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Tax evasion and Swiss bank deposits ☆

Niels Johannesen

Department of Economics, University of Copenhagen, Denmark

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ABSTRACT

Bank deposits in offshore financial centers may be used to evade taxes on interest income. A recent EU reform limits the scope for this type of tax evasion by introducing a withholding tax on interest income earned by EU households in Switzerland and several other offshore centers. This paper estimates the impact of the withholding tax on Swiss bank deposits held by EU residents while using non-EU residents who were not subject to the tax as a comparison group. We present evidence that Swiss bank deposits owned by EU residents declined by 30–40% relative to other Swiss bank deposits in two quarters immediately before and after the tax was introduced. We also present evidence suggesting that the drop in Swiss bank deposits was driven by behavioral responses aiming to escape the tax - such as the transfer of funds to bank accounts in other offshore centers and the transfer of formal ownership of Swiss bank accounts to offshore holding companies - rather than repatriation of funds.

1. Introduction

Offshore tax evasion has recently attracted much attention from policy makers as well as academic researchers. A recent paper estimates that the offshore financial wealth owned by households amounts to USD 6000 billion (Zucman, 2013). It is widely believed that most of this wealth is owned by the very richest households and that it largely escapes taxation. Hence, better enforcement of taxes on offshore wealth can potentially generate significant gains in terms of both equity and efficiency. It is therefore not surprising that the past decade has seen a number of notable policy initiatives against offshore tax evasion including information exchange agreements with offshore financial centers, amnesties for tax evaders disclosing offshore assets, criminal prosecution of bankers assisting with offshore tax evasion and the use of client information acquired from former bank employees to identify owners of undeclared offshore wealth. Little is known about the success of these measures because most economic activity in offshore financial centers is shrouded in secrecy.

This paper studies another important policy initiative known as the European Savings Directive. Since 2005, cooperating offshore centers such as Switzerland, Luxembourg and Jersey have applied a tax to the interest income of EU households and transferred the bulk of the tax revenue to the households' home countries. Since the tax is withheld by the offshore banks and tax authorities are not informed about the identity of the tax payers, the Savings Directive enforces taxation of offshore wealth without compromising the bank secrecy of the cooperating offshore centers. Importantly, households that allow the offshore bank to report their interest income are exempt from the withholding tax. This implies that the tax only affects households unwilling to report their offshore interest income - tax evaders - while leaving compliant households unaffected.

The aim of the paper is to estimate how households with undeclared offshore deposits responded to the Savings Directive. This question is key to a normative evaluation of the policy. If the Savings Directive triggered no behavioral responses, it would appear as a highly attractive policy on both equity and efficiency grounds since it would amount to a transfer from rich and untaxed households to the government with no offsetting efficiency losses. Behavioral responses may, however, affect the normative properties of the policy in different ways. Specifically, increases in compliance, for instance through repatriation or self-reporting of offshore wealth, creates efficiency gains, whereas substitution toward untaxed alternatives, for instance through transfers from Swiss bank accounts to offshore centers outside the Savings Directive, creates efficiency losses.[1]

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[1] To see this point clearly, let t^H denote the home country tax rate and t^W denote the withholding tax rate. Applying a standard argument, the marginal efficiency loss associated with a small increase in the withholding tax is captured by the revenue effect of behavioral responses to the tax change, hence increases in compliance cause an efficiency gain proportional to $t^H - t^W$ whereas substitution toward untaxed alternatives causes an efficiency loss proportional to t^W. Note that Chetty (2009) questions the validity of this argument in a tax evasion context. Also note that substitution effects are not captured by standard models of tax evasion in the tradition of Allingham and Sandmo (1972) where agents have access to a single evasion strategy, under-reporting of income.

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To study how households responded to the Savings Directive, we use a unique dataset on cross-border bank deposits from the Bank for International Settlements (the "BIS"). More than 40 countries including the world's largest offshore financial centers report deposit data to the BIS on the basis of bank balance sheets. The quarterly reports contain information about cross-border bank deposits at the bilateral level. We observe, for instance, the value of deposits in Swiss banks owned by German residents, deposits in Luxembourg banks owned by French residents and deposits in Jersey banks owned by UK residents.

The main analysis focuses on bank deposits in Switzerland. Both academic studies and industry surveys find that around one third of the global stock of household offshore wealth is managed by Swiss banks (Zucman, 2013; Boston Consulting Group, 2009) and certain features of the Swiss legal environment make it likely that a large fraction of this wealth escapes home country taxation. While Switzerland at least partly broke with its tradition for strict bank secrecy by agreeing to exchange tax relevant information with selected partner countries in 2009, it maintained a legal environment highly attractive for foreign tax evaders throughout the period of our analysis. Specifically, the legal principle of dual criminality implied that bank information may only be released by Swiss banks in cases where the alleged offense would constitute a criminal act under Swiss law. Since the simple non-declaration of income is not considered a criminal act in Switzerland, foreign tax evaders with Swiss bank deposits essentially had legal certainty that bank information would not be transmitted to their home country. According to Sullivan (2007), assets entrusted to Swiss banks by foreign households in ways that easily lend themselves to tax evasion amount to around $1000 billion.[2]

The first part of the empirical analysis estimates the size of the behavioral responses to the Savings Directive. We exploit that the Savings Directive changed the tax environment for tax evaders resident in the EU while leaving tax evaders resident outside the EU unaffected. This allows us to estimate the causal effect on Swiss bank deposits by comparing the change in deposits held by EU residents to the change in deposits held by a control group of non-EU residents. The estimated effect is large and very robust. In a variety of different specifications, we consistently find that the Savings Directive reduced EU-owned bank deposits in Switzerland by 30–40%. The reduction occurred during just two quarters immediately before and after implementation of the policy, which strongly supports a causal interpretation of the estimates. We find similar although somewhat smaller effects on bank deposits in the four other offshore centers covered by the Savings Directive for which bilateral deposit data are available, Luxembourg, Jersey, Guernsey and the Isle of Man.

These results have two important implications. First, the finding that the stock of offshore bank deposits responded strongly to a policy that only affected tax evaders is highly suggestive that a significant fraction of offshore wealth is undeclared. This is consistent with the view held by most tax specialists but while this view is largely based on anecdotal evidence, the present analysis is based on systematic information about bank deposits in some of world's leading offshore banking centers. Second, the results suggest that tax evaders are highly responsive to changes in the international tax environment. Under conservative assumptions, the estimated response to the Savings Directive implies a tax elasticity of undeclared Swiss deposits in the range of 2–2.5.

The second part of the empirical analysis attempts to uncover the nature of the behavioral responses to the Savings Directive. In other words, if EU-owned bank deposits in Switzerland dropped by 30–40% as suggested by the results reported above, what happened to all that money? First, we show that the Savings Directive caused a large increase in EU-owned bank deposits in Macao and Panama, the only two offshore centers outside the Savings Directive for which we have bilateral deposit data. This suggests that the reduction in Swiss deposits partly reflects deposit shifting to escape the withholding tax. Second, we show that the Savings Directive caused a large increase in Swiss deposits recorded in the BIS statistics as belonging to Panama, a leading offshore provider of incorporation services. This is consistent with EU households transferring formal ownership of Swiss assets to sham corporations in Panama allowing them to escape the withholding tax while keeping their assets in Switzerland. Finally, we investigate whether the estimated reduction in Swiss deposits could be driven by repatriation of funds. We exploit that the tax cost of repatriating undeclared Swiss deposits depends crucially on home country taxes. If repatriation was a quantitatively important response to the Savings Directive, we should expect the drop in Swiss deposits to be larger for EU countries with low taxes on interest income. We find no signs of such a pattern suggesting that the reduction in Swiss deposits was not to a significant extent driven by repatriation of funds.

The paper relates to several strands of literature. Two earlier papers estimate the effect of tax variables and institutional variables on cross-border deposits while paying no particular attention to offshore centers: Alworth and Andresen (1992) estimate a cross-sectional gravity model and report modestly sized effects of source taxes while Huizinga and Nicodème (2004) estimate a panel gravity equation and find no effects of source taxes in the preferred specifications. Two papers are directly concerned with the Savings Directive but employ empirical strategies quite different from ours: Hemmelgarn and Nicodème (2009) deploy national account data, deposit data and government revenue data to assess the impact of the Savings Directive and conclude that the Savings Directive had no measurable effects. Klautke and Weichenreider (2010) show that bonds, which are exempt from the withholding tax due to a grandfather clause, are not associated with lower pre-tax returns than comparable taxable bonds suggesting that there are other ways to effectively avoid the withholding tax. Another related paper is by Johannesen and Zucman (2014) who show that information exchange treaties between offshore centers and other countries induce shifting of deposits between offshore centers but no repatriation of funds. Related to the analysis of Panama sham corporations are the studies by Hanlon et al. (2011) on the use of offshore corporations by U.S. households as well as Zucman (2013) and Johannesen and Zucman (2014). Finally, Brown et al. (2011) study tax and political determinants of Swiss bank deposits and report that weak political governance in the home country is more strongly associated with large stocks of deposits in Swiss banks than high tax rates.

The paper is structured in the following way: Section 2 lays out institutional details of the international tax environment and places the Savings Directive in this context. Section 3 describes the deposit data. Section 4 presents the empirical strategy. Section 5 illustrates time trends in Swiss bank deposits around the implementation of the Savings Directive. Sections 6 and 7 present results on the size and the nature of the behavioral response to the Savings Directive respectively. Section 8 provides concluding remarks.

2. Background

The first part of this section describes some basic principles of international taxation while highlighting the institutional features that make Swiss banks attractive for tax evaders. Since we aim to describe the institutional background for the Savings Directive, we focus on the rules applicable around 2005. The next two parts provide details on the Savings Directive and subsequent institutional developments.

