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MNB WORKING PAPERS 11
2011

MAGYAR NEMZETI BANK

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MNB Working Papers 2011/11

The elasticity of taxable income of high earners: Evidence from Hungary*

(A magas jövedelműek adózó jövedelmének rugalmassága: Egy magyarországi adóemelés tanulságai)

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Published by the Magyar Nemzeti Bank

Publisher in charge: dr. András Simon, Head of Communications

8–9 Szabadság tér, H–1850 Budapest

www.mnb.hu

ISSN 1585-5600 (online)

* The authors would like to thank Péter Benczúr for his support throughout the project, Dóra Benedek, Péter Elek, Sándor Csanád Kiss and Ágota Scharle for comments on earlier drafts of the paper, participants of the 2011 conference of the IIPF in Ann Arbor, Michigan, the 2011 EEA-ESEM meeting in Oslo, the 2010 meeting of the Hungarian Society of Economics (MKE) in Budapest, and seminar participants at the University of Münster, the Ludwig-Maximilians-University in Munich, and the Institute for Economics of the Hungarian Academy of Science, for useful comments and suggestions. Any remaining error is ours. Opinions expressed in the paper are those of the authors and may not reflect the views of their institutions.
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Abstract

The paper studies how high-income taxpayers responded to the introduction of the 'extraordinary tax on individuals' in Hungary in 2007. The study is based on a panel of tax returns compiled by the Hungarian Tax Authority for the purposes of this study, containing information on 10 percent of tax-filers from 2005 and three subsequent years. We estimate the elasticity of taxable income with respect to the marginal net-of-tax rate and find that the taxable income of Hungarian high earners is moderately responsive to taxation: the estimated elasticity is about 0.2. This means that if the upper tax rate of the 2010 Hungarian tax system were increased by a small amount, the behavioral response of taxpayers would reduce the additional tax revenue by about 60 percent. We find evidence suggesting that the elasticity is a reflection of a labor supply response to the tax change on the intensive margin, and not a reflection of tax shifting, avoidance or evasion.

JEL: H20, H24, H31, J22.
Keywords: taxable income elasticity, personal income tax, tax avoidance.

Összefoglalás

A tanulmány azt vizsgálja, hogyan reagáltak a magas jövedelmű adózók a magánszemélyek különadójának bevezetésére 2007-ben Magyarországon. A vizsgálat egy, az adóhatóság által összeállított paneladatbázisra épül, amely az adózók 10 százalékáról tartalmaz információt 2005-től 2008-ig. A tanulmányban megbecsüljük, hány százalékkal nő átlagosan az adózók jövedelme, ha jövedelmük marginális hazavihető része (vagyis 1 mínusz a határadókulcs) 1 százalékkal nő. Az eredmény azt mutatja, hogy a magas jövedelmű magyar adózók mérsékelten reagálnak az adókulcsok változására: a becsült rugalmasság 0,2. A becsült rugalmasságból az következik, hogy ha a 2010-es adórendszerhez képest a felső kulcs 1 százalékponttal megemelkedett volna, az adózók viselkedési válasza az intézkedésből származó többletbevételt mintegy 60%-kal csökkentette volna. Az adatok elemzése során több indirekt bizonyítékot találunk arra, hogy a becsült rugalmasság főleg valós munkapiaci alkalmazkodást takar, nem pedig adóoptimalizáló viselkedést vagy az adóelkerülő magatartás változását.

1 Introduction

The elasticity of taxable income with respect to the marginal tax rate is a parameter of great policy relevance. Having a reliable estimate of the elasticity enables the policy-makers to make more accurate fiscal assessments of changes to the tax system. The elasticity also enables researchers to quantify the dead-weight loss of income taxation.[1]

The importance of the taxable-income elasticity is reflected in the growing literature of empirical work. The first estimates of taxable income elasticity based on a panel of tax returns were conducted by Feldstein (1995). The method used by Feldstein identifies two similar groups of taxpayers whose tax rates are affected differently by a change in tax rules. If the growth of reported taxable income differs between both groups, it is most likely caused by the change of tax rates. Later analyses developed regression methodologies that are able to control for many confounding factors in large panels (see, e.g., Auten and Carroll, 1999; Gruber and Saez, 2002). Recent surveys of the literature are provided by Giertz (2004) and Saez, Slemrod and Giertz (2009).

While estimations for the U.S. were the focus of the literature at the beginning, more recently empirical work was done on other countries as well, such as Canada (Sillamaa and Veall, 2001; Saez and Veall, 2005), Norway (Aarbu and Thoresen, 2001), Sweden (Ljunge and Ragan, 2004; Hansson, 2007; Holmlund and Söderström, 2007; Blomquist and Selin, 2010), Hungary (Bakos et al., 2008), Germany (Gottfried and Witczak, 2009), Finland (Pirttilä and Selin, 2011), and Denmark (Kleven and Schultz, 2011).

While the empirical literature is growing, many important questions about the background of the estimated elasticities remain open. One important question is to what extent the estimated elasticities reflect labor supply response on the intensive margin (whether that is hours worked, work intensity or occupation choice) and to what extent they reflect income-shifting or changing tax-avoidance behavior. Also, there is no consensus view on whether different demographic groups have systematically different taxable-income elasticity.

The present paper studies how high-income taxpayers in Hungary responded to the introduction of the 'extraordinary tax on individuals' in January 2007. The extraordinary tax was a 4% surcharge on income above the pension-contribution ceiling.[2] The analysis is based on a panel of tax returns, compiled by the National Tax Authority for this study, containing anonymous information on 10% of tax-filers in 2005 and three consecutive years.

Besides offering an analysis of a new policy episode outside the U.S., the paper intends to contribute to the literature in three ways. First, it focuses on a clean policy episode that affected high-earners. As in other countries, high-income earners have a great economic and fiscal significance in Hungary. In 2008, the lower income limit of the extraordinary tax was HUF 7.1 million (about EUR 28,000 at the contemporary exchange rate). The tax thus affected the top 2.5% of tax-filers who controlled 16% of the aggregate tax base and paid 28% of total personal income tax.[3]

Second, the focus on a well-defined group of high-income earners, and the relatively large number of observations, makes it possible for us to address a methodological problem many studies struggle with. It is known since the early literature that general income growth may differ across various segments of the income distribution for reasons not related to the change in the tax rates. One the one hand, incomes at the top might disproportionally grow because of skill-biased

[1] The relationship between the elasticity of the taxable income and the dead-weight loss of taxation was analyzed by Feldstein (1999) and Chetty (2009).

[2] The extraordinary tax of individuals was introduced by Act 59 of 2006 of the Republic of Hungary. According to paragraph 8, the extraordinary tax, as applied to those individuals who are not full-time self-employed, came into effect on January 1, 2007.

[3] Own calculation based on a 10% random sample of 2008 tax returns, excluding the full-time self-employed.

technological change. On the other hand, the phenomenon of 'regression to the mean' might affect individuals with very high or very low incomes at a given point in time. Since Auten and Carroll (1999) and Gruber and Saez (2002) it is common practice to address this problem by controlling for initial income. Still, results are often sensitive to the way initial income is controlled for, especially in studies where a broad income range is analyzed or the very top of the income distribution is involved. This study focuses on a relatively narrow range around the income limit at which the extraordinary tax was introduced. Our results are not sensitive to whether initial income is controlled for, which indicates that the sample that we concentrate on is homogeneous enough. The phenomena of mean-reversion or differential income trends do not affect parts of our sample differently.

Third and most important, we are able to conduct a series of checks that provide evidence that the estimated elasticity reflects mostly labor-market adjustment as opposed to income-shifting or a change in tax-avoidance behavior. The argument is laid out in detail in Section 3.3 but it can be summarized as follows. First, we find that the estimated elasticity is higher for women, older and younger taxpayers. While it is likely, based on past labor-market research, that these groups have a more elastic labor supply than men or prime-age workers, it is unlikely that tax-avoidance or tax-evasion is more widespread among them. Further, high-income taxpayers with wage income only, presumably the least able to engage in income-shifting, exhibit a similar elasticity of taxable income as the whole high-income sample. Finally, we do not find differential growth of capital income for taxpayers who are likely, prior to the tax change, to be affected by the extraordinary tax.

In our main specification the elasticity of taxable income with respect to the marginal net-of-tax rate (equal to one minus the marginal tax rate) is estimated to be about 0.2. This estimate is lower than most estimates for the U.S., but similar to many estimates for other countries. (Many estimates outside the U.S. are below 0.4, the preferred elasticity of Gruber and Saez (2002), which is itself in the lower range of U.S. estimates.) In a simple simulation exercise based on the 2010 Hungarian tax system we show that even this seemingly low elasticity is of great fiscal relevance. It is shown that the behavioral effect based on this elasticity reduces the static fiscal effect of a small change in the top PIT rate by about 60%.

The rest of the paper is organized as follows. Section 2 describes the theoretical background, the data and the empirical specification. Section 3 presents the results of the main specification, provides some robustness checks and indirect evidence as to the causes of the estimated elasticity. Section 4 illustrates, with a simple calculation, the fiscal significance of the results. A discussion of the results concludes the paper.

