks in future disposable income are small and mostly statistically insignificant, which we show theoretically implies that the variation in income used by the RKD to estimate the MPC is predominantly transitory. Accordingly, we interpret our estimate as the MPC out of transitory income. The MPC is estimated to be increasing in age and decreasing in years of education, net wealth and liquidity. Notably, the relationship with liquidity is mediated by other covariates, revealing a modest gradient in liquidity. This likely reflects that there are relatively few hand-to-mouth households around the top tax kink (Kaplan and Violante, 2014), and is consistent with recent evidence on excess sensitivity even for households with high liquidity (Boehm, Fize, and Jaravel, 2025; Graham and McDowall, 2024)

Much of the literature has studied spending responses to transitory income at a quarterly frequency and for non-durable components of spending (see Jappelli and Pistaferri 2010 and Havranek and Sokolova 2020 for surveys) and found MPCs around one quarter. All else equal, use of a comprehensive expenditure measure and a longer time-frame should imply larger MPC estimates. Fagereng, Holm, and Natvik (2021) estimate an average MPC around 0.4 for lotteries, using annual data and the same methodology to measure expenditure; Jappelli and Pistaferri (2020) report a mean MPC of 0.5 in Italian survey data. Our main empirical finding is that the MPC out of transitory income for high income earners is comparable to population-wide central estimates from the literature. The variation in income around the RKD that we exploit may be partly anticipated. This implies that, if consumption responds in anticipation of income receipt, our estimated MPC provides a lower bound on the total consumption response.

The use of tax kinks to estimate MPCs has three main advantages relative to other approaches. First, labor income comprises 95 percent of the variation used for identification in our regression kink sample. Variation in labor income is most relevant for understanding the welfare consequences of typical transitory income risk facing households (Ganong, Jones, Noel, Greig, Farrell, and Wheat, 2020) and spending responses to fluctuations in labor income over the business cycle. This contrasts with much of the quasi-experimental literature, which exploits unusual windfall changes in liquid wealth to estimate MPCs (Ganong, Jones, Noel, Greig, Farrell, and Wheat, 2020). Prominent studies have exploited economic stimulus payments (Johnson, Parker, and Souleles, 2006; Parker, Souleles, Johnson, and McClelland, 2013), lotteries (Fagereng, Holm, and Natvik, 2021; Golosov, Graber, Mogstad, and Novgorodsky, 2021), disbursements from the Alaska permanent fund (Hsieh, 2003; Kueng, 2018), credit-limit changes (Aydin, 2022), government shutdowns (Gelman, Kariv, Shapiro, Silverman, and Tadelis, 2020), early access to pension wealth (Kreiner, Lassen, and Leth-Petersen, 2019), and tax refunds (Agarwal, Liu, and Souleles, 2007; Gelman, Kariv, Shapiro, and Silverman, 2022) to estimate spending responses to income shocks. The labeling (Ganong, Jones, Noel, Greig, Farrell, and Wheat, 2020), method of disbursement (Sahm, Shapiro, and Slemrod, 2012) and framing of transfers may affect spending propensities via mental accounting effects (Thaler, 1985; Hastings and Shapiro, 2018).

Semi-structural approaches following Blundell, Pistaferri, and Preston (2008) can also use variation in labor income to estimate MPCs (e.g., Crawley and Kuchler 2023), but at the cost of imposing structure on the income process, which is not necessary using tax kinks. Survey methods pioneered by Shapiro and Slemrod (1995) provide a high degree of flexibility to deduce MPCs in hypothetical settings (e.g. Fuster, Kaplan, and Zafar 2021; Shapiro and Slemrod 2003) but cannot observe actual spending.

Second, unlike semi-structural approaches, the RKD approach flexibly controls for covariates correlated with income that can affect MPCs, such as time and risk preferences (Landais and Spinnewijn, 2021). This is important because there is evidence that (fixed) characteristics of households, rather than economic circumstances, explain MPC heterogeneity (Gelman, 2022; Parker, 2017; Aguiar, Bils, and Boar, 2024). This is problematic if these characteristics are unobserved and correlated with income.

Third, tax kinks are ubiquitous across time and space, and MPCs estimated using tax kinks do not rely on rare natural experiments. Our methodology can therefore be widely applied to explore heterogeneity in MPCs across time and setting. Furthermore, estimating MPCs within tax data facilitates further work linking MPC heterogeneity to behaviors observed in tax data, such as charitable giving and demand for insurance.

The remainder of the paper is structured as follows. Section 2 presents the theoretical framework; Section 3 discusses the institutional setting and data; Section 4 outlines the empirical methodology and reports the results; Section 5 discusses our findings in the context of the literature, and; Section 6 concludes.

2 Theoretical Framework

This section provides a theoretical foundation for using tax kinks to estimate the MPC out of disposable income and the conditions under which tax kinks provide variation in transitory or permanent income.

2.1 Setup

Consider a population of households living for T periods, who maximize expected utility

$$\max_{\{c_t\}} U_t = \mathbb{E}_t U(c_t, c_{t+1}, ..., c_T, b|\eta) \tag{1}$$

subject to the budget constraint

$$a_{t+1} = R_t \left(a_t + y_t - c_t\right), \tag{2}$$

where a_t is assets, $b = a_{T+1}$ is bequests, c_s is current and future consumption, R_t is the return on assets and y_t is disposable income. η is a heterogeneous taste (or type) parameter, which also captures the effect of other covariates such as the presence of children in the household, etc.

Standard household optimization implies an – often implicit – consumption function

$$c_t = c(y_t, y^e_{t+1}, ..., y^e_T, a_t, \eta), \tag{3}$$

where $y^e_s = \mathbb{E}_t(y_s)$ is expected disposable income at time $s > t$ given the information set at time t.[1]

We are typically interested in two derivatives of the consumption function (3). Either the contemporaneous marginal propensity to consume out of transitory income (the effect of a change in current disposable income on current consumption, holding disposable income in periods $s > t$ constant):

$$\frac{\partial c_t}{\partial y_t}, \tag{4}$$

[1]Consumption is also likely to depend on higher moments (such as the variance) of future income, which we for simplicity compress in the preference parameter η.

or the contemporaneous marginal propensity to consume out of permanent income – the effect of a change in disposable income in all periods $s \geq t$ on current consumption:

$$\sum_{s=t}^{T} \frac{\partial c_t}{\partial y_s^e}. \tag{5}$$

However, simply looking at the empirical relationship between c_t and y_t is unlikely to identify either of these MPCs. First, y_t might be correlated with a_t and η, and second, y_t might be arbitrarily correlated with $y_{s>t}$. Formally,

$$\frac{dc_t}{dy_t} = \frac{\partial c_t}{\partial a_t}\frac{da_t}{dy_t} + \frac{\partial c_t}{\partial \eta}\frac{d\eta}{dy_t} + \sum_{s=t}^{T} \frac{\partial c_t}{\partial y_s^e}\frac{dy_s^e}{dy_t}, \tag{6}$$

where we use $\frac{dy}{dx}$ to denote the observed (cross-sectional) relationship between x and y, and $\frac{\partial y}{\partial x}$ to denote the causal effect of x on y.

In Equation (6), we can think of the sequence of $\frac{dy_s^e}{dy_t}$ as describing the source of income differences in the population. Two extreme cases provide intuition: if $\frac{dy_s^e}{dy_t} = 0$ for all $s > t$ then future income is uncorrelated with income today, and all income differences in the population are solely driven by temporary income shocks; if $\frac{dy_s^e}{dy_t} = 1$ for all horizons $s \geq t$ then all differences in income are permanent. In reality, income is likely to be a mixture of permanent and transitory components.

2.2 Using Tax Kinks to Uncover the Marginal Propensity to Consume

Assume that disposable income is generated by stochastic, and for now exogenous, labor earnings z_t, taxed according to a kinked (piecewise-linear) tax function $\mathcal{T}_t(\cdot)$, where the subscript t allows the location of the kink to change over time

$$y_t = z_t - \mathcal{T}_t(z_t). \tag{7}$$

This implies the following empirical relationship between c_t and z_t

$$\frac{dc_t}{dz_t} = \frac{\partial c_t}{\partial a_t}\frac{da_t}{dz_t} + \frac{\partial c_t}{\partial \eta}\frac{d\eta}{dz_t} + \sum_{s=t}^{T}\frac{\partial c_t}{\partial y_s^e}\frac{dy_s^e}{dz_t} \tag{8}$$

Next, compare this relationship at two different earnings levels $(z_- < k < z_+)$ around the kink in the tax schedule (k_t) where the marginal tax rate jumps discretely from τ_- to $\tau_+ > \tau_-$ and let (z_-, z_+) converge to k_t to obtain

$$\begin{aligned}
&\lim_{z_+\to k}\left.\frac{dc_t}{dz_t}\right|_{z_+} - \lim_{z_-\to k}\left.\frac{dc_t}{dz_t}\right|_{z_-} \\
&= \left(\lim_{z_t^+\to k_t}\left.\frac{\partial c_t}{\partial a_t}\frac{da_t}{dz_t}\right|_{z_t^+} - \lim_{z_t^-\to k_t}\left.\frac{\partial c_t}{\partial a_t}\frac{da_t}{dz_t}\right|_{z_t^-}\right) + \left(\lim_{z_t^+\to k_t}\left.\frac{\partial c_t}{\partial \eta}\frac{d\eta}{dz_t}\right|_{z_t^+} - \lim_{z_t^-\to k_t}\left.\frac{\partial c_t}{\partial \eta}\frac{d\eta}{dz_t}\right|_{z_t^-}\right) \\
&+ \sum_{s=t}^{T}\left(\lim_{z_t^+\to k_t}\left(\left.\frac{\partial c_t}{\partial y_s^e}\frac{dy_s^e}{dz_t}\right|_{z_t^+}\right) - \lim_{z_t^-\to k_t}\left(\left.\frac{\partial c_t}{\partial y_s^e}\frac{dy_s^e}{dz_t}\right|_{z_t^-}\right)\right).
\end{aligned} \tag{9}$$

Under the standard RKD assumption (Card, Lee, Pei, and Weber, 2015) that (i) the distributions of covariates $(x \in a_t, \eta)$ are smooth around the kink and that (ii) the causal effects on consumption are smooth

$$\lim_{z_t^+\to k_t}\left.\frac{dx}{dz_t}\right|_{z_t^+} = \lim_{z_t^-\to k_t}\left.\frac{dx}{dz_t}\right|_{z_t^-} \quad \text{for} \quad x \in \{a_t, \eta\}, \tag{10}$$

$$\lim_{z_t^+\to k_t}\left.\frac{\partial c_t}{\partial x}\right|_{z_t^+} = \lim_{z_t^-\to k_t}\left.\frac{\partial c_t}{\partial x}\right|_{z_t^-} \quad \text{for} \quad x \in \{a_t, \eta, y_s^e\}, \tag{11}$$

Equation (9) collapses to

$$\lim_{z_+\to k}\left.\frac{dc_t}{dz_t}\right|_{z_+} - \lim_{z_-\to k}\left.\frac{dc_t}{dz_t}\right|_{z_-} = \sum_{s=t}^{T}\left.\frac{\partial c_t}{\partial y_s^e}\right|_k \left(\lim_{z_t^+\to k_t}\left(\left.\frac{dy_s^e}{dz_t}\right|_{z_t^+}\right) - \lim_{z_t^-\to k_t}\left(\left.\frac{dy_s^e}{dz_t}\right|_{z_t^-}\right)\right), \tag{12}$$

where the kink in $\mathcal{T}_t(z_t)$ at k creates a kink in disposable income y in period t and potentially also in future periods.

These derivations show the potential strength of using a tax kink to uncover the marginal propensity to consume. With the above assumptions, we can use tax kinks to eliminate the potential bias from heterogeneity in consumer types (η) when estimating the marginal propensity to consume using only observable changes in disposable income. Given such heterogeneity in consumer types, we could, for example, expect high-income households to be relatively more patient than low-income households, even if the two types of households were given the same income level, and similarly for households with different levels of liquidity (Parker, 2017; Landais and Spinnewijn, 2021; Ganong, Jones, Noel, Greig, Farrell, and Wheat, 2020). Such differences will, all else equal, bias MPC estimates downwards in observational data.

In our context, the standard RKD assumptions given by Equation (10) and (11) require (i) the density of taxable income (the running variable) to be smooth around the location of the tax kink and (ii) no deterministic sorting of taxpayers around the tax kink. These conditions imply the testable requirements that there is no discontinuity in the level or derivative of the density of taxable income at the tax kink, and that we should observe no kinks in other covariates around the tax kink.

While endogenous labor supply responses to taxation is an obvious concern that could cause these assumptions to be violated, Card, Lee, Pei, and Weber (2015, p. 2454) show that the RKD assumptions permit "...situations where agents endogenously sort but make small optimization errors (e.g., Chetty (2012))." In other words, endogenous labor supply responses subject to optimization frictions are permissible to the extent they do not violate the smooth density restrictions.