2.1. The tax environment

The interest income of households is generally taxable in the home country regardless of where it is earned. To the extent that households do not self-report interest income from foreign sources, enforcement of residence based capital taxes requires information exchange between

[2] This figure combines $606 billion of on-balance-sheet assets and $356 billion of off-balance-sheet assets typically in the form of fiduciary deposits as of 2006 (the precise meaning of fiduciary deposits is explained in the background section).

tax authorities. OECD (2006) lists two conditions necessary to ensure effective exchange of information. First, there must be a legal basis for exchange of information. In some cases, domestic law may allow tax authorities to share information with foreign countries, but more commonly the legal basis for information exchange is a bilateral treaty. Second, domestic tax authorities must have access to the information requested by foreign tax authorities. A potential obstacle is bank secrecy laws that can severely restrict access to bank information for domestic tax authorities.

OECD (2006) provides a summary of the institutional features determining effective information exchange between tax administrations at the end of 2005. Most of the 82 countries in the survey were committed to provide tax information upon request to a large number of treaty partners. Switzerland stands out as one of the few countries that never provided information to foreign tax authorities in cases of simple tax evasion. Under the principle of dual criminality, Switzerland only provided information in criminal cases as defined by the Swiss penal code. The legal standard used to determine criminality in tax cases was tax fraud defined as tax evasion conducted by means of false documents or the like whereas the simple non-declaration of income was not considered fraud. In cases of tax fraud, Switzerland could provide information to any country on the basis of Swiss domestic law. Turning to bank secrecy, most of the surveyed countries could obtain banking information in all tax matters and in many countries banks were required to transmit tax relevant information automatically to the tax authorities. In Switzerland, also the lifting of the banking secrecy was subject to a dual criminality test, hence Swiss tax authorities did not have access to banking information in cases of simple tax evasion.

For completeness, it should be mentioned that Switzerland, in principle, subjects all interest payments to a 35% withholding tax levied at the bank level. While the withholding tax essentially serves to enforce taxation of Swiss residents in an environment where bank secrecy rules prevent Swiss tax authorities from obtaining information about taxable interest income, it applies equally to domestic and foreign investors.[3] It is well-known, however, that there exists a simple way to avoid the withholding tax, which is widely used by foreign investors (Sullivan, 2007). If a foreign investor entrusts funds to a Swiss bank in its capacity as fiduciary agent and the Swiss bank then deposits the funds with a non-Swiss bank on behalf of the investor, the interest accruing to this fiduciary deposit is considered foreign source and is therefore exempt from withholding tax. According to official statistics published by the Swiss central bank, around 90% of foreign-owned deposits in Swiss banks are held in the form of fiduciary deposits.[4]

In sum, the Swiss institutional framework around 2005 was extraordinarily favorable to foreign households using Swiss bank accounts to evade taxes on interest income in their home country. Put simply, the banking secrecy rules implied that interest income would not be taxed in the home country and the use of fiduciary deposits ensured that interest income would not be taxed in Switzerland.

2.2. The Savings Directive

The aim of the European Savings Directive is to establish effective taxation of the foreign interest income of household residents in the European Union. It covers all EU countries as well as 15 offshore centers (i.e. Andorra, Anguilla, Aruba, British Virgin Islands, Cayman Islands, Guernsey, Isle of Man, Jersey, Liechtenstein, Monaco, Montserrat, Netherlands Antilles, San Marino, Switzerland and the Turks and Caicos Islands). Negotiations were concluded toward the end of 2004 and the Savings Directive took effect simultaneously in all participating countries on 1 July 2005.

The Savings Directive provides for two alternative regimes of cooperation based on automatic information exchange and withholding taxes respectively. The first regime requires banks to report interest income earned by foreign EU households to the tax authorities who automatically convey this information to the home country of the household. The second regime requires banks to levy a withholding tax on the interest income of foreign EU households at 15% in 2005 gradually increasing to 20% in 2008 and 35% in 2011. Banks remit the taxes to the tax authorities without disclosing the identity of the tax payers who thus remain anonymous. Since the withholding tax effectively replaces taxation in the home country, 75% of the revenue from the tax is transferred to the home country of the household. While most EU countries adopted the information exchange regime, most of the offshore centers including Switzerland opted for the withholding tax regime.

Importantly, households may avoid the withholding tax by accepting that information on interest income is transmitted to their home country. Hence, households with Swiss bank accounts who were self-reporting their interest income before 2005 should be utterly unaffected by the Savings Directive. On the other hand, households using Swiss bank accounts to evade home country taxes faced an increase in the effective tax rate on Swiss source interest income from 0% to 15% on 1 July 2005. Notably, this is true for investors with Swiss fiduciary deposits. Whereas fiduciary deposits allow investors to escape the withholding tax imposed under Swiss domestic law, the withholding tax imposed under the Savings Directive also applies to interest income paid by fiduciary agents.

As emphasized by the European Commission (2008), the Savings Directive may be circumvented in a number of ways. First, transferring assets to one of the many countries that do not participate in the Savings Directive is a simple and effective way to escape the withholding tax. Second, since the Savings Directive applies on an immediate ownership basis, transferring the formal ownership of assets to a corporation or a trust generally suffices to fall outside its scope. Third, investors may replace interest bearing assets with structured finance products, the return of which is not considered interest and therefore not subject to the provisions of Savings Directive.

2.3. Subsequent developments

Spurred by external pressure, the Swiss tax environment has recently undergone profound changes. In May 2008, a Swiss private banker formerly employed with the Swiss bank UBS was arrested in the U.S. on charges of conspiring with U.S. residents to evade taxes. In June 2008, a U.S. court demanded that UBS disclose the names of all U.S. clients with unreported Swiss bank accounts. Ultimately, UBS disclosed information about thousands of U.S. deposit holders and agreed to pay a settlement of $780 million. Meanwhile, the political pressure on offshore centers was mounting and in 2009, as one of the last offshore centers in the world, Switzerland endorsed the OECD standard and concluded a number of bilateral treaties allowing for information exchange on request. It is important to emphasize, however, that the events leading to the recent important changes in the Swiss tax environment all happened after our period of analysis. The Swiss regime with a very limited legal basis for provision of information to foreign countries and almost impenetrable bank secrecy was in place and essentially unchallenged throughout the period of our analysis.

3. Data

The main data source is the International Locational Banking Statistics of the Bank for International Settlements ("BIS"), which contains

[3] In some cases, the withholding tax rate may be reduced or eliminated by a double tax treaty between Switzerland and the home country of the depositor. In order to claim treaty benefits, however, depositors typically need to disclose their identity to the tax authorities in their home country (Sullivan, 2007). It is hence unlikely that double tax treaties played any role in the context of tax evasion by households.

[4] According to the statistical publication "Banks in Switzerland" available on the webpage of the Swiss central bank, fiduciary deposits with Swiss banks amounted to around CHF 291 billion in 2005 (line 38 — "fiduciary business: liabilities") whereas ordinary deposits amounted to around CHF 19 billion (line 32 — "liabilities toward customers in the form of savings and deposits").

information on assets and liabilities of banks vis-a-vis foreign counterparts. The data are based on reports from individual banks compiled and aggregated by central banks and transmitted to the BIS. Currently, a total of 41 jurisdictions report banking statistics including most OECD countries and all major offshore financial centers (see the Table A1 in the Appendix for a complete list). For most reporting countries, our dataset covers the period from the fourth quarter of 1995 ("1995q4") to the first quarter of 2008 ("2008q1"), however, some countries started reporting later. Observations are end-of-quarter and report values in US dollars.

We are ultimately interested in the behavioral responses to the Savings Directive and therefore construct a deposit measure that matches the tax base of the withholding tax as closely as possible. Specifically, we construct the variable $deposits_{bst}$ defined as the USD value of deposits in banks in country b held by the non-bank sector in country s at time t.[5] The measure is constructed so as to exclude other liabilities than deposits since income from the corresponding assets may not qualify as interest under the Savings Directive and inter-bank deposits since the withholding tax only applies to interest income earned by households. Importantly in the Swiss context, $deposits_{bst}$ includes both ordinary deposits and fiduciary deposits. For certain reporting countries, the breakdown of liabilities on counterpart countries is known by the BIS but confidential and not included in our dataset, hence $deposits_{bst}$ cannot be constructed for these countries.

Several features of the deposit data deserve mention. First, the sectoral breakdown does not allow for a distinction between subgroups within the non-bank sector, hence $deposits_{bst}$ aggregates deposits held by households and firms. This feature is undesirable because, as mentioned above, only the interest income of households is covered by the Savings Directive. To the extent that $deposits_{bst}$ overstates the true value of deposits held by households, it will cause our estimates of behavioral elasticities to be biased toward zero. Second, the deposit data are recorded on the basis of immediate rather than ultimate ownership. This implies that, for instance, Swiss deposits owned by a German household through a corporation in Panama are assigned to Panama in the statistics. Plausibly, most bank deposits assigned to offshore centers such as Panama and the British Virgin Islands are ultimately owned by residents of third countries.[6] Third, the deposit measure does not include the value of securities entrusted to custodian banks. Our results thus apply only to a single asset class covered by the Savings Directive (deposits) and we cannot study whether owners of other covered assets (e.g. bonds) responded similarly nor whether owners substituted covered assets for uncovered assets (e.g. shares).

Table 1 lists the 10 jurisdictions that attracted the largest stocks of foreign deposits in 2004. The list includes offshore centers such as Cayman Islands, Switzerland, Luxembourg, Singapore and Jersey. A significant share of deposits in the offshore centers may belong to households that evade taxes on interest income in their home countries. Other likely owners of bank deposits in offshore centers are firms with offshore operations, money market and hedge funds, many of which are based in Cayman Islands and Luxembourg, and non-evading households.

Table 1
Foreign deposits by banking country (USD bil.).

United Kingdom	882.0
United States	514.6
Cayman Islands	475.9
Germany	400.1
Switzerland	331.0
Luxembourg	165.2
Belgium	158.2
Singapore	141.0
Spain	134.3
Jersey	114.6
All BIS reporting banking countries	4224.9

Note: The numbers are deposits owned by the foreign non-bank sector averaged over the four quarterly observations in 2004.
Source: BIS Locational Banking Statistics, Table 3B.