2 Methodology and data

2.1 THEORETICAL BACKGROUND AND PROBLEMS OF IDENTIFICATION

Measurements of the elasticity of taxable income with respect to the tax rates are motivated by a simple theoretical framework in which the labor supply decision of an optimizing individual is modeled (see Appendix B for details).[4] Taxes affect the trade-off between leisure and consumption. The following relationship between income growth and tax rates can be derived from optimization:

$$\Delta \log y = \beta \Delta \log(1 - METR) + \phi \Delta \log(1 - AETR), \tag{1}$$

where y is taxable income, $METR$ is the marginal effective tax rate and $AETR$ is the average effective tax rate. (We call them *effective* tax rates because social security contributions on the employee's side are also taken into account.) The variable $(1 - METR)$ is the marginal net-of-tax rate. It measures what share of *additional* taxable income the tax payer can keep. This is the central variable of the taxable-income literature. The coefficient of this variable β measures to what extent taxpayers respond to marginal incentives or, in other words, to what extent they generate less taxable income if facing a higher marginal tax rate.

The variable $(1 - AETR)$ is the average net-of-tax rate. It measures what share of *total* taxable income the taxpayer can keep as net income. The coefficient of this variable ϕ measures the income effect: the extent to which taxpayers generate less taxable income if they receive a lump-sum transfer (or tax relief). If two taxpayers have the same taxable income and the same marginal tax rate, but face a different average tax rate, this means that the tax system treats them differently by a lump-sum component.[5]

The researcher faces two problems when estimating the relationship between taxable income and the tax rates. The first problem is that the income distribution might change for reasons independent of the tax changes: for instance, wage dispersion might increase because of skill-biased technological change. Another problem, having the opposite effect, is the phenomenon of 'regression to the mean': some individuals of extraordinarily high incomes might be experiencing a lucky year, most likely to be followed by a decrease in income. These phenomena might bias the estimation by making high incomes appear to grow faster or slower following a change in the tax code. The literature, following Auten and Carroll (1999), deals with this problem by including (log) initial income (i.e., taxable income in the period before the tax change) as a control variable. The coefficient of initial income will be negative if the phenomenon of regression to the mean is significant or if the income distribution becomes more compressed for reasons independent of the tax changes, while it will be positive if the income distribution becomes more dispersed for independent reasons. Including initial income as well as demographic variables to control for individual heterogeneity of taxable-income growth, we arrive to the following equation:

$$\Delta \log y_i = x'_i \alpha + \gamma y_{0i} + \beta \Delta \log(1 - METR_i) + \phi \Delta \log(1 - AETR_i) + u_i, \tag{2}$$

where vector x' includes demographic control variables and y_0 is initial income.

[4] The approach taken here follows Feldstein (1999), Gruber and Saez (2002), and Bakos et al. (2008).

[5] Previous studies chose different ways to operationalize the income effect in the empirical specification. This formulation follows Bakos et al. (2008) whose operationalization is a slight variant of that of Gruber and Saez (2002). For the derivation of this form and its comparison to Gruber and Saez (2002), see Appendix B.

The second econometric problem to be taken care of is that there is inverse causality between the dependent variable and some explanatory variables. Taxable income might change for many other reasons independent of taxation. If taxable income of an individual grows above average, this will, in a progressive tax system, increase their tax rates. A simple OLS regression might, spuriously, indicate that a tax hike makes taxable income grow faster.

This problem is solved here, as in much of the literature, by using the instrumental variable (IV) estimation procedure. The instruments for the actual (endogenous) tax rates are the so-called 'synthetic tax rates'. The synthetic tax rates are obtained by applying the after-change tax rules to the (indexed) before-change taxable income of each individual; they are thus based on before-change individual information only, and are, accordingly, exogenous to after-change income. The details of the procedure as applied here are described after the description of the data.

2.2 DATA AND SAMPLE

The data base was compiled by the Hungarian Tax Authority for the purposes of this study. It contains information about a panel of anonymous individual tax returns from the years 2005 through 2008, based on a 10% random sample of the population of tax-filers in 2005 (excluding the full-time self-employed). Not all taxpayers filed a tax return in all four years: while we observe 422,219 individuals in 2005, only 359,409 of these filed a tax return in 2008. Attrition is less severe among high-income earners who are the subject of this study: there are 14,467 taxpayers in the sample of 2005 with taxable income above HUF 5 million (about EUR 20,000).[6] Of these, 13,237 filed a tax return, and 13,159 had non-zero taxable income, in 2008.

The estimation is based on comparing the growth of taxable income of different individuals from year 2005 to 2008. The 'natural experiment' this paper uses for identification is the introduction of the extraordinary tax on individuals effective from January 2007. This episode would theoretically allow 2006 to be chosen as base year. However, 2006 is not suitable as a base year because some changes in taxes and contributions, passed together with the extraordinary tax, took effect already in September 2006. Thus in some cases it is not clear what the relevant effective tax rate is for a given individual, and behavior in 2006 is partly already a response to some of the policy changes. Therefore, 2005 was chosen as the base year. As comparison year, 2008 was chosen because changes in taxpayer behavior might take time. It is for this reason that most studies in the literature consider the effect of tax changes on a three-year horizon (see, e.g., Feldstein 1995 and Gruber and Saez 2002). As a robustness check, results for the period 2005–2007 are also reported.

The relevant tax base for the purposes of our study is the so-called 'aggregated tax base' *(összevont adóalap),* which we will simply call *taxable income* (consistently with Bakos et al., 2008). It is a natural choice since the statutory tax rates and the extraordinary tax are levied on exactly this definition of taxable income. Taxable income includes, according to Hungarian tax law, three main types of income: (1) income from 'not independent' activity (wage income, cost reimbursements, severance pay); (2) income from independent activity (entrepreneurial income, income from contract work, income of licensed small-scale agricultural producers); and (3) other income (income earned abroad, income from scholarships in higher education). Not part of taxable income is capital income (dividends, capital gains, etc.). Such items are called 'separately taxed' sources of income and were, during the period of study, taxed by item-specific linear rates of 10% to 30%.

A potential estimation bias, mentioned above, coming from the phenomena of 'regression to the mean' and the exogenous dispersion or compression of the income distribution is remedied in two different ways in this paper. One way of dealing with them, based on the procedure of Auten and Carroll (1999) and the later literature, is to include log initial income as a control variable in the estimated regressions. The other way to deal with these issues is to focus on a sub-sample that is as homogeneous as possible so that the disturbing factors not to affect the lower and the upper end of the sample very differently. The main results presented in this paper are based on a sample that includes individuals having taxable income

[6] During the period 2005–2008 the exchange rate varied around the convenient equivalence EUR 1 = HUF 250. We use this exchange rate to interpret Charts in Hungarian Forints (HUF) in the text.

between HUF 5 and 8 million in 2005 (about EUR 20-32 thousand).[7] The robustness of the results to the sample's income limits is examined in the last part of the analysis.

To be able to compare the income of individuals between the years 2005 and 2008 we have to take into account the changes to the legal definition of taxable income during these years. In 2007 pension income became part of the tax base, even though it was itself not taxed. This meant, in effect, that individuals whose only income source was from pensions continued to pay no income tax, but the wage income of pension recipients came to be taxed at a higher rate than before. Since the effects of this measure should not contaminate the results of this study, and since we do not observe pension income in 2005, all individuals with pension income in 2008 were left out of the sample. Of the 8,588 taxpayers in the sample with taxable income between HUF 5–8 million in 2005, 1,363 had to be excluded for this reason. After removing these individuals from the sample we have 7,225 observations.

As a last step, we leave out of the sample 309 taxpayers having income that, similarly to pension income in 2008, is part of the tax base but it is itself not taxed, leaving 6,916 in the sample. For most of these individuals this type of income is income earned abroad; we can assume that their behavior does not reflect typical reactions to Hungarian tax rates. For a minority of these individuals such income comes from child care benefit of parents with children under age 3 *('gyes')* or child care support of parents with three dependent children of whom the youngest is between 3 and 8 years old *('gyet');* since both benefits were conditional on the recipient *not* working full-time outside their homes, we exclude these taxpayers from the sample. Since their number is small, results are robust to their exclusion.

2.3 VARIABLES AND DESCRIPTIVE ANALYSIS

Incomes of 2005 are inflated to be comparable with those of 2008, using the average income growth of the sample used in the regression (an index of 1.167). Results are not sensitive to the precise index of nominal income growth.

Demographic control variables for gender, age, and the locality type of residence (Budapest, large cities, other cities, villages) are used in the regressions. Regional controls are not included as they were not significant in any specification. It should be noted that information about the taxpayer's gender is not part of a tax file as prepared by the taxpayer. Therefore, the Tax Authority has run an algorithm based on first names to generate this information for the purposes of this research. As this procedure is imperfect, it may not be able to identify uncommon, misspelled or foreign names. Therefore, gender information is missing for 537 observations in our main sample. We conduct the analysis both including and excluding these individuals. When they are included, a dummy variable for individuals with missing gender information is added to the regressions. Also, among the robustness checks, regression results are reported for men and women separately (where, of course, individuals with missing information are excluded). Another information deficiency is that the type of locality is missing for 37 observations. In 21 of these cases the locality could be identified manually based on the postal code (typically an outdated postal code was entered by the taxpayer). As a result there were only 16 observations that we had to exclude for missing locality-type information. Thus, there are 6,900 individuals in our main sample (and 6,363 in specifications where we exclude those with missing gender information).