The jump in marginal tax rate at the tax kink creates an incentive for taxpayers to bunch below the kink point, invalidating the RKD. While there is a large literature documenting bunching at kink points, sharp bunching is evident primarily for certain types of taxpayers who have the ability to precisely adjust or manipulate their income; such as the self-employed, those receiving capital income from firms and married couples with pension payments that can be shifted within the household (Kleven, 2016). In our empirical application in Section 4, we observe these groups and exclude them from our sample. This restricts our sample to taxpayers who face frictions to adjust their taxable income, where evasion has been shown to be negligible (Kleven, Knudsen, Kreiner, Pedersen, and Saez, 2011), and for whom the elasticity of taxable income is likely to be low (Kleven and Schultz, 2014; Jakobsen and Søgaard, 2022).[2]

2.3 Permanent vs. Transitory Variation in Income

The RKD implied in Equation (12) does not in itself answer the question of whether we estimate a MPC out of transitory or permanent income (or a mixture of the two). However, we can use the dynamics of future disposable income around the tax kink to answer this question. To see this note that Equation (12) is a weighted sum of MPCs out of current and future disposable income, where the weights are given by the kinks in current and future disposable income around the current tax kink, all of which can be estimated.

Theoretically, kinks in future disposable income requires a mass point in the distribution of income innovations such that individuals located around the current kink point have a mass probability of keeping their position relative to the future kink point. In situations where the kink point is fixed (in real terms), this requires that a mass of individuals experience zero (real) income changes over a given time horizon.

Proposition 1. *Assume that the distribution of innovations to income evolves smoothly in z_t around the kink point. Then there are kinks in expected future disposable income y_s for $s > t$ if and only if there is a mass point in $z_s - z_t$ at $k_s - k_t$.*

Proof. First, unpack expected future disposable income y_s^e for $s > t$:

$$\begin{aligned} y_s^e \mid z_t &= \mathbb{E}_t \left[z_s - \mathcal{T}_s(z_s) \mid z_t \right] \\ &= \mathbb{E}_t \left[(1-\tau_-)\, z_s - (\tau_+ - \tau_-) \max\left(z_s - k_s, 0\right) \mid z_t \right] \\ &= (1-\tau_-)\, \mathbb{E}_t \left[z_s \mid z_t \right] - (\tau_+ - \tau_-)\, \mathbb{E}_t \left[\max\left(z_s - k_s, 0\right) \mid z_t \right]. \end{aligned} \tag{13}$$

Let $z_s = z_t + \psi_{t,s}$, where $\psi_{t,s}$ is the cumulative innovations that occur to z between t and s. The first expectation in Equation (13) can be expressed $\mathbb{E}_t \left[z_s \mid z_t \right] = z_t + \mathbb{E}_t \left[\psi_{t,s} \mid z_t \right]$. The

[2] Chetty, Friedman, Olsen, and Pistaferri (2011) show how bargaining frictions can limit bunching.

second expectation can be expressed as follows:

$$\begin{aligned}\mathbb{E}_t\left[\max\left(z_s - k_s, 0\right) \mid z_t\right] &= \mathbb{E}_t\left[\max\left(z_t + \psi_{t,s} - k_s, 0\right) \mid z_t\right] \\ &= \int_{-(z_t - k_s)}^{\infty} \left(\psi_{t,s} + z_t - k_s\right) f_{\psi_{t,s}}(\psi_{t,s} \mid z_t) d\psi_{t,s}.\end{aligned}$$

Hence, differentiating Equation (13) with respect to z_t gives

$$\begin{aligned}\frac{d\mathbb{E}_t\left[z_s - \mathcal{T}_s(z_s) \mid z_t\right]}{dz_t} = &(1-\tau_-)\left(1 + \frac{d\mathbb{E}_t\left[\psi_{t,s} \mid z_t\right]}{dz_t}\right) - (\tau_+ - \tau_-)\left[\left(1 - F_{\psi_{t,s}|z_t}\left(-\left(z_t - k_s\right)\right)\right)\right. \\ &\left. + \int_{-(z_t-k_s)}^{\infty} \left(\psi_{t,s} + z_t - k_s\right) \frac{\partial f_{\psi_{t,s}}(\psi_{t,s} \mid z_t)}{\partial z_t} d\psi_{t,s}\right]. \qquad (14)\end{aligned}$$

If the density of $\psi_{t,s}$ and its first derivative are smooth in z_t around the kink point, the kink in expected disposable income at time s is

$$\begin{aligned}K_t\left(y_s^e\right) &= \lim_{z_t^+ \to k_t} \left.\frac{d\mathbb{E}_t\left[z_s - \mathcal{T}_s(z_s)\right]}{dz_t}\right|_{z_t^+} - \lim_{z_t^- \to k_t} \left.\frac{d\mathbb{E}_t\left[z_s - \mathcal{T}_s(z_s)\right]}{dz_t}\right|_{z_t^-} \\ &= -\left(\tau_+ - \tau_-\right)\left(\lim_{z_t^+ \to k_t} \left.F_{\psi_{t,s}|z_t}\left(-\left(z_t - k_s\right)\right)\right|_{z_t^+} - \lim_{z_t^- \to k_t} \left.F_{\psi_{t,s}|z_t}\left(-\left(z_t - k_s\right)\right)\right|_{z_t^-}\right)\end{aligned}$$

which converges to zero in the limit provided there is no mass point in the distribution of $\psi_{t,s} = z_s - z_t$ at $k_s - k_t$. The assumption that $\psi_{t,s}$ is smooth in z_t around the kink point implies, for example, no discontinuity in the rate of mean reversion in incomes; a special case is where $\psi_{t,s}$ is independent of z_t.

It is instructive to consider the following two special cases. □

Lemma 1. *(All incomes and the kink point evolve in parallel.) If all incomes and the kink point grow by a common amount $\bar{\psi}_{t,s}$ for all s, the kink in all future periods is equal to $-(\tau_+ - \tau_-)$. Thus, there is a kink in permanent income equal to $-(\tau_+ - \tau_-)$ and the RKD estimates the MPC out of permanent income. This special case implies that all differences in observed income around the tax kink are driven by differences in permanent income.*

Proof. When all incomes and the kink points grow by the same amount, the density of $\psi_{t,s}$ is degenerate with all mass at the point $\bar{\psi}_{t,s} = z_s - z_t = k_s - k_t$, which corresponds to the kink at time s. Hence,

$$\lim_{z_t^+ \to k_t} F_{\psi_{t,s}}\left(-\left(z_t - k_s\right)\right)\big|_{z_t^+} - \lim_{z_t^- \to k_t} F_{\psi_{t,s}}\left(-\left(z_t - k_s\right)\right)\big|_{z_t^-} = 1$$

. □

Lemma 2. *(Transitory income shocks.) If all taxpayers experience annual income innovations drawn independently from a continuous distribution, then there is no kink in future income and the RKD estimates the MPC out of transitory income. This special case implies that all differences in observed income are driven by differences in transitory income.*

Proof. If $z_s = z + \varepsilon_s$ where ε_s is drawn independently from a continuous distribution then $\psi_{t,s}$ has no mass points and the proof follows from Proposition 1. □

To fix ideas, consider the income process specified in Meghir and Pistaferri (2004). Income is the sum of a random walk permanent and moving average transitory component:[3]

$$z_t = p_t + e_t \tag{15}$$

$$\text{Permanent income: } p_t = p_{t-1} + \xi_t \text{ where } \xi_t \sim \text{iid}\left(0, \sigma_\xi^2\right) \tag{16}$$

$$\text{Transitory income: } e_t = \varepsilon_t - \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} \text{ where } \varepsilon_t \sim \text{iid}\left(0, \sigma_\varepsilon^2\right), \tag{17}$$

where the individual subscript is suppressed for brevity. Using this income process, income in future years can be expressed in terms of innovations to permanent and transitory income:

$$z_s = p_s + e_s = p_t + \left(\xi_{t+1} + \cdots + \xi_s\right) + e_s = z_t + \underbrace{\left(\xi_{t+1} + \cdots + \xi_s\right) + \left(e_s - e_t\right)}_{\psi_{t,s}}. \tag{18}$$

If there is a mass of people who are on their permanent income ($e = 0$) and who also do not experience shocks to their permanent income ($\xi_{s>t} = 0$), this implies a mass point in $\psi_{t,s}$. Hence, a sufficient condition for their being a mass point in the distribution of $\psi_{t,s}$ is a mass of people on their permanent income and not experiencing shocks.

[3] We abstract from the measurement error component.

Empirically, there is evidence of a small mass point at zero earnings growth (Druedahl, Jørgensen, and Graber, 2021). However, as tax kinks often (including in our setting) are indexed to (wage) inflation, it is less likely that the mass point in earnings growth carry over to a kink in future disposable income as described in Proposition 1. Hence, theoretically we should expect the RKD to exploit predominantly transitory variation in income. Intuitively, a taxpayer whose income is just above (below) the kink point in the current year has an almost equal chance of being above or below the kink in the following year. In the data, we find little evidence of kinks in future disposable income. In this case, the RKD estimate

$$MPC^{RKD} = \frac{\lim_{z_+ \to k} \frac{dc_t}{dz_t}\Big|_{z_+} - \lim_{z_- \to k} \frac{dc_t}{dz_t}\Big|_{z_-}}{\lim_{z_+ \to k} \frac{dy_t}{dz_t}\Big|_{z_+} - \lim_{z_- \to k} \frac{dy_t}{dz_t}\Big|_{z_-}}. \tag{19}$$

also corresponds to the MPC out of transitory income.

3 Institutional Setting and Data

In Denmark, individuals are taxed according to a dual tax system with generally higher and progressive taxes on labor income (and transfers) than on capital income. For this study, we focus on the top tax, which levies a 15 percent tax on so-called personal income above DKK 588,900 in 2024 (USD 85,200). Combined with the rest of the tax system, the top tax creates a top marginal tax rate on labor income equal to 55.9%.[4]

Personal income is defined by the tax code and includes both public transfers and labor income. However, as most public transfers are phased out with income, personal income consist almost entirely of labor income for our sample. The threshold for the top tax has increased over time both due to tax reforms and automatic adjustment to wage inflation. On average over our sample period, the kink point corresponds to the 75 percentile in the income distribution (see Appendix Figure A.1).

[4] See also Jakobsen and Søgaard (2022) for a recent description of the Danish tax system. On top of the direct taxation of income, Denmark also levies a 25% VAT on close to all goods and services.

We use Danish full population administrative data from 2000–2016 for individuals aged 20-65. The data combine several administrative registers linked at the individual level via personal identification numbers and contain detailed information on labor market history, education, earnings, and demographics with almost all income data being third-party reported (Kleven, Knudsen, Kreiner, Pedersen, and Saez, 2011). The data also allow us to link individuals over time and to households through unique household identifiers.

Our main variables of interest are household disposable (after-tax) income $y_{i,t}$, the difference between individual taxable (personal) income $z_{i,t}$ and the top tax kink k_t, and household consumption $c_{i,t}$. Disposable income and taxable income are both directly available in the administrative data, while we impute consumption as described below. As for the distances between individual taxable income and the top tax threshold, we use the tax simulator (similar to the NBER TAXSIM) developed by Jakobsen and Søgaard (2022). Figure 2 validates this approach by showing that the computed tax base accurately predicts top tax payments observed in the administrative data both at the extensive and intensive margin.

3.1 Imputed Consumption

Our imputation of consumption follows Browning and Leth-Petersen (2003) and Abildgren, Kuchler, Rasmussen, and Sørensen (2018). It is based on the simple accounting equation between disposable income $y_{i,t}$, (net) savings $s_{i,t}$, consumption $c_{i,t}$, and net wealth $w_{i,t}$ of individual i in year t

$$\begin{aligned} y_{i,t} &= c_{i,t} + s_{i,t} \\ w_{i,t} &= w_{i,t-1} + s_{i,t} \\ \implies c_{i,t} &= y_{i,t} - (w_{i,t} - w_{i,t-1}). \end{aligned} \tag{20}$$

We observe all components in Equation (20) in the administrative data and can therefore impute consumption for the entire adult population using the Danish register data. As wealth easily can be transferred between spouses, we impute consumption at the household level.

In practice, we need to separate net wealth into liabilities $l_{i,t}$, the market value of stocks $s_{i,t}$ and other assets $a_{i,t}$, because the value of stocks can change due to both stock market trade (i.e. changes in savings) and changes in stock prices. Therefore, our main imputation equation of consumption becomes

$$\hat{c}_{i,t} = y_{i,t} + \widehat{inheritance}_{i,t} - \left[(a_{i,t} + s_{i,t} - l_{i,t}) - (a_{i,t-1} + R^s_{i,t} s_{i,t-1} - l_{i,t-1}) \right], \tag{21}$$

where $R^s_{i,t}$ is the gross return on the stock portfolio between years $t-1$ and t and $\widehat{inheritance}_{i,t}$ is estimated inheritance from parents. As there is no register data on inheritance, we proxy inheritance by taking the net wealth of last surviving parent (or any parent if parents are divorced) and divide by the number of children. Similarly, we lack information on the composition of individual stock portfolios and use year-to-year changes in the Danish stock market index (OMX) to proxy $R^s_{i,t}$.[5]

Browning and Leth-Petersen (2003) and Abildgren, Kuchler, Rasmussen, and Sørensen (2018) compare imputed consumption to survey information on individual consumption and conclude that – except for outliers in the tails – imputed consumption closely proxies actual consumption. Baker, Kueng, Meyer, and Pagel (2022) study the effect of errors in measurement of financial trading on consumption imputation using transaction-level retail brokerage data and find the economic significance of imputation errors to generally be small. The same should hold in our setting, as measurement error in disposable income or wealth only should affect our MPC estimates if there is a kink in measurement errors at the tax kink, which is unlikely. We show this point formally in Appendix B. The main issue with measurement error in our setting is that it increases the variance of our estimates. As the RKD is a power demanding design, we address this issue by winsorizing the imputed consumption at the 10th and 90th percentile within each year.