Fig. 1 shows how the stock of foreign deposits in Swiss banks evolved during the period of 1995–2008. The vertical line indicates the implementation of the Savings Directive on 1 July 2005. A simple comparison of the total stock before and after 1 July 2005 does not reveal a negative effect of the Savings Directive. On the contrary, total deposits grew faster after 2005 than before. Since the Savings Directive only applies to EU households, it is natural to compare deposit stocks for EU residents and non-EU residents separately. To avoid confounding effects of the EU enlargements, we depict the stock of Swiss deposits for the group of countries that were EU members throughout the period and the group of countries that remained outside the EU throughout the period. While Swiss deposits owned by EU residents and non-EU residents grew at roughly similar rates until 2005, there was a noticeable drop in Swiss deposits held by EU residents around 2005 whereas Swiss deposits held by non-EU residents continued the increasing trend. This is essentially the variation that will drive our regression results.

The empirical analysis uses control variables from a number of sources: income, trade, inflation and interest rate data from the WDI, bilateral trade data from the OECD, interest data from the ECB, real exchange rate data from Darvas (2012) and tax data from the IBFD. We refer to the Table A2 in the Appendix for accurate data sources, precise definitions of variables and summary statistics.

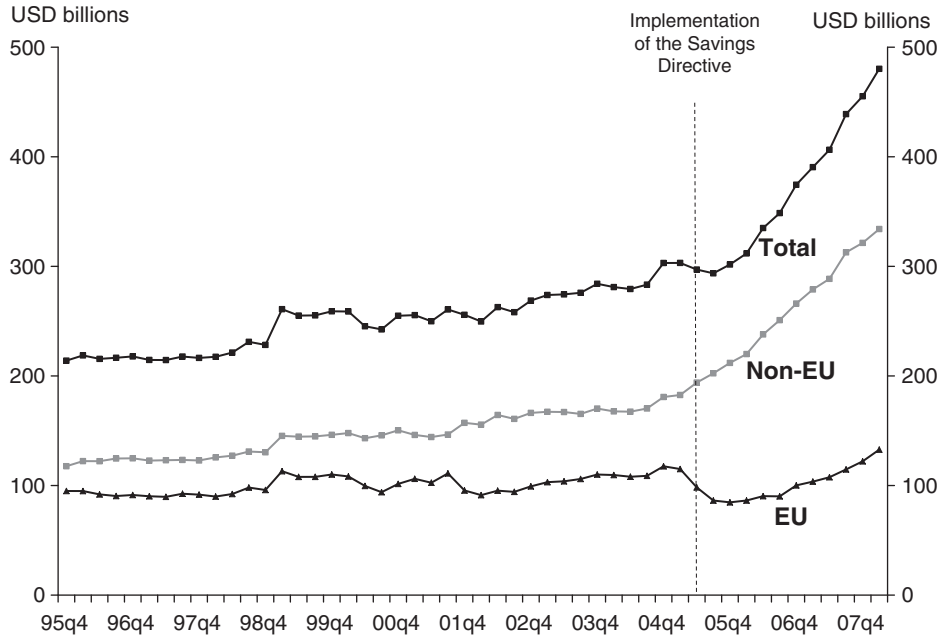
4. Empirical strategy

The aim of the empirical analysis is to estimate the effect of the Savings Directive on patterns of foreign deposits. The empirical strategy exploits that the Savings Directive changed the international tax environment facing EU residents while leaving non-EU residents unaffected. Intuitively, we use the post-2005 behavior of non-EU residents with foreign deposits to proxy for the counterfactual post-2005 behavior of EU residents with foreign deposits in the absence of the Savings Directive to estimate its causal effect on foreign deposits.

We estimate a number of different models, all of which share two characteristics. First, they employ fixed effects at the country pair level. A country pair consists of the country where the bank is resident ("host country") and the country where the deposit owner is resident ("home country"). The country pair fixed effects capture the effect of all time invariant determinants of foreign bank deposits such as bilateral distance, common language and time zone difference. Second, the models employ a set of time dummies that account for the general time trend in bank deposits. The time dummies capture the effect of all time-variant determinants of foreign bank deposits that apply uniformly to all countries such as technological progress in international banking and the financial crisis. Since the effect of the Savings Directive

[5] This corresponds to line 3B in the BIS Locational Banking Statistics with an additional breakdown on the counterpart country, which is not publicly available. The publication "Banks in Switzerland" from the Swiss central bank ("SNB"), however, contains bilateral information on ordinary deposits as well as fiduciary deposits with Swiss banks. Although the SNB data and the BIS data draw on the same underlying reports by Swiss banks, it is not possible to reconstruct the BIS data for Switzerland with the SNB data owing to the following three differences: Firstly, the SNB data are annual and not quarterly. Secondly, the SNB data lack observations for some jurisdictions. Thirdly, transactions between a Swiss bank acting as a fiduciary agent and its own foreign subsidiary are not reflected in the SNB data. Despite these qualifications, it is possible to construct a less precise measure of the tax base of the withholding tax by adding the SNB data on ordinary and fiduciary deposits. Applying our empirical framework to this publicly available measure of foreign deposits in Swiss banks yields results very similar to those reported in this paper.

[6] See Zucman (2013) for a thorough analysis of offshore assets held through sham corporations.



Note: The figure depicts total deposits in Swiss banks owned by foreign non-banks ("Total") as well as deposits owned by the 15 EU countries as of 1996 ("EU") and the non-EU countries as of 2008 ("Non-EU").

Source: BIS Locational Banking Statistics, Table 3B with additional breakdown on counterpart countries (not publicly available).

Fig. 1. Foreign deposits in Switzerland.

is estimated conditional on country pair fixed effects and time fixed effects, identification effectively comes from comparing the change in bank deposits with EU owners from pre-2005 to post-2005 to the change in bank deposits with non-EU owners over the same period. Our estimators are thus all variants of the difference-in-differences estimator.

We limit the sample in two dimensions to address two distinct empirical challenges. First, we exclude bank deposits that are recorded as belonging to offshore financial centers. As noted in the data section, the BIS statistics assign a significant share of deposits in offshore banking centers such as Switzerland to owners in other offshore centers such as Panama and the British Virgin Islands, which most likely reflects the use of sham corporations. Moreover, the Savings Directive may have increased the use of these sham corporations because transferring the ownership of bank deposits to an offshore corporation is a simple way for EU residents to escape the withholding tax. If the comparison group of non-EU countries would include Panama, the British Virgin Islands and other offshore centers for which the observed stock of Swiss deposits increased as a result of this technique, it would lead to a bias in the difference-in-differences estimates.[7] Second, we exclude bank deposits owned by the 12 countries that entered the European Union during the period of 2004–2007.[8] The new member states adopted important agreements between the EU and Switzerland on free trade, free movement of persons and free movement of capital almost simultaneously with the implementation of the Savings Directive. Since the former agreements had a potentially large effect on bank deposits held in Switzerland and we cannot credibly disentangle these effects from the effect of the Savings Directive, we exclude these countries from the sample.[9] Hence, when we refer to the full sample of home countries in the remainder of the paper, we mean all countries in the world except offshore financial centers and the 12 countries joining the EU between 2004 and 2007.

Finally, it should be emphasized that we rely crucially on the assumption that non-EU residents are unaffected by the Savings Directive. Although the Savings Directive does not directly apply to non-EU residents, it is conceivable that non-EU residents were affected by general equilibrium effects. For instance, if the Savings Directive induced EU households to reduce deposits in Swiss banks, the latter may have responded by raising deposit rates, which, in turn, may have affected stocks of foreign deposits. This particular possibility should not be a major concern since changes in Swiss deposit rates are picked up by the time fixed effects thus leaving the difference-in-difference estimator unbiased. More generally, we expect general equilibrium effects to be negligible since deposits of EU residents constitute a relatively small fraction of the total balance sheet of Swiss banks.[10]

5. Time trends in Swiss bank deposits

As a first step of the empirical analysis, we estimate the following simple model:

$$log(deposits_{st}) = \alpha + \mu\Omega_s + \gamma\Omega_t + \lambda\Omega_t \times EU_s + \varepsilon_{st} \quad (1)$$

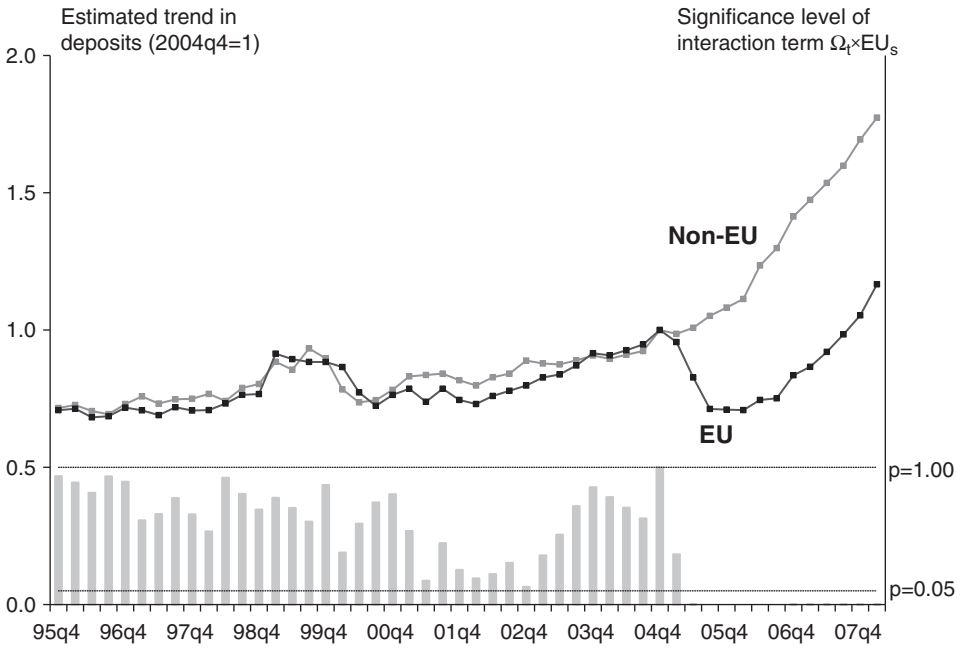
where $deposits_{st}$ is deposits in Swiss banks owned by residents of country s at time t; Ω_s is a vector of dummy variables for each home country in the sample (country fixed effects); Ω_t is a vector of dummy variables

[7] Indeed, when deposits recorded as belonging to offshore centers are included in the sample, the estimated effect of the Savings Directive on Swiss deposits is generally larger (more negative) than when they are excluded.