The explanatory variable of interest is the marginal effective tax rate *(METR):* it is used to generate the marginal net-of-tax rate *(1−METR)* and the percentage change thereof. When calculating the *METR,* social security contributions are taken into account (like in Bakos et al., 2008), since these reduce net income the same way the personal income tax does. (For an overview of tax rates and SSC rates, see Table A.1 in the Appendix.) Taxpayers who are in the withdrawal phase of a tax credit face a higher *METR.* In particular, the child tax credit was withdrawn at a 20% rate for total income above HUF 8 million in 2005 while in 2008 the withdrawal threshold varied between HUF 6 and 8 million depending on the number of children. Also, during the years studied, some tax credits were grouped together, capped at HUF 100 000 (about EUR 400), and withdrawn at a rate of 20% starting at a total income of HUF 6 million in 2005 and starting at a total income of HUF 3.4 million in 2008.[8]

[7] While this income range, evaluated at the current exchange rate, would be considered a middle-income sample in the economy of a highly developed country, it is within the top 5 percent of income earners in Hungary.

[8] 'Total income' is the sum of taxable income and capital income (i.e., all 'separately taxed items' except for income from the sale of real estate).

Table 1
Descriptive statistics of the sample

Variable	Mean	Std. Dev.	Min	Max
Female	0.311		0	1
Gender info missing	0.078		0	1
Birth year	1964		1940	1986
Residence: Budapest	0.36		0	1
Residence: large cities	0.244		0	1
Residence: other cities	0.249		0	1
Residence: villages	0.147		0	1
Taxable income 2005, HUF thousand	6,150	835	5,000	7,999
Taxable income 2008, HUF thousand	7,171	3,010	3	43,362
Change of taxable income, 2005–08	0.167	0.462	−1.000	6.412
Change of actual (1–METR)	−0.019	0.147	−0.526	0.842
Change of expected (1–METR)	−0.035	0.126	−0.443	0.649
Change of actual (1–AETR)	−0.027	0.097	−0.206	0.551
Change of expected (1–AETR)	−0.060	0.019	−0.400	−0.037

The sample consists of 6,900 taxpayers with 2005 taxable income between HUF 5-8 million. In the last five rows a value of 0 means no change; −0.5 means a 50% reduction; 1 means a growth of 100%.

The regressions are estimated with the instrumental variable (IV) procedure to deal with the endogeneity of the marginal and average net-of-tax rate. The instruments are the 'synthetic' counterparts of these: These are obtained by applying the 2008 tax rules on inflated 2005 taxable income. In the first stage of the IV estimation, the actual 2008 marginal and average net-of-tax rate is regressed on all control variables included in the main regression and both 'synthetic' tax rates. (Of course, only the synthetic marginal rate is included as a first-stage instrument in specifications where the average rate is not included as a right-hand-side variable in the main equation.) The predicted 2008 tax rates obtained from the first-stage regressions are not endogenous any more to 2008 income; therefore they can be used to explain 2008 income in the second stage of the procedure.

Table 1 shows the descriptive statistics of the benchmark sample. As Table 1 shows, women constitute slightly less than one-third while men almost two-thirds of the sample. Information on gender is missing for about 8% of the sample. More than one-third of the sample live in Budapest (the population of Budapest, the capital city, is less than one-fifth of Hungary's population), one-fourth of the sample live in large cities and another one-fourth in other cities, while 15% live in villages. Taxable income of individuals in the sample grew by an average of 16.7% in three years; some individuals had near-zero taxable income in 2008, while some saw their taxable income multiply by a factor of six. The last four lines of Table 1 summarize the actual and synthetic tax rates. The statistics show that both the average and the marginal effective tax rate of the average high-income earner rose in the course of three years. The variation is, naturally, higher in the change of individuals' actual tax rates than in the change of their synthetic tax rates.

Chart 1 summarizes information regarding the tax rates and income change in the main sample. The four panels show, respectively, the 2005 marginal and average tax rates, the expected change of the marginal tax rate (where the expected 2008 marginal rate is the synthetic marginal tax rate) and the percentage change in income.

The upper left panel shows the actual 2005 marginal effective tax rate (METR) as a function of 2005 taxable income. Most high-income taxpayers form two continuous lines in the bottom part of the panel: their METR corresponds to the regular tax and contribution rates below and above the pension contribution ceiling. Their METR is 51.5% and 43%, respectively (see Table A.1 in the Appendix for details on 2005 and 2008 tax and contribution rates). Atypical values for the METR are only observed for those who fall into the withdrawal phase of a tax credit. Most of these taxpayers have taxable income between HUF 6 and 6.5 million (about EUR 24-26 thousand): They are eligible for one of the tax credits whose common withdrawal phase is in exactly that income range. However, since the withdrawal is based on 'total income' (the sum of taxable income and capital income), some taxpayers fall into this withdrawal phase with a taxable income below HUF

Chart 1
Tax rates and change in taxable income, 2005–2008

6 million. They are the scattered dots to the left of the HUF 6m mark in the top left part of the panel. Atypical taxpayers to the right of the HUF 6.5m mark are those who are in the withdrawal phase of the child tax credit (and reach the withdrawal threshold of HUF 8 million in total income because of their capital income).

The lower left panel in Chart 1 shows the percentage change from the actual 2005 METR to the synthetic 2008 METR. The Chart shows that all typical taxpayers see their METR increase somewhat from 2005 to 2008: this is the result of a 1.5-percentage-point general increase in social security contributions (SSC). But taxpayers above the pension contribution ceiling see their marginal rates go up more substantially: they face the extraordinary tax of 4 percentage points (or about 10% of their previous METR). Just above the 2005 contribution ceiling there is a short interval if taxable income where individuals face a 20% increase in their METR. They are taxpayers who are above the contribution ceiling in 2005 but are expected to fall under the increased contribution ceiling by 2008 (the ceiling was raised in discretionary moves by the legislature at a higher rate than incomes grew in the sample). Continuing with the atypical taxpayers, between 2005 and 2008 the withdrawal phase of both the child tax credit and the composite tax credit was moved towards lower incomes. Therefore, all taxpayers with previously atypical marginal rates are expected to have typical marginal rates in 2008, thus they are expected to see their METR decrease substantially (they can be seen at the bottom of the panel). Only the child tax credit affects expected 2008 METR: In that year individuals with one or two children were not eligible any more, while those with three children had their tax credit withdrawn starting at a total income of HUF 6 million. These taxpayers can be seen on the top left part of the panel constituting an almost continuous line. They are expected to have an income of above HUF 6m in 2008, thus their income is between HUF 5 and 6 million in 2005.

The upper right panel in Chart 1 shows the actual 2005 average effective tax rate (AETR) as a function of 2005 tax base. Most taxpayers are close to the average tax rates that track the statutory rates with only tax credits differentiating between them. Finally, the bottom right panel shows the change of taxable income in the main sample. Clearly, there is great variation in the income growth around its mean: some taxpayers see their taxable income reduced to almost zero, while others see their taxable income multiply. The regression analysis below investigates whether income growth has a systematic relationship with marginal and effective tax rates.

3 Estimation results

3.1 RESULTS OF THE MAIN SPECIFICATION

Every regression below is estimated with the IV procedure that can be thought of as a two-stage procedure. In the first step the actual 2008 marginal net-of-tax-rate is regressed on its synthetic counterpart and the control variables of the main regression. (If the average net-of-tax rate is included as an explanatory variable it also has a first-stage regression. In that case both synthetic tax rates are included in both first-stage regressions.) The synthetic marginal net-of-tax rate is a good instrument: its coefficient in the first stage regression for its realized counterpart is about 0.7 (not reported in the results) and significant on all conventional levels of significance. Initial income, synthetic average net-of-tax rate and most of the demographic control variables are also statistically significant in the first stage regression, while the R^2 is around 0.45.

More systematic diagnostic tests are reported in the regression tables below. In an IV estimation, the researcher generally faces two problems: one is whether the instruments are exogenous, while the other is whether they are relevant. The exogeneity of the instruments is ensured by the way we constructed them based on information prior to the tax changes. As to the problem of relevance we report the p-value of the Kleibergen-Paap underidentification test (the generalization of the Anderson canonical correlations test for the case of non-i.i.d. errors). Under the null hypothesis, the equation is underidentified. Also, we report the partial F-statistics for the first-stage regressions. Since the problem of 'weak identification' is known to make estimators perform poorly even in cases when the underidentification test is rejected, we also report the Kleibergen-Paap Wald rk F-statistic. Finally, we also report a test for the exogeneity of actual (realized) tax rates (akin to the C-statistic).[9]

In the results below, all diagnostic statistics are favorable. The exogeneity and underidentification tests are in all cases rejected at all conventional levels of significance. The F-statistic of the K-P weak-identification tests are mostly around 1000 when only the marginal rate is included in the specification and around 100 when both tax rates are included. The F-statistics are safely high even in those cases, reported in the robustness analysis, where the regressions are run on smaller sub-samples (with the exception of very small age groups: this exception is noted in the text below).