[5] Eika, Mogstad, and Vestad (2020) use Norwegian register data to construct imputed consumption including information of individual stock portfolios and find that the additional information does not affect results.

3.2 Sample and Descriptive Statistics

Our choice of sample aims to exclude taxpayers who have the ability to precisely adjust or manipulate their income, because this leads to clear violations of the RKD assumptions outlined in Section 2. For that reason, we drop households where one (or more) member is registered as self-employed or receives non-wage labor income. This excludes both full and part-time self-employed and spouses of self-employed individuals. Similarly, we exclude households if one member lies in the top of the distribution of income, net wealth or private pension contributions (see the notes to Table 1 for details).

The result of these data restrictions on the number of observation and descriptive statistics are reported in Table 1. Columns 1-2 show statistics for the full population aged 20-65; Columns 3-4 show the main sample after we have implemented our sample restrictions, while; Columns 5-6 show the RKD sample where we zoom in on individuals with taxable income within +/- 3,000 USD from the top tax kink. There are three key takeaways from this table. First, individuals in the RKD sample are on average positioned at the 75th percentile in the both the earnings distribution and the distribution of disposable income. This mirrors the position of the top tax kink and implies that we estimate MPCs for upper-middle class households. Second, while taxable income in principle also includes public transfers, these are phased out with income and, hence, taxable income for the RKD sample is almost entirely made up of labor income (wages). Third, on most other covariates the RKD sample is not meaningfully different from the full population. The variance of age is slightly smaller, implying that individuals are less likely to be very young or very old, the sample is slightly less likely to be female, and the level and variance of net wealth is significantly smaller, reflecting that we exclude self-employed households.

4 Estimating the Marginal Propensity to Consume

4.1 Empirical Approach

Our empirical strategy builds on a standard RKD. We adopt a fuzzy RKD and estimate the kink in disposable income (the first stage) instead of relying on the statutory kink in the marginal net-of-tax rate. While the marginal net-of-tax rate mechanically affects the relationship between earnings and disposable income, disposable income includes a number of other income components (including spousal income in two person households) and, hence, it is not guaranteed that the estimated kink precisely matches the statutory tax kink.

The first-stage regresses disposable income $y_{i,s}$ on the running variable $z_{i,t}$ allowing for a discontinuity in the slope at the kink point k_t. We use a linear specification of the RKD because the tax function follows a linear schedule on each side of the tax kink. The first-stage regression is given by

$$y_{i,s} = \beta_0^s + \beta_1^s z_{i,t} + \beta_2^s \mathbb{1}[z_{i,t} > k_t] (z_{i,t} - k_t) + \delta_s + X_s + v_{i,s} \tag{22}$$

where δ_s are year dummies and X_s is a vector of additional controls. The model is estimated for $|z_{i,t} - k_t| \leq w$, where w is the bandwidth and uniform weights are used. The parameter of interest is β_2^s – the estimated change in the slope of disposable income at time s with respect to taxable income at t. With no measurement error or other income components β_2^t equals to the jump in marginal tax rate at k_t. For $s > t$, β_2^s declines towards zero, with the rate of decline depending on the share of the variation in income that is driven by temporary income shocks, as laid out in Section 2.

Similarly, the reduced form regresses consumption $c_{i,s}$ on the running variable $z_{i,t}$, allowing for a discontinuity in the slope at k_t:

$$c_{i,s} = \gamma_0^s + \gamma_1^s z_{i,t} + \gamma_2^s \mathbb{1}[z_{i,t} > k_t] (z_{i,t} - k_t) + \delta_s + X_s + u_{i,s}, \tag{23}$$

and with the same bandwidth and weights as in the first stage. The parameter γ_2^s is the discontinuity in the slope of consumption at horizon s at the kink point k_t.

Finally, because the first-stage is estimated, we use a two-stage least squares (2SLS) approach to estimate the MPC directly, facilitating computation of standard errors. The 2SLS approach regresses consumption on disposable income, controlling for taxable income, but using the interaction between taxable income and the indicator for taxable income levels above the kink point as the excluded instrumental variable. Formally,

$$c_{i,s} = \phi_0^s + \phi_1^s z_{i,t} + \phi_2^s y_{i,s} + \delta_s + X_s + w_{i,s}, \tag{24}$$

using $\mathbb{1}[z_{i,t} > k_t]\,(z_{i,t} - k_t)$ as an instrument for $y_{i,s}$. By the the standard 2SLS mechanics, the estimated parameter ϕ_2^s in the second stage equals the reduced form coefficient scaled by the first stage ($\phi_2^s = \gamma_2^s / \beta_2^s$). When all variation in $z_{i,s}$ around at k_s is driven by transitory variation, the research design isolates variation in $y_{i,t}$, holding $y_{i,s}$ constant for $s > t$ and, hence, estimates the MPC out of transitory income.

4.2 Validity of the Research Design

We begin our presentation of results by exploring the validity of the research design. As stated in Section 2, the RKD requires (i) the density of taxable income (the running variable) to be smooth around the location of the tax kink; and (ii) no deterministic sorting of taxpayers around the tax kink. In practice, this requires the density of taxpayers to be twice continuously differentiable at the kink point (Card, Lee, Pei, and Weber, 2012). Intuitively, precise sorting around the kink point could be evident in bunching at the kink, creating a discontinuity in the density or its derivative at the kink. If taxpayers, who bunch, differ from the rest of the population in terms of pre-determined covariates, we should also observe breaks in the distribution of covariates around the kink point (Card, Lee, Pei, and Weber, 2015).

Figure 3 presents the density of taxable income around the kink point, together with the test results. Panel A shows the density distribution for the full sample and our main sample around the top tax threshold, while Panel B shows the first derivatives of the density distribution. For the full sample, we see clear bunching at the kink point. However, this is entirely driven by self-employed households and once we remove these households all sharp bunching disappears. In Panels C and D, we test for (i) no discontinuity (jump) in the density of taxable income (the running variable) at the kink point and (ii) no discontinuity in the derivative of the density using an extended McCrary type test, as in (Card, Lee, Pei, and Weber, 2012). We run these tests both for the actual kink and for placebo kinks positioned between +/-6,000 USD from the actual kink point. As evident from Panel C, we cannot reject the null of no break in the density at the actual kink point, while the test fails at placebo kinks both below and above. However, in Panel D – which essentially tests if the density distribution is linear – we find that the tests fails both at the actual kink point and at placebo kinks below and above. The fact that small non-linearities are also evident at placebo kinks suggests natural variation in the slope of the density may account for the estimated kink in Panel D, rather than manipulation of earnings.

In Figure 4 we plot the evolution of covariates around the kink point for our main sample and report RKD estimates for each covariate.[6] For the first four covariates (Panel A-D), the RKD estimates reveal significant kinks. However, closer inspection of the panels suggests that the kinks appear above the actual tax kink point and, hence, likely reflect non-linearities in the covariate distribution. This is also supported by RKD estimates at placebo kink points (see Appendix Figure A.3), but choosing a smaller bandwidth does not remove the kinks before we loss too much power in the estimation (see Appendix Figure A.4). For lagged net wealth and liquid assets (Panels E and F), we see sizable and significant kinks that occur more sharply at the kink point. These covariates are somewhat different than the first four as they are more directly related to the running variable (individual taxable income). Indeed, to the extent differences in taxable income are driven by the permanent (as opposed to transitory) component of earnings we could expect the kink in disposable income to feed into kinks in savings and wealth.[7]

We deal with these potential threats to the RKD by including controls in the regressions. Our baseline controls include dummies for year, age, the number of adults in the household, and a second order polynomial in spouse earnings. We also include dummies for occupation (2-digit ISCO codes) to control for aggregate bunching (Chetty, Friedman, Olsen, and Pistaferri, 2011). Below we validate whether the included controls are sufficient to remove any effect of covariates on the estimated kinks in disposable income and consumption, and we show robustness of our MPC estimates without controls and with additional controls for net wealth and liquid assets.

[6] Appendix Figure A.2 shows the corresponding figures for the full sample.

[7] While a sharp kink in savings would feed into a sharp kink in wealth under the assumption of common returns, this is no longer the case if returns on wealth are stochastic and heterogeneous.

4.3 First Stage and Reduced Form Estimates

Figure 5 presents the first stage and reduced form RKD estimates based on Equations (22) and (23) in Section 4.1. Panel A shows the the first stage kink in the relationship between disposable income $y_{i,t}$ and taxable income $z_{i,t}$ both at the actual kink and for placebo kinks positioned between +/-6,000 USD from the actual kink point. Panel B shows similar estimates from the reduced form regression with consumption $c_{i,t}$ as the outcome. In both panels, we also plot the estimated kinks in predicted outcomes, which we form based on a regression using dummies for the number of adults, number of children, age and year, and second order polynomials in household earnings, net wealth and liquid assets as controls. Using predicted outcomes allows us to assess whether kinks in these covariates create quantitatively important kinks in the outcomes we are interested in.

As evident from Figure 5, we find clear kinks in both disposable income and consumption at the actual kink point, while placebo estimates become insignificant and close to zero once we move sufficiently far away from the actual kink point.[8] In terms of magnitudes we estimate a kink of -0.22 in disposable income (slightly bigger than the statutory kink of -0.15) and a kink in consumption of -0.12. For the predicted outcomes, the placebo estimates are close to the actual estimates sufficiently far from the actual kink point, and while the estimates turn significant at the actual kink point (in particular for disposable income), the implied potential bias is far from enough to explain the observed kink in disposable income and consumption.

4.4 RKD Estimates of the Marginal Propensity to Consume

In Table 2 we translate the first stage and reduced form estimates in Figure 5 into 2SLS estimates of the MPC defined in Section 2. Given the standard 2SLS mechanics, these estimates essentially scale the reduced form estimates with the first stage, and we estimate a MPC of 0.574 with a standard error of 0.095 (Table 5, Column 1).

Table 2 also reports a number of robustness estimates. In Column 2-3 we first add additional controls for net wealth and liquid assets and next remove all controls. Column 4

[8] As we use a bandwidth of +/-3,000 USD in the RKD, placebo estimates within this range from the actual kink will pick up part of the actual kink effect.

excludes individuals with taxable income less than 200 USD from the tax kink and Column 5 includes only singles, which eliminates any bias coming from earnings responses from the spouse. With the exception of the donut regression in column 4, none of these are significantly different and the point estimates in columns 1, 2 and 5 are almost identical. Finally, we also for comparison report simple OLS estimates of consumption on disposable, and while we cannot reject a common MPC on a 5% level (comparing columns 2 and 6), the OLS estimate is markedly smaller than the 2SLS. This suggests, as discussed in Section 2, that the cross-sectional relationship between disposable income and consumption underestimates the MPC due to, for example, high-income individuals being more patient types. The MPC estimates are similar for different bandwidths, except very small bandwidths where statistical power drops sharply (Figure A.5).

Table 3 explores heterogeneity in the MPC estimates by interacting disposable income in the second stage with selected covariates and instrumenting with the corresponding interaction between the covariate and the slope above the kink point in the first stage. Considered individually, we find that the estimated MPC is positively correlated with age and negatively correlated with the number of children, years of schooling, net wealth and liquid assets. However, stacked into one regression we find that the effect of children and liquid assets loads onto the other variables and becomes insignificant. Appendix Figure A.6 plots the MPC estimated separately by year, and while we lack statistical power to make strong conclusions, we find an interesting pattern with larger and more uncertain MPC estimates in years with a weak macro economy (the years after the Dot-com bubble and after the Financial Crisis).

4.5 Structural Interpretation of the RKD Estimate

As shown in Section 2.2, the RKD estimate of the MPC is a weighted sum of MPCs out of current and future disposable income, where the weights are given by the kinks in current and future disposable income around the current tax kink. In this subsection, we provide evidence that kinks in future disposable income $y_{i,s}$ (and consumption $c_{i,s}$) for $s > t$ are small and mostly statistically insignificant. This implies the RKD estimate of the MPC provides an estimate of the MPC out of transitory income.

Figure 6 shows estimates of the contemporaneous and future kinks in disposable income and consumption. Because our theory (Proposition 1) implies that any persistence in income arises from mass points in innovations to earnings, we restrict the sample in Years 1-4 to observations remaining within the RKD bandwidth, avoiding attenuation from large earnings innovations. The one-year-ahead estimated kink in disposable income is less than one-quarter of the size of the contemporaneous kink, while the kinks in Years 2-4 are smaller still and and statistically insignificant. Consistent with Proposition 1, this indicates that the RKD exploits mostly contemporaneous variation in earnings to estimate the MPC.[9]

For consumption, the kink estimates drop sharply after period 0 (Figure 6). The absence of any persistent consumption response is also consistent with the variation in income exploited by the RKD being transitory.