[8] Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia became EU member states on 1 May 2004, Bulgaria and Romania on 1 January 2007.

[9] In a previous version of the paper, we estimate the impact of the Savings Directive for the group of new member states separately (Johannesen, 2010). The results indicate that Swiss deposits owned by the new EU member states dropped significantly relative to the comparison group in the quarter immediately before and after the implementation of the Savings Directive but subsequently recovered.

[10] According to the statistical publication "Banks in Switzerland" published by the Swiss central bank, ordinary deposits and fiduciary deposits owned by EU residents constituted around 2% of the total balance of Swiss banks in 2005.



Note: Lines indicate trends in deposits$_{st}$ as captured by coefficients on time dummies Ω_t and interaction terms $\Omega_t \times EU_s$, that is $\exp(\gamma_t)$ for Non-EU and $\exp(\gamma_t+\lambda_t)$ for EU (left axis). Columns indicate statistical significance levels of interaction terms $\Omega_t \times EU_s$ (right axis).

Fig. 2. Time trends in Swiss deposits.

for each period in the sample (time fixed effects); and EU_s is a dummy variable taking the value one when s is an EU country. Since the sample includes only one host country (Switzerland), the time fixed effects fully capture time-variant determinants of bank deposits at the global level and at the host-country level (e.g. Swiss interest rates) whereas the country fixed effects fully capture all time-invariant determinants of bank deposits (e.g. Swiss banking secrecy laws). The vector γ tracks the average time trend in Swiss bank deposits for non-EU residents whereas the vector λ measures how the time trend in Swiss deposits for EU residents differs from this average. The time trends are scaled to intersect at 2004q4, roughly the time at which political agreement on the Savings Directive was reached, by choosing this quarter to be the omitted time category. The model is estimated with OLS with standard errors robust to serial correlation at the host country level.

Fig. 2 illustrates the results (regression output is reported in the Table A3 in the Appendix). The two lines represent the estimated trends in Swiss deposits held by EU countries and non-EU countries respectively whereas the columns indicate the statistical significance level of the interaction terms $\Omega_t \times EU_s$. There is a remarkable similarity in the time trends in the pre-2005 period followed by a striking and highly statistically significant divergence in 2005. Clearly visible signs of divergence appear between observations 2005q1 and 2005q2, that is between 1 April 2005 and 30 June 2005, and strong divergence continues between observations 2005q2 and 2005q3, that is between 1 July 2005 and 30 September 2005. In subsequent quarters, the two trend lines again have roughly similar slopes suggesting that the Savings Directive gave rise to a permanent level shift in deposits owned by EU countries.

While the results are strongly suggestive of a large and sharp response to the Savings Directive by EU residents with Swiss deposits, the model has a number of limitations: (i) it does not include time-variant determinants of Swiss deposits at the home-country level; (ii) it does not control for exchange rate fluctuations, (iii) it uses a comparison group that includes many developing countries; and (iv) it uses the log of deposits as dependent variable and therefore effectively discards zero-observations. The next section enhances the model along these dimensions.

6. Results: the size and timing of the behavioral response

6.1. Baseline model

The following baseline model goes some way toward addressing the limitations listed above:

$$log(deposits_{st}) = \alpha + \mu\Omega_s + \gamma\Omega_t + \beta EU_s \times POST_t + \delta \mathbf{X}_{st} + \varepsilon_{st} \quad (2)$$

where $POST_t$ is a dummy variable taking the value one in all periods after implementation of the Savings Directive (2005q3 and onwards). Like (1), this model includes time fixed effects and country fixed effects, but differs in two other important respects. First, instead of estimating how the time trend of EU countries deviates from the general time trend in each period, it includes the interaction term $EU_s \times POST_t$ which measures the average deviation from the general time trend in post-implementation periods. Second, it includes a set of covariates denoted by X_{st}. This is the standard multi-period difference-in-differences regression framework (Angrist and Pischke, 2009).

The set of covariates comprises the following variables: (i) the gross domestic product of the home country ("GDP"); (ii) the value of the trade between Switzerland and the home country ("Trade"); (iii) the deposit interest rate in the home country; ("Deposit rate") (iv) the real exchange rate in the home country ("Real exchange rate"), and (v) the top marginal tax rate on interest income in the home country ("Net-of-tax rate").[11] We refer to the Table A2 in the Appendix for data sources, precise definitions and summary statistics. These variables can all be expected to affect the demand for foreign bank deposits: Higher income should increase demand for all classes of financial assets including Swiss bank deposits; more trade with Switzerland should increase demand for Swiss bank deposits to the extent that importing and exporting firms rely on Swiss banks to facilitate transactions; a higher deposit interest rate

[11] The tax rate data are only available for the sample of OECD countries.

in the home country should reduce demand for Swiss bank deposits by inducing investors to substitute from foreign toward domestic bank deposits; currency appreciation implies an increase in domestic wealth, which should increase demand for foreign assets including Swiss bank deposits; and higher taxes on interest income should increase demand for assets that facilitate evasion including Swiss bank deposits. Including these variables in the model thus ensures that the estimated drop in Swiss deposits is not driven by lower income growth in EU countries than in non-EU countries, lower trade growth between Switzerland and EU countries than between Switzerland and non-EU countries, increases in deposit interest rates in EU countries relative to non-EU countries, depreciation of EU currencies relative to non-EU currencies and tax reductions in EU countries relative to non-EU countries.

The sample period is 2003q1–2007q4, which includes 6 quarterly observations before and 6 after the implementation of the Savings Directive. The relatively short time window increases the power of the fixed effects and reduces the risk that serial correlation causes standard errors to be underestimated despite the clustering at the country-pair level (Bertrand et al., 2004).

In Table 2, column (1) and (2) show the regression results with and without covariates for the full sample. The estimated effect of the Savings Directive is around −36% in the specification without covariates and drops to around −29% when covariates are included. Except the deposit rate, all covariates have the expected sign but are far from statistical significance. As a robustness test, we add the interaction term $EU_s \times time$, which allows the growth rate in Swiss deposits owned by EU residents and non-EU residents to differ by a constant and thus ensures that the estimated treatment effect does not simply pick up a lower secular growth rate in Swiss deposits owned by EU residents (Angrist and Pischke, 2009). As shown in column (3), the estimated treatment effect goes up to around 30% in this specification. The added interaction term is very far from statistical significance suggesting that the average quarterly growth rate in Swiss deposits does not differ between EU residents and non-EU residents conditional on the covariates and the level effect of the Savings Directive.

A potential concern with these results is that they effectively rely on a comparison between developed EU countries and a control group consisting mostly of developing countries. A more similar control group would arguably reduce the risk that the estimated impact of the Savings Directive picks up the effect of other shocks that coincided with the Savings Directive and affected EU countries and comparison countries differently. As shown in columns (4)–(6), the estimated effect of the Savings Directive effect tends to increase slightly when the sample is restricted to comprise only OECD countries.

A recent influential paper notes that log-transformations of constant-elasticity models have two distinct disadvantages (Silva and Tenreyro, 2006). First, zero-observations are effectively dropped. Second, the log-transformation introduces a bias in the presence of heteroscedasticity. The paper suggests that constant-elasticity models are estimated in their multiplicative form using a pseudo-maximum-likelihood estimation technique, which allows zero-observations to be retained and eliminates the potential bias. The proposed estimator is identical to the Poisson pseudo-maximum-likelihood estimator and is easily implemented with standard statistical software.[12] Columns (7)–(12) display the results for all 6 specifications previously considered but estimated in their multiplicative form. The estimated treatment effects tend to be slightly smaller than the OLS estimates in the log-linear framework but remain highly statistically and economically significant in all specifications. Note that including zero-observations generally has a very modest effect on sample size and no effect at all in the OECD sample.

[12] In stata, for instance, the fixed effect Poisson pseudo-maximum-likelihood estimator is implemented with the command xtpoisson.

6.2. Dynamics

This section studies the dynamics of the behavioral response to the Savings Directive by augmenting the baseline models with a set of interaction terms $EU_s \times impl_\tau$ where $impl_\tau$ is a dummy variable indicating time relative to implementation of the Savings Directive on 1 July 2005. Hence, $impl_{-3}$ takes the value one at 2004q4, $impl_{-2}$ at 2005q1 and $impl_{-1}$ at 2005q2 whereas $impl_{+1}$ takes the value one at 2005q3, $impl_{+2}$ at 2005q4 and $impl_{+3}$ at 2006q1. In this framework, the coefficient on $EU_s \times POST_t$ measures the long-run effect of the Savings Directive on Swiss deposits, coefficients on $EU_s \times impl_{+1}$, $EU_s \times impl_{+2}$ and $EU_s \times impl_{+3}$ measure how the short-run effects differ from the long-run effect while coefficients on $EU_s \times impl_{-1}$, $EU_s \times impl_{-2}$ and $EU_s \times impl_{-3}$ measure anticipatory effects. If the behavioral response took the form of a one-off adjustment of the deposit stock coinciding with the implementation of the Savings Directive, the coefficient on $EU_s \times POST_t$ measures the size of this response and the coefficients on $EU_s \times impl_\tau$ would all be zero. If EU residents reduced holdings of Swiss deposits prior to implementation of the withholding tax, these anticipatory effects would show as *negative* coefficients on $EU_s \times impl_{-1}$, $EU_s \times impl_{-2}$ and $EU_s \times impl_{-3}$. If EU residents reduced holdings of Swiss deposits gradually after implementation of the withholding tax, this gradual adjustment would show as *positive* coefficients on $EU_s \times impl_{+1}$, $EU_s \times impl_{+2}$ and $EU_s \times impl_{+3}$.