The regression results of the main specifications are summarized in Table 2. In the first four columns we gradually introduce the control variables into the analysis. In the specification of column (1) the only explanatory variable is the marginal net-of-tax rate. The following specifications introduce log initial income, the average net-of-tax rate and demographic controls; column (4) reports the full specification. Column (5) repeats the full specification on an alternative sample: here the observations with missing gender information are omitted.

Of the demographic control variables only gender is strongly statistically significant: the growth of taxable income over the three years is 7 percentage points lower on average for women than for men. Interestingly, taxable income growth of individuals with missing gender information is about 8 percent higher than that for men. Both effects are highly statistically significant. We noted earlier that information on gender may be missing because of uncommon or foreign names. The finding that taxable income growth was higher in this group than the rest of the sample is consistent with the conjecture that some of these individuals are foreign employees of multinationals. We also find that individuals with missing gender information are younger, on average, than the rest of the sample (65% is younger than 35 as opposed to 37% of the whole

[9] All tests were performed using the ivreg2 package in Stata. More details on the tests can be found in Baum, Schaffer and Stillman (2003; 2007) and the references therein.

Table 2
Regression results in the main specifications

Dependent variable	(1) dlog(tax.inc.)	(2) dlog(tax.inc.)	(3) dlog(tax.inc.)	(4) dlog(tax.inc.)	(5) dlog(tax.inc.)
dlog(1−METR)	0.159** (0.016)	0.155** (0.024)	0.165*** (0.009)	0.198*** (0.002)	0.191*** (0.004)
dlog(1−AETR)			−0.545* (0.082)	−0.557* (0.089)	−0.524 (0.127)
log(initial income)		−0.027 (0.624)	−0.023 (0.646)	−0.009 (0.863)	−0.001 (0.990)
Female				−0.072*** (0.000)	−0.072*** (0.000)
Gender info missing				0.087*** (0.000)	
Age				−0.001 (0.525)	−0.000 (0.692)
Large cities				0.028* (0.078)	0.031* (0.060)
Other cities				−0.003 (0.864)	0.004 (0.814)
Villages				−0.033* (0.093)	−0.024 (0.254)
Constant	−0.103*** (0.000)	0.313 (0.712)	0.243 (0.758)	0.052 (0.947)	−0.078 (0.925)
No. of obs.	6,900	6,900	6,900	6,900	6,363
Diagnostic tests					
Exogeneity of tax rate variables (p-value)	0.0007	0.0004	0	0	0
Kleibergen−Paap underid. test (p-value)	0	0	0	0	0
F-stat − first-stage reg. for (1−METR)	926.8	930.0	722.1	720.8	686.9
F-stat − first-stage reg. for (1−AETR)	–	–	102.1	99.2	91.3
Kleibergen−Paap weak ident. test (F-stat)	926.8	930.0	102.2	99.4	91.1

Results from instrumental variable (IV) estimations with robust standard errors. Robust p-values in parenthesis.
**** p<0.01, ** p<0.05, * p<0.1*
Note: The sample consists of taxpayers with tax base between HUF 5-8 million in 2005.

high-income sample) and is more concentrated in Budapest than the rest (46% lives in the capital as opposed to about 36% of the whole high-income sample). To make sure the uncertainty regarding these individuals does not confound the analysis, the full specification is repeated for the sample without these individuals [see column (5)].

The type of locality is controlled for by dummy variables; the comparison group is Budapest. The results show that in the course of three years income growth in the sample was about 3 percentage points higher in large cities than in Budapest; while it was about 3 percentage points lower in villages than in Budapest. Both effects are statistically significant on the 10% level. As a final demographic control, the coefficient of age is very close to zero and not statistically significant. The coefficient of initial income is negative in all specifications, which hints at a mild contraction of the income distribution, but the magnitude of the coefficient is small and statistically not significant.

The estimated coefficient of the central variable, the marginal net-of-tax rate is around 0.16 in the three specifications without the demographic controls and about 0.2 when all controls are included. The coefficient is estimated with increasing precision as the control variables are included: the robust p-value of the estimated coefficient decreases from about 2% in column (1) to about 0.2% in column (4). The coefficient of 0.2 implies that high-income taxpayers increase their taxable income by 0.2% if their marginal net-of-tax rate increases by 1%. The fiscal significance of the estimated elasticity is assessed in a simple simulation exercise in Section 4. The Conclusion places the estimated elasticity in the context of earlier estimates.

The variable controlling for the income effect (the average net-of-tax rate) has an estimated coefficient of about (−0.55) and is borderline significant at the 10% level. Since many previous studies have found no significant income effect, we should interpret this finding cautiously. The magnitude of the coefficient would imply that high-income taxpayers reduce their taxable income by about 0.55% if their average net-of-tax rate increases by 1%. Note that, since top tax rates usually apply from a high income threshold, a 1% cut in the marginal tax rate of high-income earners implies a cut in the average tax rate that is much lower than 1% (the change in the average tax rate is negligible at incomes just above the threshold of the upper tax rate). Therefore, even if one is confident about the magnitude of the income effect, as estimated here, the effect of the marginal tax rate will, in all practical simulations, dominate the income effect.

Column (5) repeats the specification of column (4) with the difference that observations with missing gender information are omitted, which leaves 6,363 observations. The results are almost identical to column (4). The estimated coefficient of the marginal net-of-tax-rate is 0.19 and statistically significant at the 1% level. The coefficient of the average net-of-tax rate (the income effect) is similar in magnitude as before, but this time not statistically significant on the 10% level. The estimated coefficients of demographic controls are also nearly unchanged.

3.2 ROBUSTNESS ANALYSIS

Two robustness checks are reported in this subsection. The first robustness check looks at whether results are sensitive to the income limits of the sample. In the second robustness check, the main analysis is repeated for the time period 2005 to 2007 (as opposed to 2005 to 2008).

3.2.1 Robustness to sample limits

The second robustness check looks at whether the results change if the sample is not restricted to taxpayers with a tax base of HUF 5–8 million in 2005, but the interval is broadened to include lower and higher earners. Thus the regressions were run on different samples. The results are reported in Table A.2 of the Appendix. The regressions reported in columns (1) and (3) include demographic controls but exclude initial income and the average net-of-tax rate. The full specifications are reported in columns (2) and (4).

The first two columns of the table report results based on a sample that was broadened to include taxpayers with lower incomes: the income range is now defined as HUF 4–8 million in 2005. The estimated coefficients are qualitatively similar to the main results. The coefficient of the marginal net-of-tax rate is slightly lower, about 0.16, but still statistically significant on the 1% level. The coefficient of the average net-of-tax rate is somewhat higher in absolute terms than in the main regressions, and is now also statistically significant. The estimated coefficients of the demographic controls are similar to those obtained in the main specification. The age variable is a slight exception: its estimated coefficient is negative, still very small in magnitude but now statistically significant at the 5% level.

The last two columns of Table A.2 report results based on a sample that was broadened to include taxpayers with incomes of up to HUF 20 million. The results are again qualitatively similar to the main results. In column (3), where only the demographic controls are included, the main elasticity is about 0.18 and statistically significant on the 1% level. Including initial income and the average net-of-tax rate as control variables in column (4) makes the elasticity fall to a level of about 0.14, remaining statistically significant on the 5% level.

The coefficient of the average net-of-tax rate is about half of previous specifications and not statistically significant. This is probably caused by the fact that the variation used to identify this variable comes from tax credits and the taxpayers eligible for these are increasingly rare at the top of the income distribution.

The estimated coefficient of initial income (taxable income in 2005) is 0.13 when the sample is broadened upwards, and is now statistically highly significant. This estimated coefficient would imply that if the initial income of an individual were higher by 1%, we should expect their income growth to be lower by 0.13%. This significant coefficient hints at the possibility that the inclusion of initial income is the likely reason why the measured effect of the marginal net-of-tax rate becomes weaker in the broader sample. The background of this phenomenon is noted by Gruber and Saez (2002): since we identify the effect of the marginal tax rate by initial income (i.e., marginal tax rates of higher-income individuals are expected to increase more because of the extraordinary tax), controlling additionally for initial income will interfere with identification. Based on this consideration, it seems justified that we use the narrower sample as the basis of the main analysis: First, the sample remains more homogeneous, and second, controlling for initial income does not harm identification. Still, in summary, changing the income limits of the sample does not change qualitatively the main results.

3.2.2 Robustness to the time period

In the second robustness check the growth of taxable income is analyzed for the period 2005–2007 (rather than for 2005–2008, as in the main analysis). The year 2007 was the first year of the extraordinary tax. Thus, these results show the immediate effect of the tax changes while the main specification measures the effect in the second year after the tax changes (the tax system remained virtually unchanged from 2007 to 2008). Results are shown in Table A.3 of the Appendix. The columns (1)-(4) report results of specifications where control variables are gradually added, similarly to the main analysis. The results are qualitatively similar to the main results. Demographic control variables have a similar effect in 2007 than in 2008, except that this time the income growth of individuals with missing gender information is not statistically different from that of men. The growth of taxable income for high-income women falls short of men's by about 7 percentage points; the premium of large cities on Budapest is about 2.5%, the discount of other cities about 4%. Age again has a small negative, and statistically not significant, effect.