5 Discussion

We have used an RKD design to estimate a a MPC of 0.6, and provided evidence that this can be interpreted as an MPC out of primarily transitory variation in income. Our findings contribute to a large quasi-experimental literature studying spending responses to transitory income changes (see Jappelli and Pistaferri 2010; and Havranek and Sokolova 2020 for surveys). This literature indicates a mean quarterly MPC for non-durable goods and services of 0.15-0.25 for a windfall 500-1,000 USD increase in income (Kaplan and Violante, 2022). Our MPC estimate is based on a broader measure of expenditure, including services and uses an annual rather than quarterly frequency, and so all else equal is expected to be larger. Parker, Souleles, Johnson, and McClelland (2013) find significant spending responses for durable goods and services in response to the 2008 economic stimulus payments and report a quarterly MPC for total consumption of 0.50-0.90. The most comparable study to ours from a measurement perspective is Fagereng, Holm, and Natvik (2021), who impute consumption from Norwegian administrative tax data and estimate

[9] Appendix C shows that we can replicate the dynamic pattern of kinks when Equation (22) is estimated on data simulated from a realistic but exogenous income process. This provides reassurance that the dynamic pattern of kinks observed in Figure 6 is not driven by unobserved manipulation of earnings.

an MPC of 0.4 from lottery winning.

A key difference between our study and prior work is that we study spending responses for high income earners. It is conventional wisdom that MPCs out of transitory income decline with income, implying that we should expect to find smaller MPCs than comparable prior work. However, prior work does not provide strong evidence that MPCs decline with income. Fagereng, Holm, and Natvik (2021) find no clear relationship between income and spending propensities for lottery winnings; Kueng (2018) estimates MPCs out of predictable disbursements from the Alaska permanent fund to be monotonically *increasing* with income, and; Jappelli and Pistaferri (2014) find MPCs to be large and flat between the second and fifth disposable income quintiles in Italian survey data.

Relative to a complete markets benchmark, an annual MPC out of transitory income of 0.6 is large. Two mechanisms have been put forward in the literature to explain large MPCs for high income earners. Kaplan and Violante (2014) argue that many wealthy households hold few liquid assets. Accordingly, their spending responds to small income fluctuations in a similar manner to traditional hand-to-mouth households. Kueng (2018) argues that optimization frictions explain excess sensitivity of consumption for high income earners. We do not observe a strong liquidity gradient (conditional on other covariates), suggesting a limited role for wealthy hand-to-mouth behavior in our sample: the median household in our analysis sample holds around 2 months of disposable income in liquid form. Our finding of large MPCs for high income earners is consistent with optimization errors, and other recent work finding large MPCs even for those with high liquidity (Boehm, Fize, and Jaravel, 2025; Graham and McDowall, 2024).

Another strand of the literature argues that fixed characteristics of households are important for understanding MPC heterogeneity (Aguiar, Bils, and Boar, 2024; Gelman, 2022). Specifically, while low liquidity is a proximate cause of high MPCs, characteristics of households rather than economic circumstances may be the source of low liquidity. Characteristics of households that give rise to low liquidity include impatience, financial sophistication and risk-aversion (Parker, 2017; Landais and Spinnewijn, 2021). Many of these characteristics are correlated with income. Parker (2017) finds that spending responses to the 2008 economic stimulus payments are almost equally well predicted by liquidity and income two years prior. Consistent with this, we find that the liquidity gradient falls to 1/3rd of its size when controlling for other covariates. Thus, unobserved sources of heterogeneity in MPCs correlated with income may bias inference on the source of MPC heterogeneity. Our methodology addresses this issue because the RKD non-parametrically controls for unobserved characteristics of households that may be correlated with income.

Along with Ganong, Jones, Noel, Greig, Farrell, and Wheat (2020), our approach is novel in exploiting variation in labor income to estimate MPCs. This is important because spending responses can differ depending on the source and form of variation in resources: labels applied to transfers affect spending propensities (Hastings and Shapiro, 2018; Beatty, Blow, Crossley, and O'Dea, 2014); mental accounting is an explanation for high spending out of windfall income (Thaler, 1985, 1990), and; the method of disbursement of economic stimulus payments can affect spending behavior (Sahm, Shapiro, and Slemrod, 2012). Labor income is the largest source of income uncertainty for wage and salary earners and therefore most welfare relevant for households.

6 Conclusion

We have proposed a new methodology to estimate the MPC using variation in disposable income caused by kinks in income tax schedules. We employ a RKD and estimate the MPC as the ratio of the change in the slope of consumption to the change in slope of disposable income at a tax kink. We use data (including the running variable) comprised almost entirely of third-party reported income, which taxpayers have limited ability to precisely manipulate, satisfying the identifying assumptions of the RKD. Consumption is imputed from comprehensive administrative tax and wealth data.

Applying our methodology to Denmark, we estimate a MPC of 0.6 (s.e. 0.1) for taxpayers at the top tax kink. We have shown theoretically and empirically that the RKD exploits primarily transitory variation in disposable income across a tax kink to estimate the MPC. We therefore interpret our estimated MPC as the spending response to transitory income. The evidence we provide on MPCs for high income earners is novel. Approaches used in the existing literature have been unable to estimate the MPC for high income earners because data sets contain few high income earners or exploit variation in income that affects few high income earners. Our findings inform the benefits of extending fiscal stimulus and social insurance program to high income earners.

The variation we exploit to estimate MPCs is predominantly wage and salary income. This contrasts with quasi-experimental evidence using rare windfalls, such as economic stimulus payments or lotteries. This matters because the source and labeling of windfall income can affect spending propensities. Consumption responses to labor income variation is most welfare relevant for households because labor income risk is the predominant source of risk faced. Unlike semi-structural approaches, our approach does not place any restrictions on the income process. Furthermore, the RKD flexibly controls for unobserved determinants of consumption correlated with income (e.g., risk attitudes).

Our methodology does not reply on rare natural experiments and can therefore be widely applied. A feature of estimating MPCs within tax data is the ability to link MPC heterogeneity to behaviors observable on tax returns. Recent work has identified risk-aversion as a source of heterogeneity in MPCs. This could be explored using demand for insurance, observable within tax data, as a proxy for risk attitudes. Another potential application is estimating the propensity to make charitable contributions.

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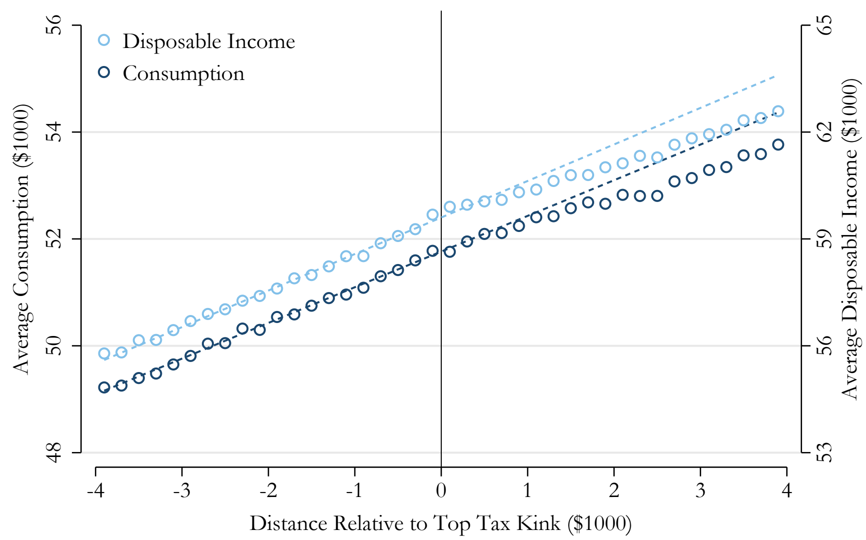
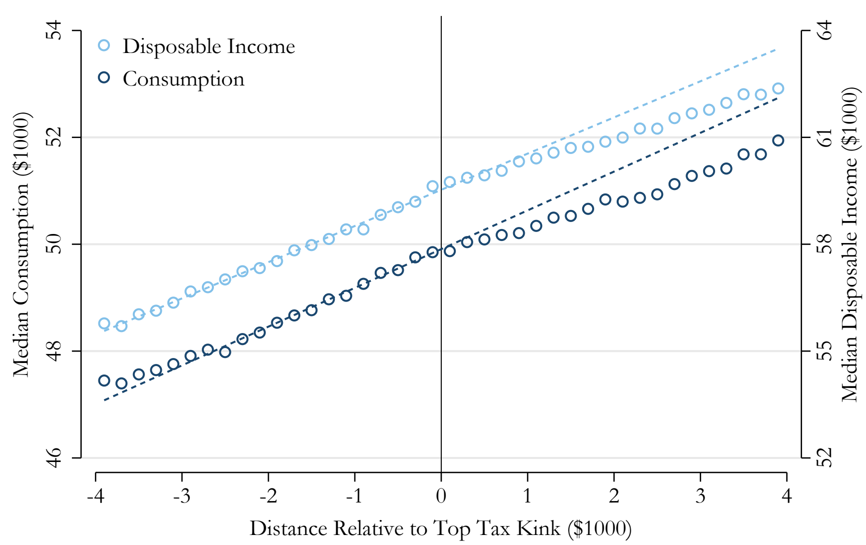
Figures and Tables

Figure 1: Evolution of Disposable Income and Consumption around the Top Tax Kink

A: Average



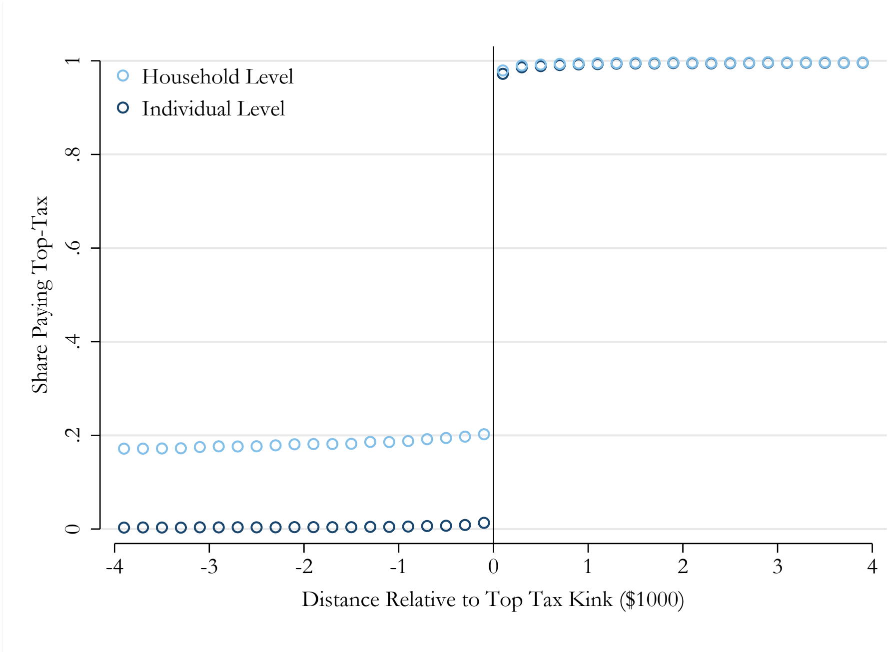
B: Median



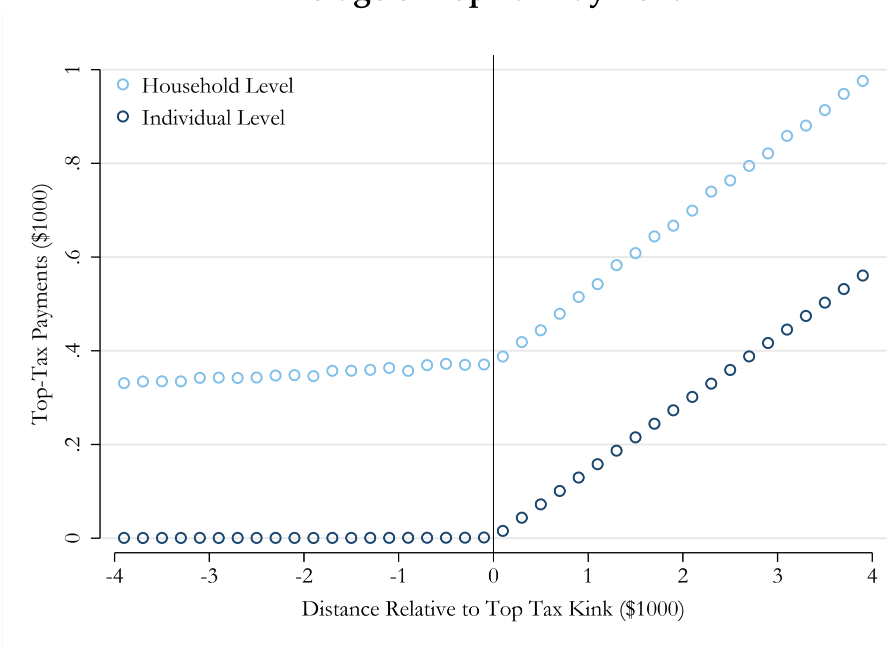
Notes: The figure shows average (Panel A) and median (Panel B) household disposable income and consumption in 200 USD bins around the top tax kink. The figure uses data for the period 2000-2016 centered on the top tax kink in each year. The dashed lines shows the estimated trend line based on the binned data between 0 and -3,000 USD below the tax kink. See Table 1 for sample and variable definitions.