Table 3 reports results for eight different specifications, that is all combinations of log-linear and multiplicative models with and without covariates and employing the full and the OECD sample. The coefficients on $EU_s \times impl_{-3}$ and $EU_s \times impl_{-2}$ are generally very small and statistically insignificant suggesting that there was no anticipatory response before 1 April 2005. The coefficient on $EU_s \times impl_{-1}$ is in most specifications highly statistically significant with point estimates suggesting that the value of Swiss deposits owned by EU deposits dropped by 10%–20% between 1 April 2005 and 30 June 2005 in anticipation of the implementation of the Savings Directive on 1 July 2005. The coefficient on $EU_s \times impl_{+1}$ is small in most specifications and only in a single specification does it reach borderline statistical significance. Together with the statistically insignificant coefficients on $EU_s \times impl_{+2}$ and $EU_s \times impl_{+3}$, this suggests that the entire behavioral response had taken place already by 30 September 2005. The full response as measured by the coefficient on $EU_s \times POST_t$ tends to be somewhat larger than in the baseline model with most specifications yielding estimates between −35% and −40%.

The results imply that we cannot statistically reject that the entire behavioral response to the Savings Directive occurred between 1 April 2005 and 30 September 2005. This confirms the visual impression from Fig. 2 that the response to the Savings Directive was both large and unusually sharp. Given the timing of the quarterly observations, the results are in fact consistent with the entire decrease in Swiss deposits taking place on the day before and the day of implementation of the Savings Directive.

6.3. Exchange rate fluctuations

The dependent variable in the baseline model $deposits_{st}$ measures the USD value of Swiss deposits owned by residents of country s at time t. To the extent that deposits are denominated in other currencies, the USD value is computed using the exchange rate at time t. This procedure may be a cause of concern since exchange rate fluctuations mechanically affect the deposit measure in a manner that may be correlated with exposure to the Savings Directive. Assume for instance that EU residents hold a larger share of their Swiss deposits on EUR-denominated accounts and a smaller share on USD-denominated accounts than non-EU residents. If EUR depreciated against USD around the time the Savings Directive was

Table 2
Baseline results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Model	Log-linear	Log-linear	Log-linear	Log-linear	Log-linear	Log-linear	Multiplicative	Multiplicative	Multiplicative	Multiplicative	Multiplicative	Multiplicative
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	PML	PML	PML	PML	PML	PML
Host	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland
Home	Full	Full	Full	OECD	OECD	OECD	Full	Full	Full	OECD	OECD	OECD
EU × POST	−0.4451***	−0.3375***	−0.3612***	−0.4417***	−0.4110***	−0.3654***	−0.4136***	−0.3561***	−0.3316***	−0.3835***	−0.3534***	−0.2840***
	(0.0000)	(0.0010)	(0.0000)	(0.0003)	(0.0003)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0012)	(0.0000)
EU × time			0.0025			−0.0048			−0.0028			−0.0072
			(0.7545)			(0.6309)			(0.7125)			(0.2785)
GDP (in logs)		0.3098	0.3145		2.3555*	2.3711*		0.5649	0.5408		2.2134	2.2031
		(0.1175)	(0.1222)		(0.0551)	(0.0538)		(0.1096)	(0.1616)		(0.2101)	(0.2157)
Trade (in logs)		0.0666	0.0667		−0.1898	−0.2033		0.0308	0.0323		0.0933	0.0754
		(0.5107)	(0.5108)		(0.5227)	(0.5201)		(0.8525)	(0.8453)		(0.6432)	(0.7221)
Deposit rate		0.0051	0.0050		0.0192	0.0197		0.0017	0.0022		0.0118	0.0130
		(0.4897)	(0.4994)		(0.1055)	(0.1004)		(0.7812)	(0.7160)		(0.5232)	(0.4770)
Real exchange rate		−0.0038	−0.0038		−0.0263*	−0.0265*		−0.0062	−0.0060		−0.0309	−0.0308
		(0.2419)	(0.2395)		(0.0708)	(0.0677)		(0.1780)	(0.2247)		(0.1418)	(0.1489)
Net-of-tax rate (in logs)					0.4704	0.4266					1.0514**	1.0347**
					(0.5962)	(0.6389)					(0.0204)	(0.0244)
Observations	3012	1809	1809	500	464	464	3139	1824	1824	500	464	464
R-squared	0.2563	0.3136	0.3137	0.4189	0.4820	0.4827						
Number of panel id	158	108	108	25	24	24	158	108	108	25	24	24
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response	−35.9%	−28.6%	−30.3%	−35.7%	−33.7%	−30.6%	−33.9%	−30.0%	−28.2%	−31.9%	−29.8%	−24.7%

Note: The dependent variable is the value of Swiss deposits held by savers of country *s* at the end of quarter *t*. The variable *EU* is a dummy taking the value one when country *s* belongs to EU15. The variable *POST* is a dummy taking the value one for observations after 1 July 2005. The variable GDP measures the gross domestic product of country *s*. The variable Trade measures total trade between Switzerland and country *s*. The variable Deposit rate measures the deposit interest rate in country *s*. The variable Real exchange rate measures the real effective exchange rate in country *s*. The variable net-of-tax rate measures one minus the tax rate in country *s*. The sample period is 2003q1–2007q4. In columns (1)–(6), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of country *s*. In columns (7)–(12), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust standard errors clustered at the level of country *s*. In columns (1)–(3) and (6)–(8), the sample consists of all countries, in columns (4)–(6) and (10)–(12) only OECD countries. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

Table 3
Dynamics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model	Log-linear	Log-linear	Log-linear	Log-linear	Multiplicative	Multiplicative	Multiplicative	Multiplicative
Estimator	OLS	OLS	OLS	OLS	PML	PML	PML	PML
Host	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland
Home	Full	Full	OECD	OECD	Full	Full	OECD	OECD
$EU \times POST$	−0.4909***	−0.3511***	−0.4730***	−0.4610***	−0.4396***	−0.3907***	−0.4110***	−0.3944***
	(0.0000)	(0.0065)	(0.0013)	(0.0012)	(0.0000)	(0.0014)	(0.0002)	(0.0033)
$EU \times impl_{-3}$	0.0129	0.0451	0.0331	0.0170	0.0218	0.0227	0.0273	−0.0182
	(0.7993)	(0.3245)	(0.5198)	(0.7996)	(0.4356)	(0.3491)	(0.3955)	(0.6829)
$EU \times impl_{-2}$	−0.0052	0.0220	−0.0186	−0.0296	−0.0166	0.0001	−0.0064	−0.0410
	(0.9098)	(0.6866)	(0.7637)	(0.6947)	(0.5974)	(0.9992)	(0.9059)	(0.5177)
$EU \times impl_{-1}$	−0.1761***	−0.1086	−0.1873***	−0.1790**	−0.2124***	−0.1966***	−0.1665***	−0.2059***
	(0.0041)	(0.1336)	(0.0041)	(0.0271)	(0.0000)	(0.0010)	(0.0094)	(0.0016)
$EU \times impl_{+1}$	0.1261*	0.0682	0.0551	0.1113	0.0663	0.0432	0.0873	0.0263
	(0.0635)	(0.3243)	(0.5207)	(0.1403)	(0.2555)	(0.5177)	(0.1115)	(0.7618)
$EU \times impl_{+2}$	0.0960	0.0066	0.0432	0.0616	−0.0014	−0.0115	0.0406	−0.0232
	(0.1381)	(0.9204)	(0.5087)	(0.3122)	(0.9779)	(0.8338)	(0.3024)	(0.7396)
$EU \times impl_{+3}$	0.0673	−0.0025	0.0422	0.0615	−0.0035	0.0063	0.0293	0.0429
	(0.1924)	(0.9561)	(0.5124)	(0.3453)	(0.9346)	(0.8814)	(0.4755)	(0.4588)
GDP (in logs)		0.2980		2.3671*		0.4864		2.1849
		(0.1450)		(0.0625)		(0.2159)		(0.2305)
Trade (in logs)		0.0668		−0.1981		0.0515		0.1222
		(0.5076)		(0.5170)		(0.7588)		(0.5706)
Deposit rate		0.0050		0.0194		0.0023		0.0135
		(0.4916)		(0.1049)		(0.7054)		(0.4665)
Real exchange rate		−0.0038		−0.0271*		−0.0059		−0.0315
		(0.2421)		(0.0705)		(0.2144)		(0.1472)
Net-of-tax rate (in logs)				0.3083				1.0278**
				(0.7502)				(0.0382)
Observations	3012	1809	500	464	3139	1824	500	464
R-squared	0.2577	0.3151	0.4272	0.4907				
Number of panel id	158	108	25	24	158	108	25	24
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response								
-At t = −1	−16.1%	−10.3%	−17.1%	−16.4%	−19.1%	−17.8%	−15.3%	−18.6%
-At t = +1	−30.6%	−24.6%	−34.2%	−29.5%	−31.2%	−29.4%	−27.7%	−30.8%
-Long-run	−38.8%	−29.6%	−37.7%	−36.9%	−35.6%	−32.3%	−33.7%	−32.6%

Note: The dependent variable is the value of Swiss deposits held by savers of country s at the end of quarter t. The variable EU is a dummy taking the value one when country s belongs to EU15. The variable $POST$ is a dummy taking the value one for observations after 1 July 2005. The variables $impl_\tau$ are dummies taking the value one τ observations after 1 July 2005. The variable GDP measures the gross domestic product of country s. The variable Trade measures total trade between Switzerland and country s. The variable Deposit rate measures the deposit interest rate in country s. The variable Real exchange rate measures the real effective exchange rate in country s. The variable net-of-tax rate measures one minus the tax rate in country s. The sample period is 2003q1–2007q4. In columns (1)–(4), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of country s. In columns (5)–(8), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust standard errors clustered at the level of country s. In columns (1)–(2) and (5)–(6), the sample consists of all countries, in columns (3)–(4) and (7)–(8) only OECD countries. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

implemented, this would have reduced the USD value of Swiss deposits held by EU residents relative to those held by non-EU residents.

To address this concern, we exploit that the dataset includes a currency breakdown of deposit stocks. Specifically, we let $deposits_{sta}$ denote the USD value of Swiss deposits denominated in currency a held by residents of country s at time t and run the baseline model with this currency specific deposit measure as dependent variable for each of the major currencies. To the extent that the effect of the Savings Directive estimated in the baseline model was caused by a sharp depreciation of the currencies preferred by EU residents relative to the currencies preferred by non-EU residents, we should find no effect of the Savings Directive in currency specific regressions.