The estimated coefficient of the marginal net-of tax rate is between 0.10–0.13, smaller than in the main results, but statistically significant at the 5% level in the full specification (and at least at the 10% level in all other specifications). The result suggests that taxpayers' response became stronger in the course of time.

3.3 WHAT LIES BEHIND THE ELASTICITY?

Perhaps the most intriguing question related to the taxable-income elasticity is: How much of it reflects adjustments in labor supply (reflected in hours worked or work intensity), and how much of it reflects a mere regrouping of income between different forms (e.g., wage vs. capital income) or even tax evasion? The question, by its nature, is very difficult to answer since it is hardly possible to measure the extent of tax evasion (whether it takes the form of underreporting of secondary income by the tax payer or undocumented payments by the employer) and, to a lesser extent, tax avoidance (e.g., some non-pecuniary benefits are tax exempt). We are able to conduct, however, a series of exercises that provide indications as to the explanation of the elasticity. The evidence below indicates that the elasticity reflects mainly the intensive adjustment of labor supply.

The rest of this subsection describes, in detail, three findings. (1) Higher income elasticities are estimated for women, the young and the old; (2) individuals with wage income only exhibit a taxable-income elasticity similar to the whole sample; and (3) we find no evidence for income shifting (capital income shows no differential response).

The first of these findings is consistent with previous studies finding that labor supply of women is more sensitive to wage incentives than that of men (see, e.g., the survey of Meghir and Phillips, 2008), while no alternative explanation related to tax evasion or tax avoidance would predict this asymmetry between the sexes. On the contrary, Meghir and Phillips note that with respect to tax avoidance, one should rather expect the opposite asymmetry. Similarly, with respect to tax evasion Semjén et al. (2009) have found with a survey methodology that men are almost twice as likely to be paid partly or fully in cash, than women, in Hungary.[10] A similar argument can be made regarding the age groups: presumably, older and younger age groups can increase or decrease their work effort (or even working hours) more easily than those between 30 and 55 years, who are more likely to work full-time in the first place. It is harder, however, to argue that older and younger groups are more prone to tax avoidance or tax evasion.

The second and third findings rule out the most likely form of tax avoidance as an explanation of the estimated elasticity. If we assume that those individuals who have wage income only in 2005 have less flexibility to 'relabel' their income as

[10] In the survey, 19% of men and 11% of women said that they received such unreported payments in the course of the two years prior to the survey (Semjén et al., 2009, pp. 233–234).

non-wage income, then we should expect to observe that those individuals with wage income only exhibit a taxable income elasticity that is closer to zero than that of the whole sample. More importantly, the third finding establishes that capital income of individuals to be affected by the extraordinary tax did not in fact grow faster (either in nominal terms or as a share of the tax base) than the capital income of their slightly lower-income peers.

A final piece of indirect evidence is that, as was reported among the robustness checks, the estimated elasticity is larger in the second year after the tax change than in the first year. While the adjustment of labor supply is very plausibly gradual, there is less reason to think that tax avoidance or tax evasion exhibits its effect with a time lag.

3.3.1 Higher income elasticities are estimated for women, the young and the old

To see whether different demographic groups exhibit different behavior, regressions of the main specifications are run for the sexes and age groups separately. Results show that the marginal tax rate influences the taxable income of all subgroups, albeit to a different degree. Table A.4 of the Appendix shows the regression results for women and men separately. The first two columns show the results for women and the last two columns for men. In the regressions reported in column (1) and (3) the average net-of-tax rate was omitted as an explanatory variable. The table shows that estimated coefficients are higher for women (0.23-0.25) than for men (0.17-0.19). For both sexes separately, the coefficient is statistically significant on the 5% level.

The estimated coefficients of the control variables show that the sexes are affected differently by factors controlled for in the estimations. Notably, age affects the taxable-income growth of the sexes in the opposite way: it affects income growth positively for women in the sample, but negatively for men; both effects are highly statistically significant. It is likely that this finding is caused by the fact that many younger women reduce their labor supply when they have young children. Thus we find that the near-zero overall estimated effect masks significant opposite effects for both sexes. The estimated effect of the type-of-locality variables is rarely statistically significant in the sub-samples but is broadly in line with overall findings. The coefficient of initial income (tax base in 2005) is negative for men, positive for women, but it is not statistically significant in either case. The income effect seems to be much stronger for women.

In the next step, regressions were run separately for different age groups. Taxpayers were divided into three groups: below 30 years, between 30 to 55 years, and above 55 years (as of 2005). Table A.5 of the appendix shows the results. As above, results from two specifications are reported for all three groups: the full specification is reported in the even columns, while in the odd columns the average net-of-tax rate is omitted as a control variable. The results of the odd-numbered columns are interpreted here, as the inclusion of the average net-of-tax rate makes the estimation of smaller groups unstable (especially column (2) and column (6)). In these two cases the first-stage equation for the average net-of-tax rate is not well specified (or the synthetic average net-of-tax rate is not strong enough as an instrument) as testified by the low values of the Kleibergen-Paap weak identification F-statistics reported in column (2) and column (6). These are the only instances in the analysis where we have a weak instrument problem, caused probably by the small number of observations in these subgroups.

Interpreting the results of the specifications without the income effect, we find that the taxable-income elasticity is estimated to be lowest for taxpayers between 30-55 years of age (a coefficient of 0.12), while it is larger for those under 30 years (0.62) and those above 55 years of age (0.34). The estimated coefficient of the marginal net-of-tax rate is significant at the 10% level (at the 5% level for taxpayers above 55 years). While the coefficients are not estimated very precisely for the subgroups their magnitudes are an indication that younger and older taxpayers have a higher elasticity than those in-between.

Turning to the control variables we find that the difference in income growth between women and men is affected by age. High-earning women's disadvantage in income growth is strongest for those under 30 (here the difference is almost 30 percentage points and statistically strongly significant); the disadvantage is above 10 percentage points for those older than 55 years, but here the high variance makes the effect statistically insignificant. The disadvantage of high-earning women between 30 and 55 is about 4 percent and statistically significant.

3.3.2 Similar elasticity is estimated for individuals with wage income only

Presumably individuals with wage income only are less flexible to shift their income from wage income to other forms of income (e.g., capital income), and are less able to underreport their income. Therefore, we have run our main regressions for a restricted sample of those taxpayers who had only wage income in 2005 (no entrepreneurial income and no capital income). The restricted sample consists of 4,240 observations, a majority of the original sample. The results are reported in Table A.6 of the Appendix.

Demographic control variables show similar effects to the main specification: income growth of women is about 9% lower, while income growth of individuals with missing information is about 10% higher than that of men; both effects are highly statistically significant. The disadvantage of villages is about 4.5 percentage points and statistically significant on the 10% level; the coefficient of age is about zero and not statistically significant. Initial income is close to zero and never close to being statistically significant.

The elasticity of taxable income with respect to the marginal net-of-tax rate is about 0.10-0.15 when demographic controls are not included (and not statistically significant) but very similar to the main results (about 0.21) when demographic controls are included and statistically significant at the 5% level. Interestingly, the income effect also appears to be stronger than in the full sample: the estimated coefficient of the average net-of-tax rate is about 0.7 and statistically significant at the 5% level.

In sum, based on the results of the full specification, individuals with wage income only seem to exhibit a similarly sensitive reaction to tax changes as others, contrary to the prediction of the tax-avoidance explanation.

3.3.3 No evidence for income shifting (capital income shows no differential response)

Much of the evidence we are able to collect as to the underlying causes of the estimated elasticity is indirect evidence. There is one exception, however, as we do observe the capital income of each tax payer both before and after the introduction of the extraordinary tax. To recall, capital income is not part of taxable income in the Hungarian tax system: various sources of capital income are taxed separately, subject to various linear tax rates that are lower than the regular tax rate on high-income individuals.

If the tax-avoidance explanation is right, we should observe a differential increase in capital income of those individuals who are likely, ex-ante, to become subject to the extraordinary tax. In this spirit, we divided our main sample (individuals earning HUF 5-8 million in 2005) to two sub-groups: individuals who, based on the average growth rate of income, are expected to be subject to the extraordinary tax in 2008 (the 'higher-income group'), and those who are not ('lower-income group').

Since some rules regarding capital incomes changed between 2005 and 2008 (in particular, new items were introduced under the legal definition of 'capital income'), we applied the 2005 definition also in 2008 to keep the two years comparable. (We repeated the exercise with contemporaneous definitions of capital income, and the results were unchanged.)

About 3800 observations are in the lower-income group and 3100 in the higher-income group. Six outliers were excluded from the sample: these were cases where an individual received capital income of HUF 100 million (about EUR 400,000) or higher. The income earned by these six individuals was great enough to move the results of the sample; the results are robust to any further restriction on the sample. The summary statistics of this comparison are shown in Table 3.