Figure 2: Top Tax Payments around the Tax Kink

A: Share Paying the Top Tax

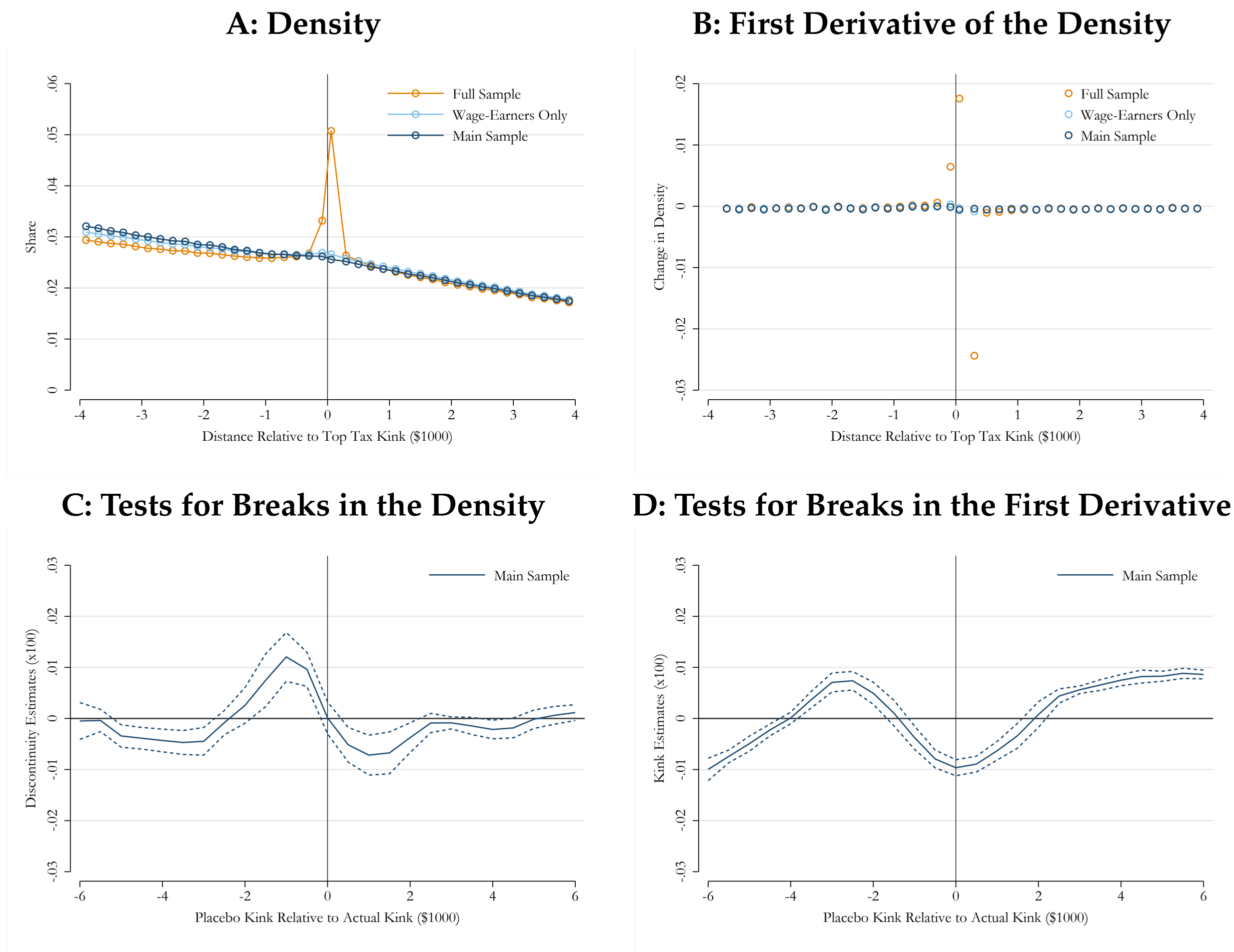


B: Average of Top Tax Payment



Notes: The figure shows the share of individuals and households, who pay the top tax (Panel A), and the average amount paid (Panel B) in 200 USD bins around the top tax kink. As the x-axis measures the individual's distance to the top tax kink, households below the tax kink pay the top tax if the spouse has an income above the kink. See Table 1 for sample and variable definitions.

Figure 3: Distribution of Individuals around the Tax Kink

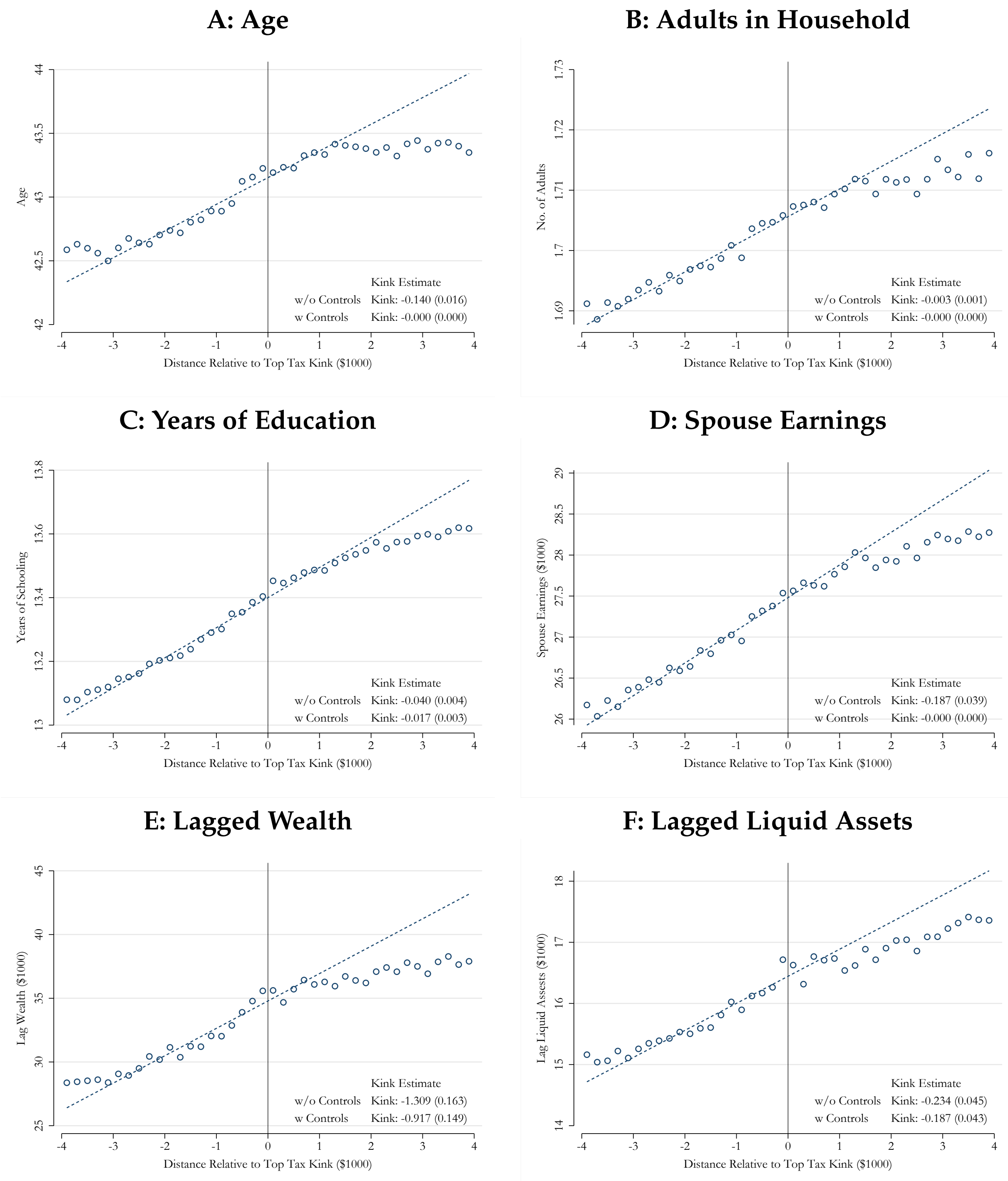


Notes: The figure shows the distribution of individuals around the top tax kink. Panel A shows the share of individuals in 200 USD bins around the top tax for three successively more restricted samples: 1) the full sample of individuals between 20 and 65 years old, 2) a sample of wage earners only, and 3) our main (trimmed) sample, where we also exclude households in the top income and wealth distributions and with large private pension contributions (see Table 1 for details). Panel B shows the bin-to-bin changes in the share of individuals. Panel C and D report tests for breaks in the distribution for the main sample, both at the actual tax kink (0) or at placebo kinks positioned between +/-6,000 USD from the actual tax kink. For each (placebo) kink point c, we run the regression

$$s_b = \beta_0^c + \beta_1^c(z_b - c) + \beta_2^c \mathbb{1}(z_b > c) + \beta_3^c \mathbb{1}(z_b > c)(z_b - c) + v_b,$$

where s_b is the share of individuals within bin b and z_b is average taxable income the bin. Panel C reports the discontinuity estimates, $\hat{\beta}_2^c$, and Panel D reports the kink estimates, $\hat{\beta}_3^c$. As we use a bandwidth of +/-3,000 USD, placebo estimates within this range from the actual kink will pick up part of the actual kink effect. The dashed lines represent the 95% confidence intervals based on robust standard errors.

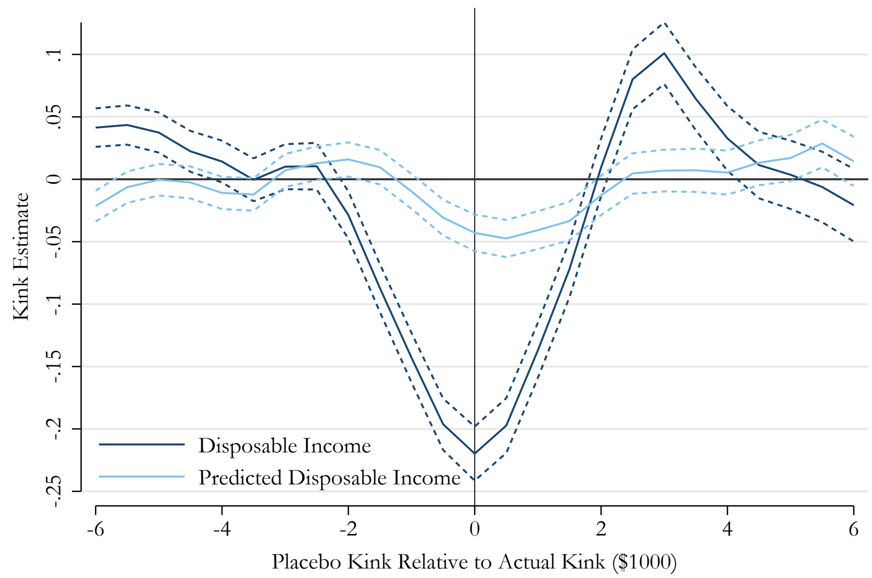
Figure 4: Evolution of Covariates around the Tax Kink



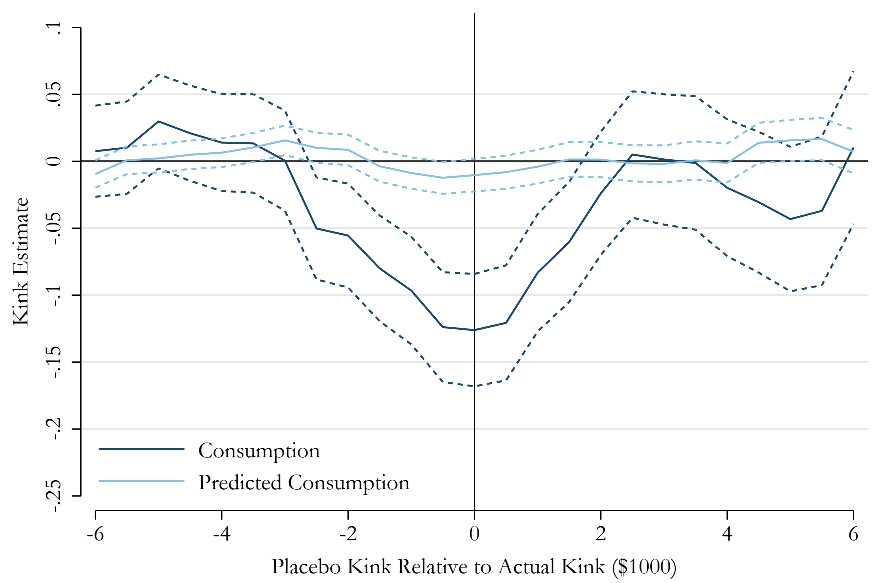
Notes: The figure shows the average value of selected covariates for our main sample in 200 USD bins around the top tax kink. The dashed lines shows the estimated trend line based on the unbinned data between 0 and -3,000 USD below the tax kink. The figure also report two RKD estimates. One without controls (based on the same regression as used to estimate the trend lines) and one where we add our baseline set of controls: dummies for year, age, number of adults in the household, occupation (2-digit ISCO codes) and a second order polynomial in spouse earnings. Standard errors are clustered at the household level.