Table 4 reports results for the log-linear model and the multiplicative model for each of the four major currencies, USD, EUR, GBP and CHF. The estimated treatment effect is statistically and economically significant in all cases but varies somewhat by currency and by model. The estimates tend to be numerically larger in the log-linear model than in the multiplicative model and are larger for deposits denominated in USD, EUR and GBP than for deposits denominated in CHF in both models.

6.4. Other cooperating offshore centers

Besides Switzerland, the BIS dataset contains bilateral deposit data for four other offshore banking centers that implemented the Savings Directive, namely Luxembourg, Jersey, Guernsey and the Isle of Man. In this subsection, we explore whether behavioral responses similar to those estimated for Switzerland occurred in these jurisdictions. We thus estimate the following model, which is a simple extension of the baseline model to include more host countries:

$$log(deposits_{bst}) = \alpha + \mu\Omega_{bs} + \gamma\Omega_t + \theta EU_s \times t + \beta EU_s \times POST_t + \delta \mathbf{X}_{st} + \varepsilon_{bst}. \quad (3)$$

Note that the fixed effects Ω_{bs} are now at the country-pair level and therefore continue to capture all time-invariant determinants of bank deposits in country b owned by residents of country s. Since no reliable bilateral trade data exists for Jersey, Guernsey and the Isle of Man, the trade variable now measures total foreign trade of the home country instead of bilateral trade between the home country and the host country.

Results are reported in Table 5. As shown in columns (1)–(4), the log-linear model consistently yields statistically significant estimates

Table 4
Exchange rates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model	Log-linear	Log-linear	Log-linear	Log-linear	Multiplicative	Multiplicative	Multiplicative	Multiplicative
Estimator	OLS	OLS	OLS	OLS	PML	PML	PML	PML
Host	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland
Home	Full	Full	Full	Full	Full	Full	Full	Full
Currency	EUR	USD	GBP	CHF	EUR	USD	GBP	CHF
EU × *POST*	−0.4578***	−0.3307***	−0.5017***	−0.1962***	−0.2998***	−0.3902***	−0.3617***	−0.0593*
	(0.0000)	(0.0005)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0023)	(0.0784)
EU × *time*	0.0092	−0.0101	−0.0163	0.0092	−0.0037	−0.0121*	0.0111	0.0003
	(0.3734)	(0.2761)	(0.2317)	(0.3542)	(0.7640)	(0.0931)	(0.3766)	(0.9675)
GDP (in logs)	0.0783	0.5632**	0.0693	−0.0174	0.9633	0.4838*	0.2571	0.6678
	(0.8000)	(0.0211)	(0.8787)	(0.9521)	(0.2768)	(0.0956)	(0.7608)	(0.3069)
Trade (in logs)	0.0797	0.1001	0.1489	0.0966	0.0270	0.0385	0.4075*	−0.2359*
	(0.3759)	(0.4536)	(0.1640)	(0.1385)	(0.8514)	(0.8539)	(0.0728)	(0.0571)
Deposit rate	0.0024	0.0020	0.0084	0.0163**	0.0033	0.0008	−0.0034	0.0248***
	(0.8061)	(0.8107)	(0.5110)	(0.0169)	(0.6778)	(0.8764)	(0.8467)	(0.0001)
Real exchange rate	0.0044	−0.0093**	0.0057	−0.0000	−0.0093	−0.0060	0.0070	−0.0038
	(0.4872)	(0.0227)	(0.4412)	(0.9977)	(0.3482)	(0.2084)	(0.4474)	(0.5867)
Observations	1727	1797	1370	1710	1791	1824	1517	1751
R-squared	0.2445	0.2343	0.3106	0.0618				
Number of panel id	106	108	85	101	106	108	85	101
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response	−36.7%	−28.2%	−39.4%	−17.8%	−25.9%	−32.3%	−30.4%	−5.8%

Note: The dependent variable is the value of Swiss deposits held by savers of country *s* at the end of quarter *t* denominated in currency *a*. The variable *EU* is a dummy taking the value one when country *s* belongs to EU15. The variable *POST* is a dummy taking the value one for observations after 1 July 2005. The variable GDP measures the gross domestic product of country *s*. The variable Trade measures total trade between Switzerland and country *s*. The variable Deposit rate measures the deposit interest rate in country *s*. The variable Real exchange rate measures the real effective exchange rate in country *s*. The sample period is 2003q1–2007q4. In columns (1)–(4), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of country *s*. In columns (5)–(8), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust errors standard clustered at the level of country *s*. In columns (1) and (5), currency a is euro, in columns (2) and (6) it is the U.S. dollars, in columns (3) and (7) it is British pounds and in columns (4) and (8) it is Swiss francs. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

Table 5
Responses in Luxembourg, Jersey, Guernsey and the Isle of Man.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model	Log-linear	Log-linear	Log-linear	Log-linear	Multiplicative	Multiplicative	Multiplicative	Multiplicative
Estimator	OLS	OLS	OLS	OLS	PML	PML	PML	PML
Host	Other SD	Other SD	Other SD	Other SD	Other SD	Other SD	Other SD	Other SD
Home	Full	Full	OECD	OECD	Full	Full	OECD	OECD
EU × *POST*	−0.2548***	−0.1712***	−0.3725***	−0.2244***	−0.2799*	−0.0689	−0.2954***	−0.0796
	(0.0000)	(0.0055)	(0.0000)	(0.0041)	(0.0682)	(0.4113)	(0.0047)	(0.3607)
EU × *time*		−0.0003		−0.0111		−0.0069		−0.0177**
		(0.9625)		(0.1335)		(0.3584)		(0.0287)
GDP (in logs)		0.0399		1.8444**		0.6984**		2.3547***
		(0.8594)		(0.0129)		(0.0118)		(0.0000)
Trade (in logs)		0.3081**		−0.8301*		−0.4208		−0.3940
		(0.0158)		(0.0870)		(0.1791)		(0.3780)
Deposit rate		−0.0035		−0.0179		−0.0139		−0.0699
		(0.7099)		(0.4125)		(0.1735)		(0.1133)
Real exchange rate		0.0007		−0.0164*		−0.0059		−0.0328***
		(0.8406)		(0.0505)		(0.1575)		(0.0001)
Net-of-tax rate (in logs)				0.0461				1.0469
				(0.9728)				(0.1126)
Observations	6198	5244	1852	1732	6844	5669	1856	1736
R-squared	0.1049	0.1032	0.1450	0.1435				
Number of panel id	354	300	94	90	354	300	94	90
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response	−22.5%	−15.7%	−31.1%	−20.1%	−24.4%	−6.7%	−25.6%	−7.7%

Note: The dependent variable is the value of deposits in banks in country *b* held by savers of country *s* at the end of quarter *t* where country *b* is Luxembourg, Jersey, Guernsey or the Isle of Man. The variable *EU* is a dummy taking the value one when country *s* belongs to EU15. The variable POST is a dummy taking the value one for observations after 1 July 2005. The variable GDP measures the gross domestic product of country *s*. The variable Trade measures total trade between country *s* and the rest of the world. The variable Deposit rate measures the deposit interest rate in country *s*. The variable Real exchange rate measures the real effective exchange rate in country *s*. The variable net-of-tax rate measures one minus the tax rate in country *s*. The sample period is 2003q1–2007q4. In columns (1)–(4), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of the country pair (b, s). In columns (5)–(8), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust standard errors clustered at the level of the country pair (b, s). In columns (1)–(2) and (5)–(6), the sample consists of all countries, in columns (3)–(4) and (7)–(8) only OECD countries. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

of the effect of the Savings Directive on bank deposits in Luxembourg, Jersey, Guernsey and the Isle of Man ranging from around −15% to around −30%. The multiplicative model yields similarly sized estimates in the simplest specification but the estimates become small and insignificant when covariates and the EU-specific exponential time trend are included as shown in columns (5)–(8).

A possible explanation for the smaller estimated reduction in bank deposits in these countries than in Switzerland is that the share of bank deposits owned by households is smaller. There exists no reliable breakdown of deposit ownership on the household sector, the corporate sector and the fund sector, however, the facts that Swiss banks manage a very substantial part of the global offshore wealth owned by households and that Luxembourg, Jersey, Guernsey and the Isle of Man all host a considerable fund industry could suggest that a relatively large fraction of bank deposits in Switzerland are owned by households whereas a relatively large fraction of bank deposits in Luxembourg, Jersey, Guernsey and the Isle of Man are owned by funds.

6.5. Implied behavioral elasticities

Most of our estimates suggest that the reduction in Swiss bank deposits caused by the Savings Directive was in the range of 30–40%. The 15% withholding tax reduced the net-of-tax rate on undeclared interest income from 1 to 0.85. Assuming that the entire response to the Savings Directive was driven by the 15% withholding tax applicable as from 1 July 2005, the implied elasticity of Swiss bank deposits with respect to the net-of-tax rate is therefore in the range of 2–2.5. The estimates of the reduction in bank deposits in Luxembourg, Jersey, Guernsey and the Isle of Man are in the range of 15–30%, which implies a smaller elasticity in the range of 1–2.

Two caveats apply: First, the withholding tax only affected the incentives of non-compliant households since firms were explicitly outside the scope of the Savings Directive whereas compliant households could easily avoid the tax by allowing banks to report information that would be self-reported anyway. This strongly suggests that the estimated 30–40% reduction in Swiss bank deposits derives entirely from the fraction of Swiss deposits owned by non-compliant households. If this is true, the elasticity of undeclared Swiss deposits with respect to the net-of-tax rate on undeclared interest income, which is the theoretical parameter of interest, is larger than the elasticity of total Swiss deposits reported above. Assume, for instance, that one half of the Swiss bank deposits initially belonged to evading households whereas the other half belonged to compliant households and firms that did not respond to the Savings Directive. In that case, the estimated 30–40% reduction in total Swiss bank deposits corresponds to a 60–80% reduction in undeclared Swiss bank deposits, hence an implied tax elasticity in the range of 4–5.