Table 3
The behavior of capital income in the high-income sample, 2005–2008

	Lower group	Higher group
Income in 2005	HUF 5-6.12 million	HUF 6.12-8 million
No. of observations*	3,735	3,159
% having capital income** in 2005	9.9	10.8
% having capital income** in 2008	11.3	10.9
Average capital income in 2005, HUF thousand	248	164
Average capital income in 2008, HUF thousand	266	174
Average increase of capital income, 2005–2008, HUF thousand	+18	+9
Avg. cap. inc. as a share of taxable income in 2005	4.50%	2.40%
Avg. cap. inc. in 2008 as a share of 2005 taxable income	4.80%	2.50%
Avg. increase of cap. income, 2005–2008, as a share of 2005 taxable income, HUF	0.33%	0.15%

** Six outliers were removed; these were instances of capital income above HUF 100m. Subsample averages were sensitive to these outliers but not to further restrictions on the data.*
*** We applied the 2005 legal definition to generate a comparable capital income for 2008. Additional items became taxable as capital income in the years between 2005 and 2008. The inclusion of these items into the definition of 2008 capital income, however, does not change the results.*

Contrary to what could be expected based on the tax-avoidance explanation, there is no indication in the data that the higher-income group increased its capital income to a greater extent than the lower-income group. Indeed, the share of taxpayers that has reported positive capital income grew more in the lower-income group (a growth of 1.4 percentage points vs. no increase at all). Average capital income stayed largely flat in both groups, increasing by a mere HUF 16 thousand (EUR 64) for the lower-income group as opposed to HUF 9 thousand (EUR 36) for the higher-income group. The results stay the same if we compare capital income of both groups as a share of 2005 tax base or as a share of contemporaneous tax base.

In sum, there is no indication that capital income increased more for the group affected by the extraordinary tax.

4 Fiscal significance of the main estimate: a simple calculation

To interpret the estimates of this study in the context of fiscal policy, a simple calculation is performed to evaluate a hypothetical tax change of the 2010 Hungarian tax system.[11] (All steps of the calculation are reported in Table A.7 of the Appendix.) In 2010 the upper personal-income-tax (PIT) rate was 32%, as applied to 'super-gross' taxable income (i.e., gross taxable income multiplied by 1.27, where 27% is the rate of employer contributions) above the threshold of HUF 5 million (also in super-gross terms). The calculation in this section examines the fiscal effect of a one-percentage-point increase in the upper tax rate (to 33%) and makes a comparison between the static case (where behavior does not react to tax changes) and the dynamic case (in which high-income taxpayers react to tax changes as our estimates suggest they would). To keep the Charts comparable to the rest of the paper, we will present the calculations in gross (as opposed to 'super-gross') terms. In gross terms, we are calculating the consequences of an increase of the top tax rate from 40.64% (=32%*1.27) to 41.91 (=33%*1.27), where the lower limit of the top income bracket is HUF 4 million in gross terms (approximately equal to 'super-gross' HUF 5 million).

Our concrete assumptions about taxpayers' behavior are as follows. Taxpayers with gross taxable income below HUF 5 million (= EUR 20,000) do not react to tax changes at all. Taxpayers with taxable income above HUF 5 million do react: their taxable-income elasticity with respect to the net-of-tax rate is 0.2 (as in our main estimation). In this calculation we abstract from the income effect.

We base our calculations on the 2010 tax collection data of the National Tax Authority (aggregated over relatively finely defined income groups). As our estimation excluded the self-employed, we base our calculation on the aggregate Charts on employees (about 90% of all taxpayers). According to the data, the taxable income of all employees in Hungary was HUF 7,707 billion in 2010. Of this, HUF 1,973 billion was earned by individuals with a taxable income exceeding HUF 5 million (about 5% of all taxpayers). The upper PIT rate applied to about HUF 1,100 billion of this 1,973-billion tax base. A one-percentage-point increase of the upper PIT rate brings additional tax revenue of 14 billion if there is no change in behavior.

To calculate the behavioral effect consistent with the elasticity estimated in this study, the net-of-tax rate of the affected taxpayers must first be determined. There are two groups of high-income taxpayers: those below and those above the pension contribution ceiling. Since the contributions paid by both groups are different, a one-percentage-point increase in their marginal tax rates raises their effective tax burden to a different extent in percentage terms.

Let us consider the taxpayers above the pension contribution ceiling. The 32% marginal tax rate on super gross income is equivalent to a 1.27*0.32 = 40.6% marginal tax rate on gross income; adding the social security contribution (SSC) rate of 7.5% the marginal effective tax rate (METR) is 40.6+7.5 = 48.1 per cent while the net-of-tax rate is 100−48.1 = 51.9 percent. Raising the marginal PIT rate to 33% decreases the net-of-tax rate by 1.27 percentage points, or about 2.5 percent. The elasticity of taxable income with respect to the net-of-tax rate is estimated in this study to be around 0.2 for high-earners. Thus, according to this estimate taxable income will decrease as a consequence of the tax raise by 2.5*0.2 = 0.5 percent. A similar calculation carried out for taxpayers below the pension contribution ceiling finds that the taxable income of these taxpayers will decrease by 0.6 percent (see Table A.7 of the Appendix).

This behavioral response to the tax increase is translated to a decrease of aggregate tax base from HUF 1,973 billion to

[11] Significant changes to the Hungarian PIT system came into effect in 2011 and are planned for 2012. The 2011 system is a flat tax (with an effective rate of 20.3%) with a reduced wage tax credit and an extended child tax credit.

HUF 1,962 billion for taxpayers who earn more than HUF 5 million in gross terms. The part of this tax base that falls under the upper PIT rate falls from HUF 1,100 billion to 1,090 billion. Thus tax revenue from high-income taxpayers is HUF 4.5 billion less than without a behavioral effect. Compared to the additional revenue expected from the tax increase without behavioral change (HUF 14 billion), this means that the elasticity can dampen the static fiscal estimate by about one third.

One should, however, also take into account the additional revenue fallout from employee contributions (HUF 1.2 billion) and employer contributions (HUF 2.9 billion) as a result of a decreased taxable income. Taking this into account we find that additional government revenue falls short of the static estimate by 60% if social security contributions are also taken into account (as opposed to about one-third when only the PIT is taken into account).

It might be surprising that a relatively low elasticity can have a relatively high revenue effect. There are two reasons for this. First, the elasticity expresses the percentage change of taxable income as a reaction to a one-percent change in the marginal net-of-tax rate. If the marginal net-of-tax rate is about 50%, a one-percentage-point tax change means a 2% change in the marginal tax rate. Thus the effect of tax changes measured in percentage points are in reverse proportion to the level of the marginal net-of-tax rate.

The second reason is related to the fact that such back-of-the envelope calculations are slightly sensitive to the extent of the overlap between the group of taxpayers who are affected by the hypothetical tax change and the group of taxpayers who are thought to react to tax changes. In particular, if a tax increase affects all taxpayers but only high-income taxpayers are thought to have non-zero taxable-income elasticity, the aggregate behavioral effect will be small relative to the additional government revenue. If, however, a tax increase only affects the high-income group, the behavioral effect will be more substantial. In this section we calculated the effect of an increase of the top tax rate in Hungary. The behavioral effect would clearly be lower for an across-the-board tax increase.

This example calculation is directly comparable to the one by Benczúr (2007, Table 1), who estimated ex-ante the dynamic fiscal effect of the extraordinary tax based on international estimates of the taxable-income elasticity. As a difference to that calculation the present calculation takes into account employer-side contributions. According to Benczúr’s example calculation an elasticity of 0.4 (the main estimate of Gruber and Saez, 2002) implies that government revenue is barely increased by the introduction of the extraordinary tax (it is increased by about 1/20 of the static effect). In our example, the elasticity of 0.2 estimated in this study implies a positive total revenue effect even if employer contributions are taken into account, although the behavioral effect reduces additional revenue significantly.

5 Discussion

The paper examines how high-income taxpayers in Hungary responded to the introduction, in 2007, of the extraordinary tax on individuals. The methodology is based on explaining the growth in taxable income of individuals earning between HUF 5 and 8 million in 2005 by the predicted change of their tax rates and other control variables. The elasticity of high earners' taxable income with respect to the net-of-tax rate (1–METR) is estimated to be about 0.2 in the main specification. A series of indirect evidence is presented in support of the view that most of the estimated effect reflects labor-supply adjustment on the intensive margin rather than tax avoidance or tax evasion.

The estimated elasticity of 0.2 in this study is lower than most estimates for the U.S. but close to some recent estimations for other countries. Differences across countries with respect to the taxable-income elasticity do not necessarily pose a puzzle since, as Slemrod (1998) and Slemrod and Kopczuk (2002) pointed out, the elasticity depends on aspects of the tax system (definition of the tax base, possibility of income-shifting, etc.) that are not accounted for in the estimations. At the same time, the extent of income-shifting affects the welfare-relevance of the estimated elasticity. Chetty (2009) showed that the welfare-relevant elasticity is lower than the taxable-income elasticity if the cost of sheltering income is not a pure resource cost but rather involves transfers among economic agents or if it is overestimated by agents. Since the Hungarian tax system provides hardly any opportunities for deductions for employees (during the time of study it organized all tax expenditures as tax credits, that is, as reductions of the tax due), taxable income is difficult to manipulate. This and the fact that we found no indication of income-shifting towards capital income suggests that the elasticities measured in this study are closer to the welfare-relevant elasticity than many previous estimates.