Figure 5: First Stage and Reduced Form Estimates

A: First Stage

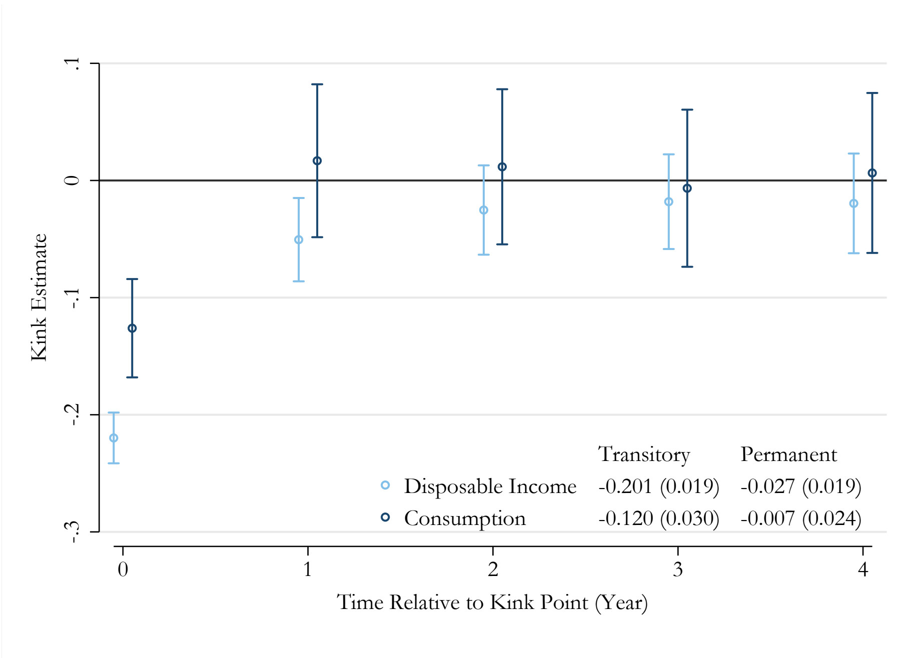


B: Reduced Form



Notes: The figure shows estimates for the first stage regression of disposable income on a kink (Panel A) and reduced form regressions of consumption on a kink (Panel B) both at the actual top tax kink (0) or at placebo kinks positioned between +/-6,000 USD from the actual tax kink. In the RKD regressions, we control for year, age, number of adults in the household, occupation (2-digit ISCO codes) as dummies and a second order polynomial in spouse earnings. The figure plots estimates both for actual consumption and disposable income and the corresponding predicted variables from regressions using the number of adults, number of children, age and year dummies, and second order polynomials in household earnings, lagged net wealth and lagged liquid assets as controls. As we use a bandwidth of +/-3,000 USD, placebo estimates within this range from the actual kink will pick up part of the actual kink effect. Standard errors are clustered at the household level.

Figure 6: Dynamic Kinks Estimates



Notes: The figure shows estimates from our RKD regressions of current and future $(t + s)$ disposable income and consumption on the tax kink at time t. The estimates for $s = 0$ correspond to the estimates at the actual kink in Figure 5. In the regressions, we include our baseline set of controls: dummies for year, age, number of adults in the household, occupation (2-digit ISCO codes) and a second order polynomial in spouse earnings measured at $t + s$, and use a bandwidth of +/-3,000 USD. Because Proposition 1 implies that any persistence in income arises from mass points in innovations to earnings, we restrict the sample in Years 1-4 to observations remaining within the RKD bandwidth. Standard errors are clustered at the household level.

Table 1: Descriptive Statistics

	Population		**Main Sample**		**RKD Sample**	
	Mean	SD	Mean	SD	Mean	SD
Individual Characteristics						
Age	43.29	12.36	41.60	12.63	43.06	10.33
Female	0.49	0.50	0.50	0.50	0.40	0.49
Education Years	12.56	2.61	12.32	2.59	13.37	2.35
Earnings Rank	50.00	28.87	47.87	28.29	75.42	11.02
Indiv. Earnings	32.25	60.84	28.22	21.57	43.86	7.37
Taxable Income	37.12	61.82	34.40	16.75	45.87	4.02
Household Characteristics						
No. of Adults	1.68	0.47	1.60	0.49	1.70	0.46
No. of Children	0.76	1.02	0.70	0.99	0.91	1.04
Diposable Income Rank	50.00	28.87	47.27	27.77	73.40	11.10
Diposable Income	54.32	70.60	46.48	25.21	59.22	20.80
Imputed Consumption	47.15	28.20	42.19	22.34	51.51	20.90
Net Wealth	62.76	505.24	21.36	91.81	32.54	102.30
Liquid Assets	25.92	206.77	13.63	26.40	16.62	28.13
Spouse Earnings	26.64	65.79	21.30	24.86	27.31	25.35
Self-employed	0.17	0.38	0.00	0.00	0.00	0.00
+/- USD3.000 from Tax Kink	0.14	0.35	0.13	0.33	1.00	0.00
Observations	45,828,598		29,425,503		2,808,832	

Notes: The table shows descriptive statistics and observations for the full population of taxpayers aged 20 to 65 from 2000 to 2016 in Column 1. Column 2 includes all standard wage earners, with a set of trimming restrictions applied at the individual level. Our definition of wage-earners exclude all households, where one (or more) member is registered as self-employed or receive non-wage labor income. Hence, we also exclude part-time self-employed and spouses to self-employed individuals. A total of six restrictions are imposed in the following order: (1, 2) remove individuals with negative disposable income or negative contributions to capital pension schemes; (3) remove individuals with annual contributions to the capital pension schemes above the 90th percentile; (4, 5) remove individuals above the 99th percentile for disposable income or net wealth; (6) keep individuals with a household consumption-to-disposable income ratio between zero and three. For couples, both members must independently satisfy the criteria; otherwise, the household is excluded from the sample. Column 3 represents our RKD sample, including standard wage earner observations within +/- 3,000 USD from the top tax kink. We winsorize our consumption measure at the 10th and 90th percentiles in the full sample within household size, self-employment status and year. All income values are deflated using the Danish Consumer Price Index (CPI) and expressed in 2010 terms. Income variables are converted to U.S. dollars using an exchange rate of 1 USD = 7.76 DKK. Ranks are calculated by self-employment status and year.

Table 2: RKD Estimates of the Marginal Propensity to Consume

	2SLS					OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Disp. Income	0.574	0.537	0.625	0.758	0.519	0.372
	(0.095)	(0.111)	(0.063)	(0.082)	(0.173)	(0.002)
N	2,808,832	2,808,832	2,808,832	2,615,789	832,251	2,808,832
Controls:						
- Baseline	X	X				X
- Additional		X				X
Singles Only					X	
Bandwidth	3,000	3,000	3,000	3,000	3,000	3,000
Donut				200		

Notes: The table reports 2SLS estimates of the marginal propensity to consume (MPC) out of disposable income based on our RKD. Column 1 includes our baseline controls for year, age, number of adults in the household, occupation (2-digit ISCO codes) as dummies and a second order polynomial in spouse earnings. Column 2 additionally includes controls for lagged net wealth and lagged liquid assets, while we in Column 3 drop all controls. Column 4 excludes a donut of +/- 200 USD around the tax kink. Column 5 only includes singles. To preserve power, we also drop all controls in these two regressions. Finally for comparison, we report the OLS estimate of consumption on disposable income for the same sample. Standard errors are clustered at the household level.

Table 3: Heterogeneity in the Marginal Propensity to Consume

	2SLS							**OLS**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Disp. Income	0.574	0.571	0.583	0.554	0.571	0.572	0.573	0.313
	(0.095)	(0.095)	(0.093)	(0.096)	(0.108)	(0.100)	(0.109)	(0.002)
Interaction Effects								
× Age		0.028					0.034	0.043
		(0.009)					(0.010)	(0.001)
× No. of Children			-0.018				-0.005	-0.004
			(0.008)				(0.009)	(0.001)
× Years of Schooling				-0.022			-0.014	-0.002
				(0.007)			(0.007)	(0.001)
× Lagged Net Wealth Rank					-0.046		-0.050	-0.005
					(0.011)		(0.012)	(0.001)
× Lagged Liquidity Rank						-0.034	-0.013	0.004
						(0.009)	(0.010)	(0.001)
N	2,808,832	2,808,832	2,808,832	2,808,832	2,808,832	2,808,832	2,808,832	2,808,832
Baseline Controls	X	X	X	X	X	X	X	X
Bandwidth (USD)	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000

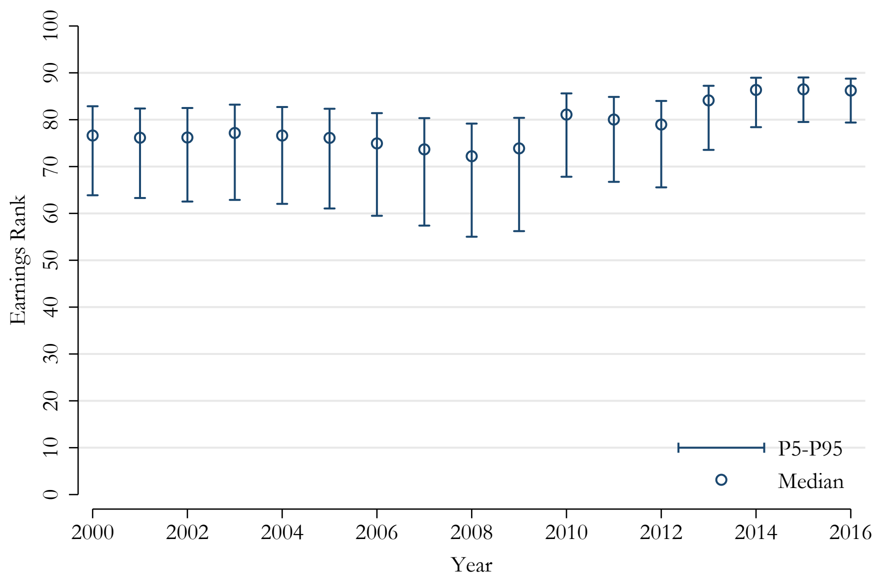
Notes: The table explores heterogeneity in the marginal propensity to consume (MPC) using our RKD. For each dimension of heterogeneity x, we interact disposable income with x in the second stage and instrument the interaction with corresponding interaction between the slope above the kink and x in the first stage. Columns 2-6 explores various dimensions of heterogeneity individually, while column 7 includes all dimensions in one regression. Finally for comparison, column 8 reports the corresponding OLS estimates for the same sample. To ease comparison, we have standardized all dimensions x to mean 0 and unit variance. Standard errors are clustered at the household level.