Second, while the Savings Directive introduced a 15% withholding tax on interest income in Switzerland, it also contained other provisions that may have affected stocks of Swiss bank deposits. On one hand, most EU countries adopted automatic exchange of information on interest income at the same time as Switzerland adopted the withholding tax. This may have induced some households with undeclared deposits in other EU countries to transfer these deposits into Switzerland either because the 15% withholding tax was preferable to home country taxation from a narrow tax perspective or because the funds derived from illicit activities such that anonymity was the overriding concern. This type of response implies that the true reduction in Swiss deposits caused by the withholding tax is even larger than suggested by our estimates. On the other hand, the Savings Directive provided for gradual increases in the withholding tax rate to 20% on 1 July 2008 and to 35% on 1 July 2011 and it is conceivable that the prospect of future rate increases contributed to the estimated drop in Swiss deposits. For instance, in the presence of convex variable adjustment costs at the household level, we should expect households to anticipate the rate increase on 1 July 2008 with reductions in Swiss deposits in the preceding quarters, which could, in principle, affect our estimates. The analysis of the introduction of the withholding tax on 1 July 2005 showing no measurable behavioral responses before 1 April 2005 suggests, however, that any anticipatory responses to the rate increase on 1 July 2008 occurred after 1 April 2008 and thus after the end of our sample period.

In sum, the reported elasticities underestimate the true responsiveness of evading households to the extent that our deposit measure includes deposits owned by compliant households and firms; underestimate it to the extent that assets were moved into Switzerland in response to the adoption of automatic information exchange in the EU; and overestimate it to the extent that the anticipated rate increase on 1 July 2008 contributed to decreases in Swiss deposits before 31 December 2007. On balance, we find it more likely that the reported elasticities underestimate than overestimate the true responsiveness of evading households.

7. Results: the nature of the behavioral response

The previous section established that the Savings Directive induced a large drop in bank deposits in Switzerland and other offshore centers cooperating with the European Union. While this evidence is consistent with several ways in which tax evaders may have escaped the withholding tax, it is also consistent with an increase in compliance through repatriation. This section aims to shed light on the nature of the behavioral responses underlying the considerable drop in EU-owned deposits in cooperating offshore centers, hence we address the following questions: Did EU depositors move funds to offshore banking centers not participating in the Savings Directive? Did they transfer their assets to offshore corporations to avoid the withholding tax? Or did they repatriate funds to their home country?

7.1. Deposit shifting to other jurisdictions

The main aim of this subsection is to investigate whether the Savings Directive caused EU residents with deposits in Switzerland and other cooperating offshore centers to transfer funds to non-cooperating offshore centers. We thus estimate a model similar to (3) except that we include deposit data for all 30 jurisdictions for which we have bilateral deposits data (see Table A1 in the Appendix for a complete list) and that the interaction term $EU_s \times POST_t$ is itself interacted with four different interaction terms: $STD_b \times OFC_b$; $(1 - STD_b) \times OFC_b$; $STD_b \times (1 - OFC_b)$; and $(1 - STD_b) \times (1 - OFC_b)$ where SD_b is a dummy indicating if the host country participates in the Savings Directive and OFC_b is a dummy indicating if the host country is an offshore center.

The basic idea underlying this specification is that all country pairs where the home country is an EU member state were "treated" by the Savings Directive but that the nature of the treatment differs along two dimensions: First, host countries cooperating under the Savings Directive received a direct and negative treatment in the sense that it became less attractive for EU households to own bank deposits in these countries whereas non-cooperating host countries received an indirect and positive treatment in the sense that it became relatively more attractive for EU households to own bank deposits in these countries. Second, offshore centers presumably received a quantitatively larger treatment than others since the Savings Directive effectively targets tax evaders that are likely to account for a larger share of deposit stocks in offshore centers. The specification thus allows for heterogeneous effects of the Savings Directive on EU owned deposits in four different types of host countries: (i) offshore centers cooperating under the Savings Directive (e.g. Switzerland and Luxembourg); (ii) other countries cooperating under the Savings Directive (e.g. Germany and France); (iii) offshore centers not cooperating under the Savings Directive (e.g. Macao and Panama); and (iv) other countries not cooperating under the Savings Directive (e.g. the US and Canada) where the comparison group continues to be non-EU residents with foreign deposits.

Table 6
Responses in all BIS-reporting countries.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model	Log-linear	Log-linear	Log-linear	Log-linear	Multiplicative	Multiplicative	Multiplicative	Multiplicative
Estimator	OLS	OLS	OLS	OLS	PML	PML	PML	PML
Host	All	All	All	All	All	All	All	All
Home	Full	Full	OECD	OECD	Full	Full	OECD	OECD
EU × POST × STD × OFC	−0.3073***	−0.4368***	−0.4883***	−0.5109***	−0.3689***	−0.3233***	−0.3867***	−0.2633**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0024)	(0.0001)	(0.0229)
EU × POST × (1 − STD) × OFC	0.3205	0.2122	0.1553	0.1442	1.3551***	1.3980***	1.3395***	1.4689***
	(0.2615)	(0.4615)	(0.5933)	(0.6214)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
EU × POST × STD × (1 − OFC)	0.1585***	0.0293	−0.0214	−0.0437	−0.0389	−0.0012	−0.0567	0.0523
	(0.0019)	(0.5713)	(0.7454)	(0.5224)	(0.7003)	(0.9891)	(0.5997)	(0.5804)
EU × POST × (1 − STD) × (1 − OFC)	0.0652	−0.0692	−0.1114	−0.1409	0.3294**	0.2757***	0.3116**	0.3290***
	(0.4023)	(0.3440)	(0.2082)	(0.1035)	(0.0138)	(0.0099)	(0.0251)	(0.0054)
EU × time		0.0193***		0.0013		−0.0004		−0.0085
		(0.0000)		(0.8181)		(0.9720)		(0.4227)
GDP (in logs)		0.2746***		0.9297*		0.3707		0.9581*
		(0.0088)		(0.0571)		(0.2328)		(0.0661)
Trade (in logs)		0.0246		−0.8634***		−0.3709		−0.3871
		(0.6966)		(0.0031)		(0.2013)		(0.3106)
Deposit rate		0.0059**		0.0140*		0.0142**		0.0162
		(0.0475)		(0.0958)		(0.0207)		(0.1376)
Real exchange rate		−0.0004		−0.0057		−0.0021		−0.0067
		(0.7952)		(0.3912)		(0.5543)		(0.3164)
Net-of-tax rate (in logs)				0.0111				0.6870
				(0.9855)				(0.1830)
Observations	44,430	37,481	12,738	11,896	51,628	42,675	13,437	12,517
R-squared	0.1120	0.1108	0.1511	0.1468				
Number of panel id	2737	2307	709	674	2672	2253	686	653
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response:								
-In OFCs in Savings Directive	−26.5%	−35.4%	−38.6%	−40.0%	−30.9%	−27.6%	−32.1%	−23.1%
-In OFCs outside Savings Directive	37.8%	23.6%	16.8%	15.5%	287.7%	304.7%	281.7%	334.4%
-In nonOFCs in Savings Directive	17.2%	3.0%	−2.1%	−4.3%	−3.8%	−0.1%	−5.5%	5.4%
-In nonOFCs outside Savings Directive	6.7%	−6.7%	−10.5%	−13.1%	39.0%	31.7%	36.6%	39.0%

Note: The dependent variable is the value of deposits in banks in country *b* held by savers of country *s* at the end of quarter t where country *b* can any of the 30 countries for which we have bilateral deposit data. The variable *EU* is a dummy taking the value one when country *s* belongs to EU15. The variable *POST* is a dummy taking the value one for observations after 1 July 2005. The variable *STD* is a dummy taking the value one if country b cooperates with the EU under the Savings Directive. The variable OFC is a dummy taking the value one if country *s* is an offshore financial center. The variable GDP measures the gross domestic product of country *s*. The variable Trade measures total trade between country *s* and the rest of the world. The variable Deposit rate measures the deposit interest rate in country *s*. The variable Real exchange rate measures the real effective exchange rate in country *s*. The variable net-of-tax rate measures one minus the tax rate in country *s*. The sample period is 2003q1–2007q4. In columns (1)–(4), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of the country pair (*b*, *s*). In columns (5)–(8), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust standard errors clustered at the level of the country pair (*b*, *s*). In columns (1)–(2) and (5)–(6), the sample consists of all countries, in columns (3)–(4) and (7)–(8) only OECD countries. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

Results are reported in Table 6. Throughout the 8 different specifications, the coefficient on $EU_s \times POST_t \times STD_b \times OFC_b$ is negative and highly significant with an implied treatment effect in the range from −25% to −40%. This is in line with the finding in Section 6 that bank deposits owned by EU residents in the 5 cooperating offshore centers in our sample, Switzerland, Luxembourg, Jersey, Guernsey and the Isle of Man, dropped significantly in response to the Savings Directive. The estimated responses are generally larger than those estimated in Section 6. The coefficient on $EU_s \times POST_t \times (1 - STD_b) \times OFC_b$ measures how bank deposits in the 2 non-cooperating offshore centers in our sample, Macao and Panama, responded to the implementation of the Savings Directive. This amounts to an indirect test of the hypothesis that EU residents with deposits in cooperating offshore centers shifted funds to non-cooperating offshore centers in response to the Savings Directive. The results are somewhat mixed. As shown in columns (1)–(4), the log-linear model yields sizable but statistically insignificant coefficients whereas, as shown in columns (5)–(8), the multiplicative model produces very large and statistically significant coefficients with an implied treatment effect in the range from 280% to 340%. The coefficient on $EU_s \times POST_t \times STD_b \times (1 - OFC_b)$ is small and insignificant except in column (1) suggesting that bank deposits in the other countries that adopted the Savings Directive were not affected. It is quite intuitive that a policy directly targeting tax evaders did not have large effects on deposits in countries where tax evaders were unlikely to invest their assets in the first place. Finally, the coefficient on $EU_s \times POST_t \times (1 - STD_b) \times (1 - OFC_b)$ measures how bank deposits in non-cooperating countries other than offshore centers responded to the implementation of the Savings Directive. Again, the results are somewhat mixed with the log-linear model producing small and insignificant coefficients and the multiplicative model producing economically and statistically significant coefficients with treatment effects in the range of 30%–40%. The latter result suggests that deposits from cooperating offshore centers such as Switzerland were shifted not only to non-cooperating offshore centers like Macau but also to other non-cooperating countries like the U.S. in response to the Savings Directive. This is consistent with the claim made by prominent tax professionals that the U.S. may serve as a tax haven for foreign households (Goulder, 2009).