One caveat is in place as to applying estimated elasticities to evaluate proposed tax policy. The reaction of taxpayers is, in this study, based on a policy episode where statutory marginal tax rates increased by 1.5–4.5 percentage points (see Table A.1 in the Appendix). With more radical changes to the tax system it is conceivable that mechanisms become operative that were not operative in the case of a smaller tax change, limiting the usefulness of past estimations. For example, radical changes might affect the relative tax burden of different types of income (e.g., wage vs. entrepreneurial income) and thus influence the decision of taxpayers (or employers) about the type of their income. Radical changes in the tax system might also influence the choice of legal form for businesses. While some of these mechanisms shift the tax base between types of taxes, others may influence the total tax base as well.

While this is a warning to any policy advice related to radical tax reform, it must also be noted that limited changes in the tax code (like in the episode analyzed in this paper) provide a better opportunity to measure the behavioral effects that economists are interested in, exactly because there are less confounding factors than in the case of radical tax reform.

Meanwhile, in Hungary top tax rates were radically cut in 2011, with a fiscal effect that is an order of magnitude larger than the changes analyzed in this paper. It is the task of future research to assess the behavioral effects of that tax reform.

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Appendix

APPENDIX A: TABLES

Table A.1
Tax rates and rates of social security contributions of Hungarian high-income earners in the years 2005 and 2008

	2005	2008
PIT lower rate	18%	18%
Limit of lower tax bracket	HUF 1.5 M	HUF 1.7 M
PIT upper rate	38%	36%
Extraordinary tax on individuals	–	4%
– *levied on income above*	–	HUF 7.139 M
Employee pension contribution rate	8.5%	9.5%
Pension contribution ceiling	HUF 6.0 M	HUF 7.139 M
Other employee contributions	5%	7.5%
Typical METR at income HUF 5 million	51.5%	53%
Typical METR at income HUF 8 million	43%	47.5%
Typical (1–METR) at income HUF 5 million	48.5%	47%
percentage change relative to 2005	–	–3.09%
Typical (1–METR) at income HUF 8 million	57%	52.5%
percentage change relative to 2005	–	–7.89%

METR: marginal effective tax rate.

Table A.2
Robustness analysis 1. The income limits of the sample

Sample	(1) HUF 4-8 mill	(2) HUF 4-8 mill	(3) HUF 5-20 mill	(4) HUF 5-20 mill
Dependent var.:	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)
dlog(1−METR)	0.163***	0.161***	0.184***	0.135**
	(0.009)	(0.005)	(0.001)	(0.021)
dlog(1−AETR)		−0.596***		−0.228
		(0.001)		(0.532)
log(initial income)		−0.049*		−0.130***
		(0.051)		(0.000)
Female	−0.067***	−0.057***	−0.086***	−0.088***
	(0.000)	(0.000)	(0.000)	(0.000)
Gender info missing	0.072***	0.071***	0.101***	0.097***
	(0.000)	(0.000)	(0.000)	(0.000)
Age	−0.001**	−0.002***	−0.000	−0.000
	(0.031)	(0.002)	(0.720)	(0.929)
Large cities	0.039***	0.030***	0.052***	0.039***
	(0.002)	(0.010)	(0.001)	(0.009)
Other cities	0.010	0.003	0.028*	0.016
	(0.478)	(0.792)	(0.096)	(0.320)
Villages	−0.022	−0.027**	−0.009	−0.019
	(0.136)	(0.050)	(0.641)	(0.312)
Constant	−0.044*	0.707*	−0.106***	1.947***
	(0.081)	(0.067)	(0.001)	(0.000)
No. of obs.	13,311	13,311	10,201	10,201
Diagnostic tests				
Exogeneity of tax rate variables (p-value)	0	0	7.27e-06	0
Kleibergen-Paap underid. test (p-value)	0	0	0	0
F-stat - first-stage reg. for (1−METR)	1,069.5	581.3	1,831.9	1,357.9
F-stat - first-stage reg. for (1−AETR)	–	369.8	–	118.0
Kleibergen-Paap weak identification test (F-stat)	1,069.5	360.6	1831.9	115.4

All results are from IV estimations with robust standard errors. Robust p-values in parenthesis.
**** p<0.01, ** p<0.05, * p<0.1.*

Table A.3
Robustness analysis 2. Time period 2005–2007

Dependent var.:	(1) dlog(tax.inc.)	(2) dlog(tax.inc.)	(3) dlog(tax.inc.)	(4) dlog(tax.inc.)
dlog(1–METR)	0.125**	0.108*	0.111*	0.124**
	(0.029)	(0.079)	(0.055)	(0.033)
dlog(1–AETR)			–0.392	–0.314
			(0.167)	(0.290)
log(initial income)		–0.055	–0.058	–0.052
		(0.288)	(0.237)	(0.297)
Female				–0.068***
				(0.000)
Gender info missing				–0.022
				(0.484)
Age				–0.001
				(0.380)
Large cities				0.026*
				(0.078)
Other cities				0.006
				(0.724)
Villages				–0.039**
				(0.047)
Constant	–0.078***	0.774	0.811	0.768
	(0.000)	(0.334)	(0.287)	(0.322)
No. of obs.	7,255	7,255	7,255	7,255
Diagnostic tests				
Exogeneity of tax rate variables (p-value)	0	0	0	0
Kleibergen–Paap underident. test (p-value)	0	0	0	0
F-stat – first-stage reg. for (1–METR)	1,048.3	898.7	548.9	539.7
F-stat – first-stage reg. for (1–AETR)	–	–	132.2	129.3
Kleibergen–Paap weak identification test (F-stat)	1,048.3	898.7	129.9	127.5

All results are from IV estimations with robust standard errors. Robust p-values in parenthesis.
**** p<0.01, ** p<0.05, * p<0.1.*
Note: The sample is defined the same way as in the 2005–2008 analysis.

Table A.4
Regressions run separately for the sexes

Sample:	(1) women	(2) women	(3) men	(4) men
Dependent var.:	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)
dlog(1–METR)	0.252**	0.232**	0.175**	0.185**
	(0.040)	(0.024)	(0.047)	(0.028)
dlog(1–AETR)		–1.194**		–0.246
		(0.014)		(0.568)
log(initial income)	0.106	0.084	–0.063	–0.057
	(0.303)	(0.333)	(0.349)	(0.388)
Age	0.011***	0.007***	–0.004***	–0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Large cities	0.054*	0.032	0.026	0.024
	(0.073)	(0.229)	(0.225)	(0.243)
Other cities	0.021	0.015	–0.002	–0.003
	(0.564)	(0.622)	(0.939)	(0.895)
Villages	0.010	–0.002	–0.033	–0.033
	(0.791)	(0.951)	(0.223)	(0.202)
Constant	–2.221	–1.759	1.063	0.954
	(0.166)	(0.198)	(0.313)	(0.352)
No. of observations	2,144	2,144	4,219	4,219
Diagnostic tests				
Exogeneity of tax rate variables (p-value)	0	0	0.03	0
Kleibergen–Paap underident. test (p-value)	0	0	0	0
F-stat – first-stage reg. for (1–METR)	408.4	342.2	505.8	398.0
F-stat – first-stage reg. for (1–AETR)	–	64.2	–	62.2
Kleibergen–Paap weak identification test (F-stat)	408.4	53.5	505.8	62.4

All results are from IV estimations with robust standard errors. Robust p-values in parenthesis.
**** p<0.01, ** p<0.05, * p<0.1.*

Table A.5
Regressions run separately for age groups

Sample:	(1) younger than 30	(2) younger than 30	(3) between 30 and 55	(4) between 30 and 55	(5) older than 55	(6) older than 55
Dependent var.:	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)	dlog(tax.inc.)
dlog(1–METR)	0.618*	0.623	0.123*	0.148**	0.340**	1.211
	(0.099)	(0.207)	(0.094)	(0.024)	(0.039)	(0.178)
dlog(1–AETR)		0.071		–0.764**		12.521
		(0.975)		(0.026)		(0.277)
log(initial income)	0.063	0.064	–0.023	–0.008	–0.006	0.276
	(0.756)	(0.780)	(0.692)	(0.880)	(0.982)	(0.651)
Female	–0.325***	–0.329**	–0.041**	–0.032**	–0.155	–0.355
	(0.000)	(0.025)	(0.010)	(0.032)	(0.336)	(0.388)
Gender info missing	0.059	0.059	0.075***	0.077***	0.192	0.419
	(0.125)	(0.127)	(0.002)	(0.001)	(0.113)	(0.222)
Age	0.000	0.000	0.001	0.000	–0.037	–0.069
	(0.976)	(0.987)	(0.487)	(0.809)	(0.313)	(0.370)
Large cities	0.043	0.045	0.034*	0.028*	–0.073	0.014
	(0.354)	(0.482)	(0.055)	(0.093)	(0.438)	(0.933)
Other cities	0.062	0.063	–0.003	–0.006	–0.199*	–0.493
	(0.199)	(0.375)	(0.883)	(0.765)	(0.065)	(0.200)
Villages	0.013	0.014	–0.028	–0.031	–0.207	–0.579
	(0.799)	(0.827)	(0.229)	(0.139)	(0.103)	(0.274)
Constant	–1.044	–1.070	0.238	–0.005	2.154	0.003
	(0.742)	(0.770)	(0.794)	(0.995)	(0.679)	(1.000)
No. of observations	1,172	1,172	5,389	5,389	339	339
Diagnostic tests						
Exogeneity of tax rates	0.190	0	0.002	0	0.065	0
K.–P. underid. p-value	0	0.004	0	0	0	0.064
F-stat, 1st-st. (1–METR)	124.4	168.1	753.8	535.0	512.7	255.4
F-stat, 1st-st. (1–AETR)	–	10.4	–	82.3	–	18.9
K.–P. weak id. F-stat	124.4	3.92	753.8	82.1	512.7	1.96