Online Appendix

(Not for Publication)

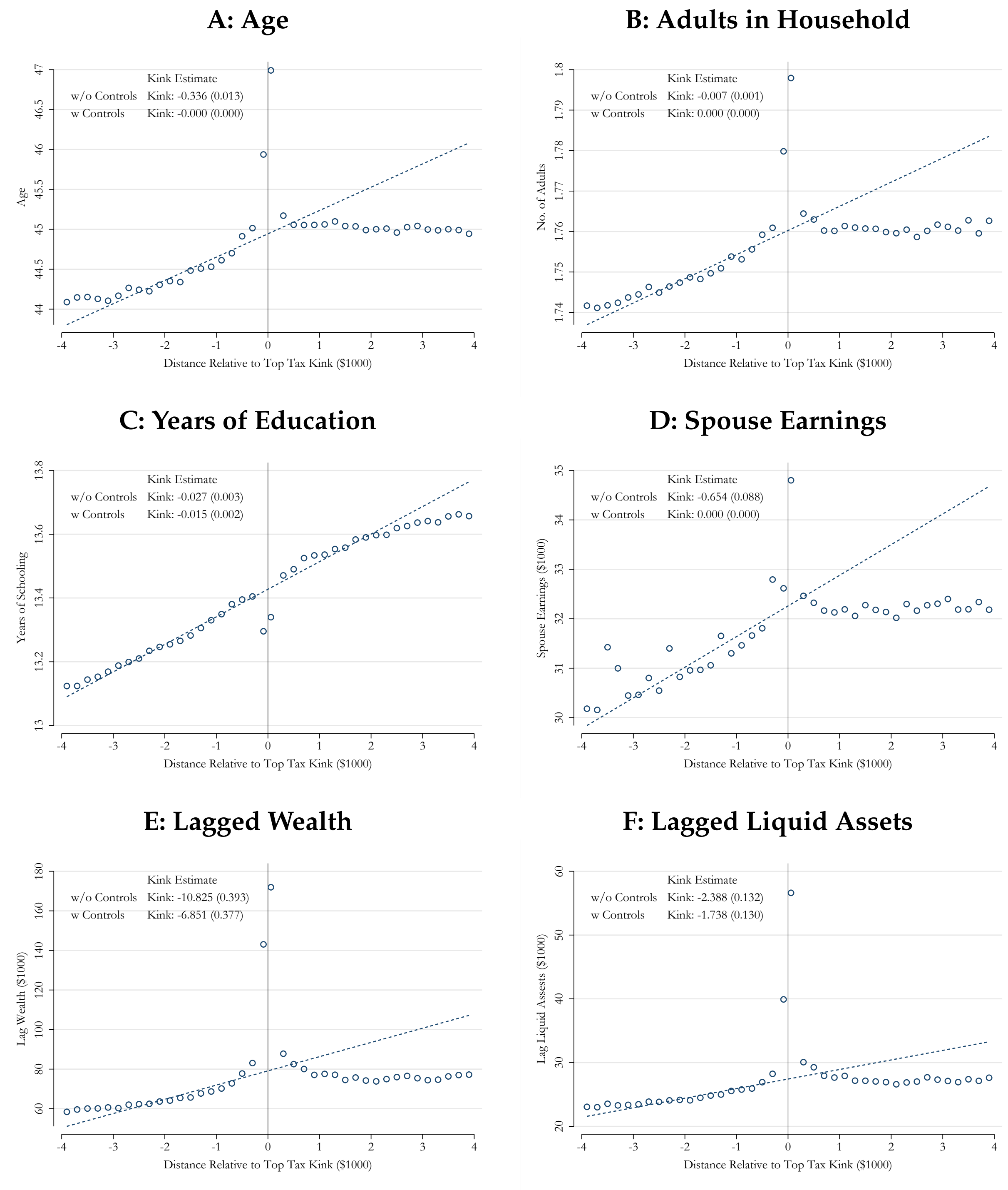
A Supplementary Figures

Figure A.1: Position of the Top Tax Kink and Range of the RKD Sample over Time



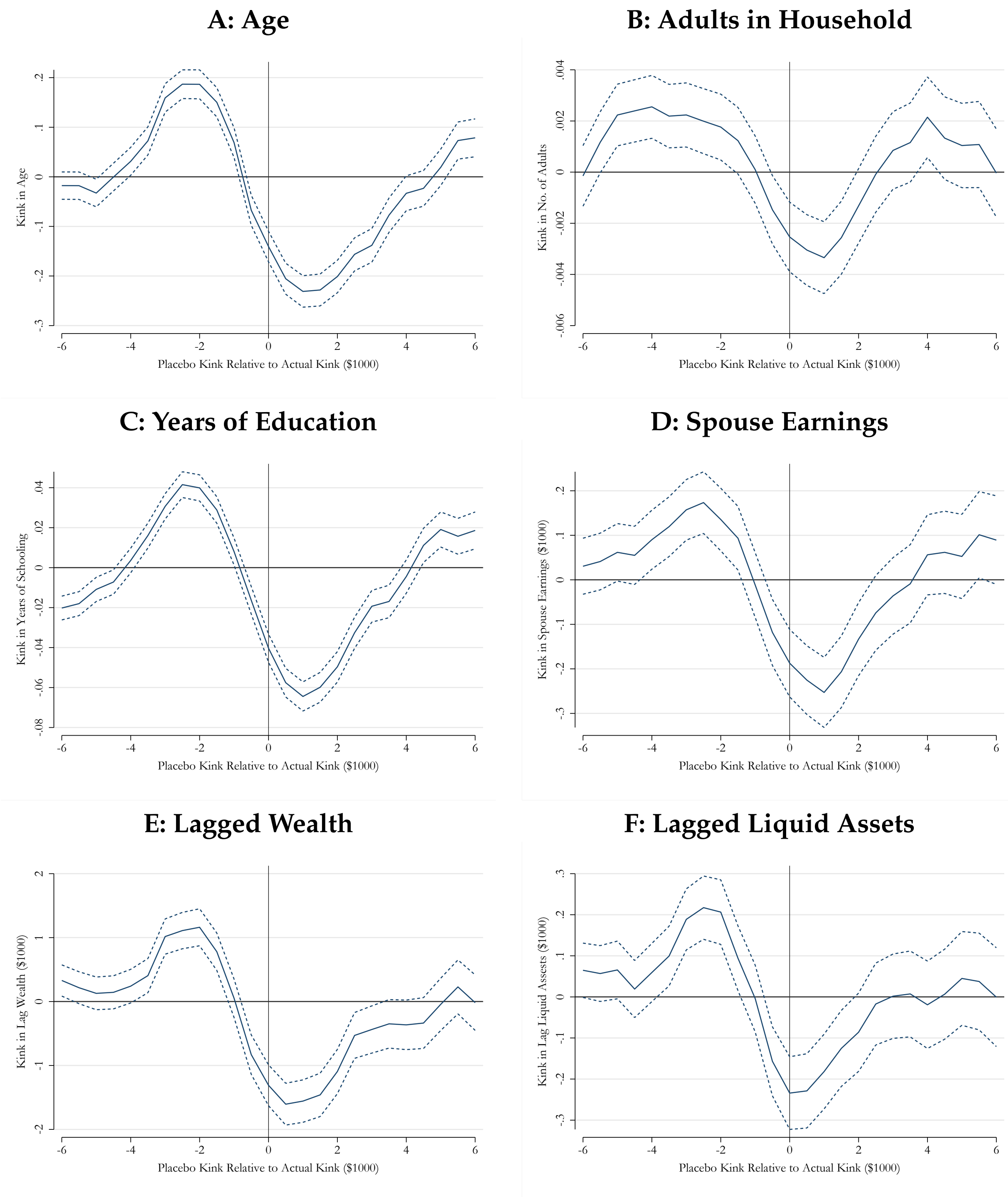
Notes: The figure shows the position of the top tax kink and the range of the RKD sample over time.

Figure A.2: Evolution of Covariates around the Tax Kink – Full Sample



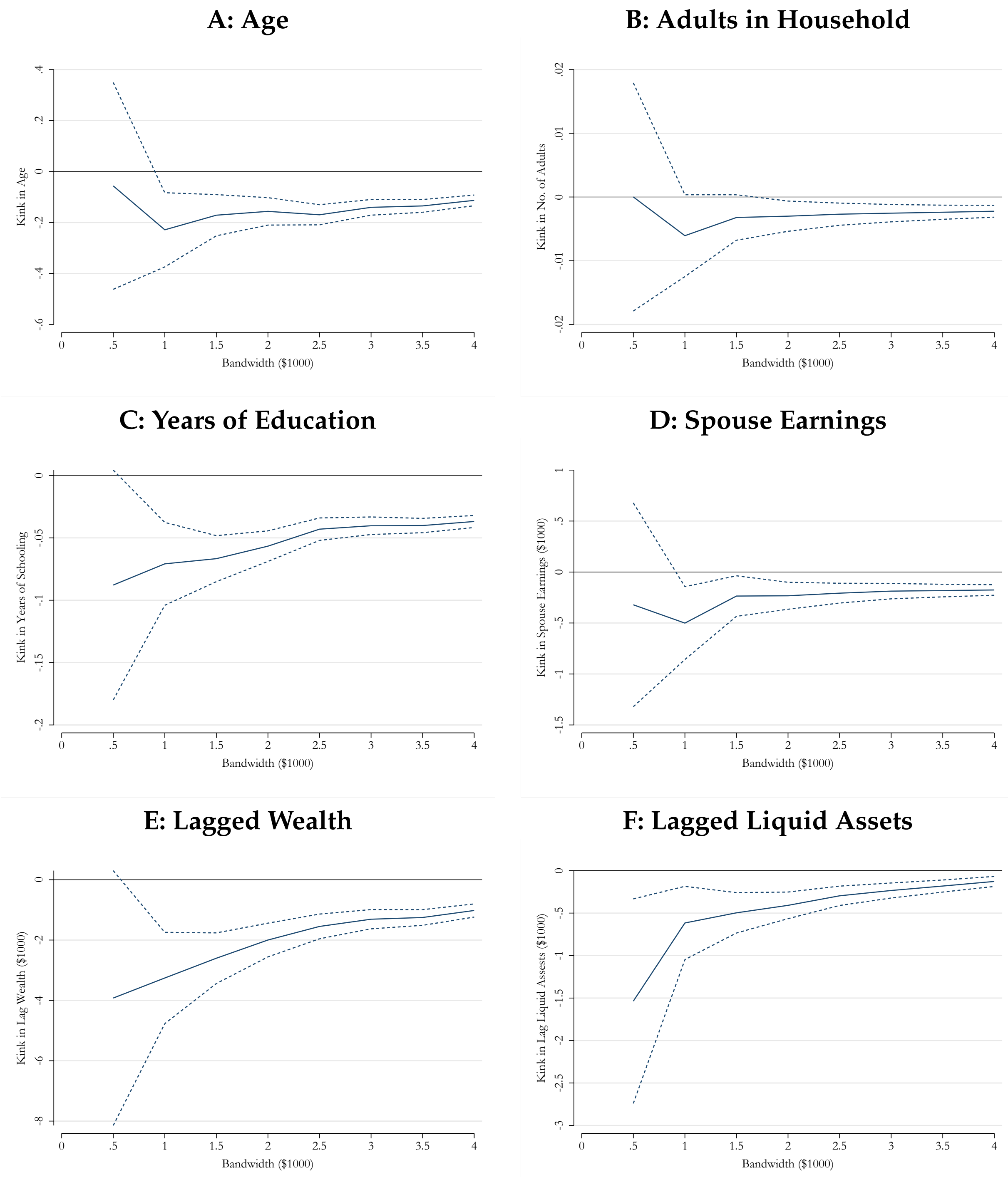
Notes: The figure shows the average value of selected covariates for the full sample (including self-employed and individuals with high earnings/pension contributions) in 200 USD bins around the top tax kink. The dashed lines shows the estimated trend line based on the unbinned data between -200 USD and -3,000 USD below the tax kink. The figure also reports two RKD estimates. One without controls (based on the same regression as used to estimate the trend lines) and one where we add our baseline controls: dummies for year, age, number of adults in the household, occupation (2-digit ISCO codes) and a second order polynomial in spouse earnings. The RKD estimates exclude a donut of +/- 200 USD around the tax kink. Standard errors are clustered at the household level.

Figure A.3: Estimated Kinks in Covariates at Placebo Kinks



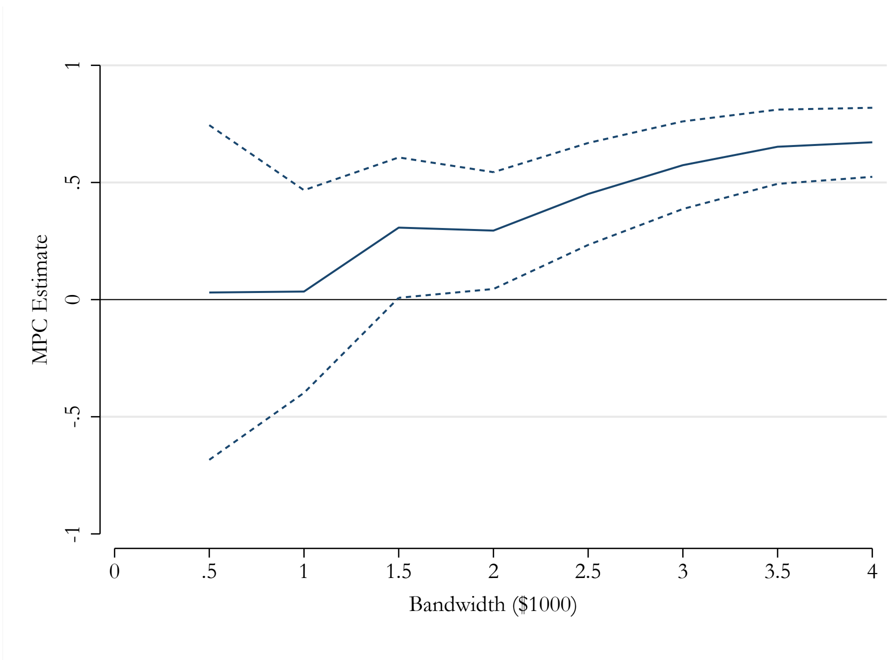
Notes: The figure shows estimates of kinks in selected covariates both at the actual top tax kink (0) or at placebo kinks positioned between +/-6,000 USD from the actual tax kink. As we use a bandwidth of +/-3,000 USD in the RKD, placebo estimates within this range from the actual kink will pick up part of the actual kink effect. Standard errors are clustered at the household level.