All results are from IV estimations with robust standard errors. Robust p-values in parenthesis.
**** p<0.01, ** p<0.05, * p<0.1.*

Table A.6
Regression results for individuals with wage income only
(no independent income, no capital income)

Dependent variable:	(1) dlog(tax.inc.)	(2) dlog(tax.inc.)	(3) dlog(tax.inc.)	(4) dlog(tax.inc.)
dlog(1−METR)	0.110	0.104	0.156	0.212**
	(0.318)	(0.374)	(0.134)	(0.040)
dlog(1−AETR)			−0.734**	−0.743**
			(0.017)	(0.022)
log(initial income)		−0.025	−0.007	0.020
		(0.731)	(0.916)	(0.757)
Female				−0.097***
				(0.000)
Gender info missing				0.080***
				(0.000)
Age				0.000
				(0.650)
Large cities				0.032
				(0.110)
Other cities				0.010
				(0.625)
Villages				−0.043*
				(0.078)
Constant	−0.105***	0.282	−0.019	−0.399
	(0.000)	(0.802)	(0.985)	(0.692)
No. of observations	4,240	4,240	4,240	4,240
Diagnostic tests				
Exogeneity of tax rate variables (p-value)	0.161	0.145	0	0
Kleibergen-Paap underident. test (p-value)	0	0	0	0
F-stat – first-stage reg. for (1−METR)	314.8	301.3	249.3	250.9
F-stat – first-stage reg. for (1−AETR)	–	–	151.1	135.0
Kleibergen-Paap weak identification test (F-stat)	314.8	301.3	149.2	133.7

All results are from IV estimations with robust standard errors. Robust p-values in parenthesis.
**** p<0.01, ** p<0.05, * p<0.1.*
Note: The sample consists of those taxpayers in the main sample who did not have entrepreneurial or capital income in 2005.

Table A.7
The fiscal effect of a hypothetical one-percentage-point raise of the upper tax rate in the 2010 Hungarian tax system
(sums in HUF billion)

Line	Variable	Below the contribution ceiling	Above the contribution ceiling	Sum
#1	income range (gross*)	HUF M 5-7.5	HUF M 7.5-	
	Actual tax and contribution rates			
#2	Marginal PIT rate (= 32% * 1.27)	40.6%	40.6%	
#3	Employee contributions	17%	7.5%	
#4	METR (typical)	57.6%	48.1%	
#5	1–METR (typical)	42.4%	51.9%	
	Hypothetical scenario			
#6	Marginal PIT rate (= 33% * 1.27)	41.9%	41.9%	
#7	METR (typical)	58.9%	49.4%	
#8	1–METR (typical)	41.1%	50.6%	
#9	Percentage change of 1–METR	–3.0%	–2.5%	
#10	Elasticity of income w.r.t. (1–METR)	0.2	0.2	
#11	Change of taxable income (= #9 * #10)	–0.6%	–0.5%	
	Before change			
#12	Taxable income for the income group	773.5	1,199.1	1,972.5
#13	… of which falling under upper PIT rate (>4M)	259.9	840.2	1,100.1
#14	Tax revenue from the upper PIT rate	105.6	341.4	447.1
	After change, static estimate			
#15	Tax revenue from the upper PIT rate	108.9	352.1	461.0
#16	Additional tax revenue (= #15–#14)	3.3	10.7	14.0
	After change, dynamic estimate			
#17	Taxable income for the income group	768.8	1,193.1	1,961.9
#18	… of which falling under upper PIT rate (>4M)	255.3	834.2	1,089.5
#19	Tax revenue from the upper PIT rate	107.0	349.6	456.6
#20	Additional tax revenue (= #19–#14)	1.4	8.2	9.5
#21	*Diff. from static estimate (only PIT) (= #20–#16)*			–4.5
#22	*% difference from static estimate (only PIT)*			–32%
#23	Fallout of employee contributions	0.8	0.4	1.2
#24	Fallout of employer contributions	1.3	1.6	2.9
#25	Total revenue effect (= #20–#23–#24)	–0.7	6.2	5.4
#26	*Diff. from static estimate (with SSC) (= #25–#16)*			–8.6
#27	*% diff. from static estimate (with SSC)*			–61%

** In 2010 statutory tax rates were applied to 'super gross' income (i.e. gross income*1.27, as the employer contribution rate was 27%). In this table every figure is in gross terms (and not in super-gross terms) for easier interpretation.*
Source: Own calculations based on the actual 2010 income distribution of employees as reported by the National Tax Authority.

APPENDIX B: THE DERIVATION OF THE INCOME EFFECT

In the main specifications we followed Bakos et al. (2008) in the operationalization of the income effect. Their solution is a slight variant of that by Gruber and Saez (2002), the difference being a minor step of approximation. In explaining the difference we somewhat extend the exposition of Bakos et al. (2008).

The starting point of the theory is an optimizing agent who has an income supply function $y=y((1-\tau),R)$, where is the marginal tax rate and R is virtual income. Virtual income is defined, in a non-linear tax schedule, by the expression $y-T(y)=R+(1-\tau)y$, where $T(y)$ is the total tax due at income level y. The agent's response to a tax change can be written as:

$$dy = -\frac{\partial y}{\partial(1-\tau)}d\tau + \frac{\partial y}{\partial R}\partial R.$$

Introducing the uncompensated tax price elasticity $\beta^u=[(1-\tau)/y][\partial y/\partial(1-\tau)]$, the income effect $\phi=(1-\tau)\partial y/\partial R$ and the compensated tax price elasticity $\beta=\beta^u-\phi$ we obtain:

$$\frac{dy}{y} = -\beta\frac{d\tau}{1-\tau} + \phi\frac{dR - yd\tau}{y(1-\tau)}.$$

Most studies estimate this equation in a log-log specification, replacing dy/y by $\log(y_2/y_1)$ and $(-d\tau/(1-\tau))$ by $\log[(1-\tau_2)/(1-\tau_1)]$. Before Gruber and Saez (2002) the income effect was mostly assumed to be zero. They, in contrast, did include the income effect in the estimation by approximating the last term $(dR-yd\tau)/(y(1-\tau))$ with $\log[(y_2-T_2(y_2))/(y_1-T_1(y_1))]$. As they note in a footnote on page 10 they use the approximation $y(1-\tau)\approx y-T(y)$ to obtain this form. We can thus reconstruct their derivation as follows:

$$\frac{dR - yd\tau}{y(1-\tau)} \approx \frac{d[y-T(y)]}{y(1-\tau)} \approx \frac{d[y-T(y)]}{y-T(y)} \approx \log\left[\frac{y_2 - T_2(y_2)}{y_1 - T_1(y_1)}\right].$$

The first equation uses the fact that $dR-yd\tau$ is equal to the change in tax liability with changing tax rates and a constant income y; the second step makes the approximation in the denominator described above; while the last step is just a logarithmic approximation. Thus the income effect, equal in its original form to the change in after-tax income divided by after-tax income minus virtual income, is approximated by the percentage change in after-tax income.

Bakos et al. (2008) use the same approximation $y(1-\tau)\approx y-T(y)$ to justify a different estimated equation. They reach the following income effect:

$$\frac{dR - yd\tau}{y(1-\tau)} \approx \log\left[\frac{(y_2 - T_2(y_2))/y_2}{(y_1 - T_1(y_1))/y_1}\right] = d\log(1-\text{AETR}).$$

We can derive the approximation of Bakos et al. (2008) 'backwards', i.e., starting from the resulting form and reaching the original expression, as follows:

$$d\log\left(\frac{y-T(y)}{y}\right) = d\log\left(\frac{R+y-y\tau}{y}\right) = \frac{dR + dy - dy\tau - yd\tau}{R+y-y\tau} - \frac{dy}{y} \approx$$
$$\approx \frac{dR + dy - \tau dy - yd\tau}{y(1-\tau)} - \frac{dy}{y} = \frac{dR - yd\tau}{y(1-\tau)}.$$

Here the first equality follows from the definition of virtual income R; the second equality follows from total differentiation; the third step uses, in the denominator, the same approximation that Gruber and Saez also use ($R+y-y\tau=y-T(y)\approx y(1-\tau)$); while the last step is just a subtraction.

The difference between both approximations is slight. Total differentiation in the derivation of Bakos et al. means that in that step they allow y to change as well as the tax rates. In contrast, the first step in the derivation of Gruber and Saez, as reconstructed here, holds exactly only if income is constant; it is an approximation if income changes.

Clearly, both approximations are legitimate. In this paper we choose the approximation of the income effect as derived by Bakos et al. for two reasons. First, while this form is reached using a crucial approximating step Gruber and Saez also uses, it appears to us that altogether it is reached after fewer approximating steps. Second, we find it aesthetically appealing to measure both the substitution and the income effect by the change of an easily interpretable tax rate, i.e., by the change of the marginal and average net-of-tax rate, respectively.

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