Figure A.4: Estimated Kinks in Covariates for Different Bandwidths



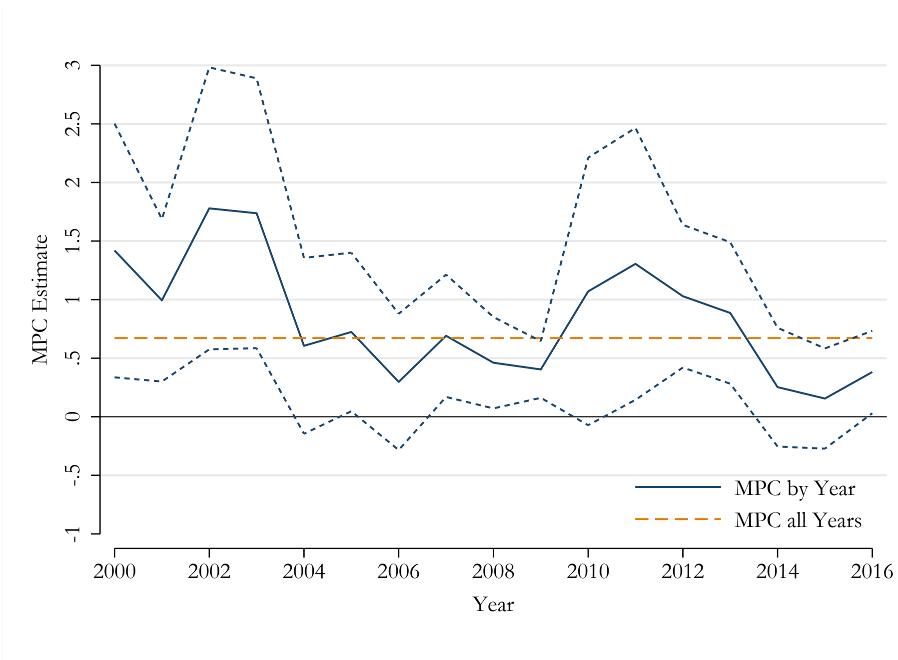
Notes: The figure shows estimates of kinks in selected covariates for different bandwidth ranging between 500 and 4,000 USD. Standard errors are clustered at the household level.

Figure A.5: MPC Estimates for Different Bandwidths



Notes: The figure shows 2SLS estimates of the marginal propensity to consume (MPC) out of disposable income based on our RKD for different bandwidths ranging from 500 to 4,000 USD. The estimations include our baseline controls: dummies for year, age, number of adults in the household, occupation (2-digit ISCO codes) and a second order polynomial in spouse earnings. Standard errors are clustered at the household level.

Figure A.6: MPC Estimates by Year



Notes: The figure shows separate 2SLS estimates of the marginal propensity to consume (MPC) out of disposable income based on our RKD for each year in our sample period. The estimations include our baseline controls: dummies for year, age, number of adults in the household, occupation (2-digit ISCO codes) and a second order polynomial in spouse earnings. Standard errors are clustered at the household level.

B Measurement Error in Consumption Data

The use of a RKD means our results should be less affected by measurement error than other approaches. For measurement error in disposable income or wealth to affect our MPC estimates, there must be a kink in measurement errors coinciding with the tax kink, which is unlikely. To see this, suppose that taxable income and wealth are measured with error:

$$z_{i,t} = z^*_{i,t} + \epsilon^z_{i,t}$$
$$w_{i,t} = w^*_{i,t} + \epsilon^w_{i,t}$$

where starred variables are the truth and $\epsilon^z_{i,t}$ and $\epsilon^w_{i,t}$ are the measurement errors in taxable income and consumption, respectively. Tax liability is based on measured taxable income $z_{i,t}$ rather than true taxable income $z^*_{i,t}$.[10] Thus, true disposable income is $y^*_{i,t} = z^*_{i,t} - T(z_{i,t})$ and measured disposable income is $y_{i,t} = z_{i,t} - T(z_{i,t})$. Crucially, any measurement error in observed taxable income affects tax liability and contributes to the kink in (true) disposable income. From Equation (20) in the main paper, consumption imputed from the observed data (incorporating measurement errors) is

$$\begin{aligned} c_{i,t} &= \underbrace{z_{i,t} - T(z_{i,t})}_{y_{i,t}} - (w_{i,t} - w_{i,t-1}) \\ &= \underbrace{z^*_{i,t} - T(z_{i,t})}_{y^*_{i,t}} + \epsilon^z_{i,t} - \left(w^*_{i,t} - w^*_{i,t-1}\right) - \left(\epsilon^w_{i,t} - \epsilon^w_{i,t-1}\right) \\ &= c^*_{i,t} + \underbrace{\epsilon^z_{i,t} - \left(\epsilon^w_{i,t} - \epsilon^w_{i,t-1}\right)}_{\widetilde{\epsilon}_{i,t}}. \end{aligned} \tag{25}$$

where $\widetilde{\epsilon}_{i,t}$ is the composite measurement error in taxable income and wealth. The relationship between $c_{i,t}$ and $y_{i,t}$ will differ from the relationship between $c^*_{i,t}$ and $y^*_{i,t}$ if measurement errors are correlated with income (Baker, Kueng, Meyer, and Pagel, 2022). But this is

[10] This specification of measurement error in taxable income is equivalent to tax evasion, which is arguable less important in our setting, where the vast majority of income information is third-party reported.

not necessarily the case in a RKD. Using the RKD estimator, the observed MPC is

$$
\begin{aligned}
&\frac{\lim_{z_t^+ \to k_t} \frac{dc_{i,t}}{dz_{i,t}}\Big|_{z_t^+} - \lim_{z_t^- \to k_t} \frac{dc_{i,t}}{dz_{i,t}}\Big|_{z_t^-}}{\lim_{z_t^+ \to k_t} \frac{dy_{i,t}}{dz_{i,t}}\Big|_{z_t^+} - \lim_{z_t^- \to k_t} \frac{dy_{i,t}}{dz_{i,t}}\Big|_{z_t^-}} \\
=&\frac{\left[\lim_{z_t^+ \to k_t} \frac{dc^*_{i,t}}{dz_{i,t}}\Big|_{z_t^+} - \lim_{z_t^- \to k_t} \frac{dc^*_{i,t}}{dz_{i,t}}\Big|_{z_t^-}\right] + \left[\lim_{z_t^+ \to k_t} \frac{d\widetilde{\epsilon}_{i,t}}{dz_{i,t}}\Big|_{z_t^+} - \lim_{z_t^- \to k_t} \frac{d\widetilde{\epsilon}_{i,t}}{dz_{i,t}}\Big|_{z_t^-}\right]}{\left[\lim_{z_t^+ \to k_t} \frac{dy^*_{i,t}}{dz_{i,t}}\Big|_{z_t^+} - \lim_{z_t^- \to k_t} \frac{dy^*_{i,t}}{dz_{i,t}}\Big|_{z_t^-}\right] + \left[\lim_{z_t^+ \to k_t} \frac{d\epsilon^z_{i,t}}{dz_{i,t}}\Big|_{z_t^+} - \lim_{z_t^- \to k_t} \frac{d\epsilon^z_{i,t}}{dz_{i,t}}\Big|_{z_t^-}\right]},
\end{aligned}
\tag{26}
$$

where the second line uses the decomposition in Equation (25). Unless there is a kink in measurement error at the tax kink, the second term in both the numerator and denominator of Equation (26) is equal to zero and the RKD estimator uncovers the true relationship between consumption and disposable income. This result does not rely on any restrictions on the correlations between measurement errors in taxable income and wealth. Measurement error can thus be conceptualized as an unobserved determinant of measured consumption, which the RKD is robust to under the assumption of no kink in measurement error at the tax kink.

C Earnings Process Simulation

This appendix uses data simulated from the earnings process estimated for Denmark by Druedahl, Jørgensen, and Graber (2021) to show that the dynamic pattern of kinks estimated on the observed data can be replicated on simulated data. The earnings process from Druedahl, Jørgensen, and Graber (2021) comprises permanent/persistent and transitory components and closely matches the mean, variance and higher-order moments of labor earnings for Danish workers. Crucially for our setting, the earnings process matches the empirical mass-points at zero for monthly earnings growth. We simulate data from the earnings process at a monthly frequency (the data and estimation frequency for the earnings process) then aggregate to annual frequency. Section C.1 below provides details of the simulation process.

Figure A.7 reports the coefficients β_2^s from the first stage of the RKD (Equation 22 in the main paper) estimated on the simulated data. The estimated kink in contemporaneous disposable income matches the legislated kink in the tax function, while the kinks in future disposable income are insignificantly different than zero.

C.1 Details on Earnings Process

Data are simulated using the baseline earnings process specified in Druedahl, Jørgensen, and Graber (2021). The monthly log earnings process is

$$y_t = z_t + p_t + \pi_t^{\xi}\xi_t + \pi_t^{\eta}\eta_t,$$

where

$$z_t = z_{t-1} + \pi_t^{\phi}\phi_t$$

is a permanent component that experiences a shock with probability p_ϕ that has mean μ_ϕ and variance σ_ϕ^2;

$$p_t = \varrho p_{t-1} + \pi_t^{\psi}\psi_t \text{ with } \varrho_t = 1 - \pi_t^{\psi}\left(1-\rho\right)$$

is a persistent component which decays at rate ρ and experiences a shock with probability p_ψ that has a mean of zero and variance of σ_ψ^2 (between shocks the value of the process is constant); ξ_t is a transitory component that experiences a shock with probability p_ξ that has mean μ_ξ and variance σ_ξ^2; η_t is a mean-zero transitory shock that experiences a shock with probability p_η that has variance σ_η^2. All shocks are *iid* and $\pi_t^x \sim \text{Bernoulli}\,(p_x)$ where $x \in \{\phi, \psi, \xi, \eta\}$.

The monthly earnings *level* is

$$Y_t = (1 - \pi_t^u)\, e^{y_t},$$

where $\pi_t^u \in \{0, 1\}$ is an unemployment indicator. The probability of becoming unemployed is p_e if working and the probability of remaining unemployed depends on the duration of employment d_t. Formally,

$$\pi_t^u | d_t \sim \text{Bernoulli}\,(p_u\,(d_t))$$

with

$$p_u\,(d_t) = \begin{cases} 1 - p_e & \text{if } d_t = 0 \\ p_{u|d}\,(d_t) & \text{otherwise} \end{cases}$$

Annual earnings in year s is given by

$$\bar{Y}_s = \sum_{t=1}^{12} Y_{(s-1)\cdot 12 + t} \tag{27}$$

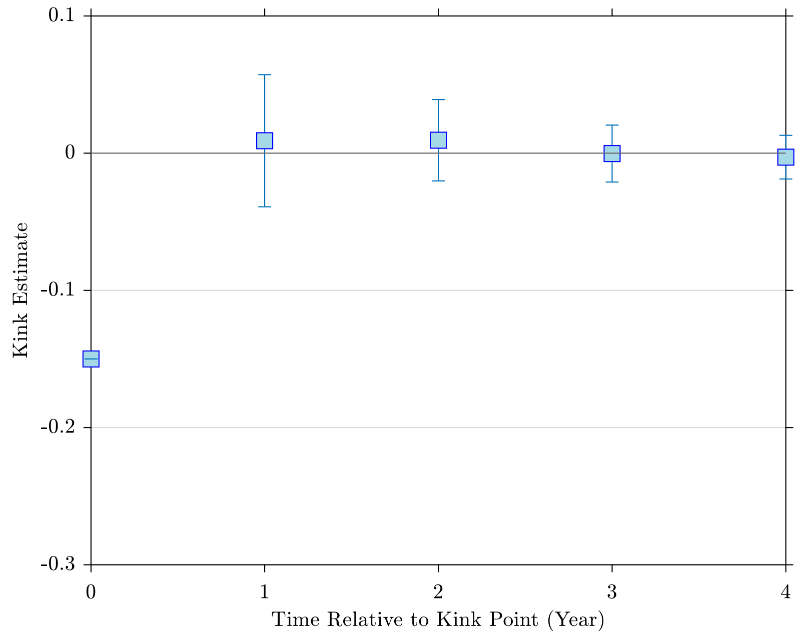
The baseline parameter values from Druedahl, Jørgensen, and Graber (2021) are reproduced in Table A.1. The conditional unemployment transition probabilities $p_u\,(d_t)$ are from Figure 4.8 of Druedahl, Jørgensen, and Graber (2021). We simulate a 10-year panel of N=1 million taxpayers, after discarding a burn-in period of 10-years. The simulated data closely matches the annual mean, variance and kurtosis at horizons up to 6-years ahead documented in Druedahl, Jørgensen, and Graber (2021).

Table A.1: Simulated Earnings Process Parameter Values

Parameter	Value
Probability of permanent shock: p_ϕ	0.146
Probability of persistent shock: p_ψ	0.008
Probability of transitory shock: p_η	0.206
Probability of mean-zero transitory shock: p_η	0.071
Standard deviation of permanent shock: σ_ϕ	0.015
Standard deviation of persistent shock: σ_ψ	0.198
Standard deviation of transitory shock: σ_ξ	0.122
Standard deviation of mean-zero transitory shock: σ_η	0.646
Persistence: ϱ	0.000
Mean of permanent shock: μ_ϕ	0.012
Mean of transitory shock: μ_ξ	0.085

Notes: The table reports parameter values for the earnings process described in Appendix C.

Figure A.7: Dynamic Kink Estimates: Simulated Data



Notes: The figure shows coefficients β_2^s from Equation (22) estimated on data simulated from the earnings process specified by Druedahl, Jørgensen, and Graber (2021) and described in Appendix C.