What explains the remarkably large difference between the results of the log-linear model and the multiplicative model with regard to the coefficient on $EU_s \times POST_t \times (1 - STD_b) \times OFC_b$? Recall that one of the main differences between the two models is that zero-observations are effectively dropped in the log-linear model whereas

they are retained in the multiplicative model. In the case of the small offshore centers of Macao and Panama, several EU countries literally had zero bank deposits before the Savings Directive whereas deposit stocks surged to hundreds of millions of dollars at the time of implementation. This variation is reflected in the large estimate derived from the multiplicative model whereas it is not reflected in the small estimate derived from the log-linear model. The prevalence of zeroes suggests that this is indeed a case in which the estimates from the multiplicative model are more reliable than those from the log-linear model.[13]

Finally, when interpreting the evidence presented above, one should bear in mind that initial deposit stocks were much larger in the 5 cooperating offshore centers than in the 2 non-cooperating offshore centers, hence the estimated 30% drop in deposits in the former represents a much larger dollar amount than the estimated 300% increase in the latter.

7.2. Sham corporations

A common technique to ensure a high level of secrecy for tax evading households is to own undeclared financial assets through an offshore sham corporation. A number of offshore centers host specialized providers of inexpensive incorporation and domiciliation services. Offshore banks and wealth managers typically liaise directly with these providers of offshore corporate services, which makes implementation of offshore holding structures very straightforward for customers.

In the context of Swiss wealth management, several facts point to Panama and the British Virgin Islands ("BVI") as the most important jurisdictions for setting up holding companies. First, more than half of all Swiss bank deposits assigned to offshore owners in the BIS statistics are assigned to Panama and the BVI reflecting that the immediate owner but not necessarily the ultimate owner is resident in one of these two jurisdictions. Second, unlike other offshore centers to which the BIS statistics assign large stocks of Swiss bank deposits such as the Cayman Islands, the Bahamas and Hong Kong, there is neither an important financial sector nor a large fund industry in Panama and the BVI that could explain the large amounts of Swiss deposits assigned to these jurisdictions. Finally, corporate laws, notably in Panama, are highly conducive to secrecy by allowing foreigners to operate corporations in an essentially untraceable fashion.[14]

Since the Savings Directive applies to interest paid directly to EU households, it adds a motive for offshore holding structures besides secrecy. While an EU household with an undeclared Swiss bank account in its own name is subject to withholding tax on interest income under the Savings Directive, the tax can be avoided by acquiring a Panama corporation and transferring the ownership of the Swiss bank account to the corporation. This section investigates whether the reduction in EU-owned Swiss deposits to some extent reflects that ownership was transferred to offshore corporations.

In order to study this question, we need to modify the empirical strategy. So far, we have identified the effect of the Savings Directive by comparing EU residents to non-EU residents. To apply the same identification strategy to the use of holding structures, we would need to compare Swiss deposits held by EU residents through sham corporations to Swiss deposits held by non-EU residents through sham corporations. While we observe the total value of Swiss deposits held through Panama and the BVI respectively, we cannot distinguish those that ultimately belong to EU residents from those belonging to non-EU residents. Hence, the empirical strategy that we have used so far is not implementable.

Instead, we rely on other comparisons for identification purposes. In a first step, we simply compare bank deposits in Switzerland held through Panama/BVI to bank deposits outside the Savings Directive held through Panama/BVI. The difference-in-differences estimator relies on the identifying assumption that bank deposits in Switzerland held through Panama/BVI would have grown at the same average rate as bank deposits in non-cooperating financial centers held through Panama/BVI in the absence of the Savings Directive. To implement this strategy, we estimate the following equation:

$$log(deposits_{bst}) = \alpha + \mu\Omega_{bs} + \gamma\Omega_t + \beta CH_b \times POST_t + \varepsilon_{st} \quad (4)$$

where CH_b is a dummy variable indicating that the host country is Switzerland. The sample only consists of deposits assigned to Panama/BVI.

We provide separate results for deposits held through Panama and the BVI in Table 7. As shown in columns (1) and (2), the coefficient on $CH_b \times POST_t$ is positive and statistically significant for deposits held through Panama but insignificant for deposits held through the BVI. The results suggest that the Savings Directive caused a 129% increase in Swiss bank deposits held through Panama. To the extent that some Swiss deposits assigned to Panama are ultimately owned by non-EU residents who were unaffected by the Savings Directive, the result suggests an increase in EU-owned Swiss deposits held through Panama of more than 129%.

One concern is that these results could be driven by a general shock to Swiss bank deposits around the implementation of the Savings Directive. To address this concern, we include deposits assigned to other offshore financial centers than Panama/BVI in the sample and estimate the following equation:

$$log(deposits_{bst}) = \alpha + \mu\Omega_{bs} + \gamma\Omega_t + \psi SHAM_s \times POST_t + \chi CH_b \times POST_t + \beta CH_b \times SHAM_s \times POST_t + \varepsilon_{st}$$

where $SHAM_s$ is a dummy variable indicating that the home country is either Panama or the British Virgin Islands. The term $SHAM_b \times POST_t$ controls for a general shock to deposits from Panama/BVI around the implementation of the Savings Directive whereas the term $CH_b \times POST_t$ controls for a general shock to Swiss deposits assigned to offshore centers. The variable of interest is $CH_b \times SHAM_s \times POST_t$ which is a difference-in-difference-in-differences estimate of the effect of the Savings Directive on Swiss deposits held through Panama/BVI.

As shown in columns (3) and (4), the coefficient on $CH_b \times SHAM_s \times POST_t$ is positive and statistically significant for deposits held through Panama but insignificant for deposits held through the BVI. The results suggest that the Savings Directive caused a 95% increase in Swiss deposits held through Panama. As a robustness test, we add the terms $CH_b \times time$ and $SHAM_s \times time$, which allow the average deposit growth rate to differ between Switzerland and other host countries as well as between Panama/BVI and other home countries. As shown in columns (5) and (6), the coefficient on $CH_b \times SHAM_s \times POST_t$ is still highly statistically significant for deposits held through Panama with an implied treatment effect around 98% whereas there is still no significant effect for deposits held through the BVI. Finally, columns (7)–(12) display the results for all 6 specifications estimated in their multiplicative form. The results are very similar with slightly smaller but still statistically significant coefficients in regressions for Panama and insignificant coefficients in regressions for the BVI.

[13] To further investigate whether the relatively small coefficients on $EU_s \times POST_t \times (1 - STD_b) \times OFC_b$ in the log-linear model are indeed due to the omission of zero-observations, we have estimated the log-linear model with $log(deposits_{bst} + 1)$ as dependent variable. This allows us to retain zero-observations in the log-linear model at the cost of introducing another source of bias. This procedure leads to implied treatment effects on EU-owned deposits in non-cooperating offshore centers in the range of 180%–230%.

[14] As of 2005, foreign owners of Panama corporations were protected by confidentiality statutes prohibiting the disclosure of ownership and accounting information. Even Panama government authorities had no legal power to obtain this information for the purposes of assisting foreign governments (OECD; 2006).

Table 7
Sham corporations in Panama and the BVI.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Model	Log-linear	Log-linear	Log-linear	Log-linear	Log-linear	Log-linear	Multiplicative	Multiplicative	Multiplicative	Multiplicative	Multiplicative	Multiplicative
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	PML	PML	PML	PML	PML	PML
Host												
	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries	Switzerland and non-cooperating countries
Home	Panama	BVI	OFCs (exl BVI)	OFCs (excl Pan.)	OFCs (excl. BVI)	OFCs (excl Pan.)	Panama	BVI	OFCs (excl. BVI)	OFCs (excl Pan.)	OFCs (excl. BVI)	OFCs (excl Pan.)
CH × POST	0.8303**	0.0589	0.1413	0.1424	−0.0652	−0.0578	0.5722***	−0.2437	0.0771	0.0772	0.0557	0.0652
	(0.0252)	(0.8663)	(0.1768)	(0.1733)	(0.3980)	(0.4500)	(0.0000)	(0.6086)	(0.5779)	(0.5778)	(0.2994)	(0.2770)
SHAM × POST			−0.4652*	0.0281	−0.2479	0.1051			−0.1532	0.4142	−0.3507**	0.3281
			(0.0889)	(0.9273)	(0.1421)	(0.5879)			(0.2342)	(0.4190)	(0.0334)	(0.4926)
CH × SHAM × POST			0.6694**	−0.0917	0.6839**	−0.0907			0.4951***	−0.3445	0.4951***	−0.3433
			(0.0197)	(0.7739)	(0.0192)	(0.7787)			(0.0025)	(0.5095)	(0.0025)	(0.5099)
CH × time					0.0208**	0.0202**					0.0021	0.0012
					(0.0381)	(0.0429)					(0.8648)	(0.9137)
SHAM × time					−0.0232	−0.0078					0.0196**	0.0084
					(0.2260)	(0.7104)					(0.0410)	(0.2966)
Observations	153	148	3581	3576	3581	3576	176	168	4318	4310	4318	4310
R-squared	0.1560	0.2185	0.1083	0.1123	0.1100	0.1135						
Number of panel id	9	10	244	245	244	245	9	9	231	231	231	231
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response	129.4%	6.1%	95.3%	−8.8%	98.2%	−8.7%	77.2%	−21.6%	64.1%	−29.1%	64.1%	−29.1%

Note: The dependent variable is the value of deposits in banks in country *b* held by savers of country *s* at the end of quarter t where *b* is either Switzerland or one of the countries outside the Savings Directive. The variable *CH* is a dummy taking the value one when country *b* is Switzerland. The variable *SHAM* is a dummy taking the value one when country *s* is Panama or the British Virgin Islands ("BVI"). The variable *POST* is a dummy taking the value one for observations after 1 July 2005. The sample period is 2003q1–2007q4. In columns (1)–(6), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of the country pair (*b*, *s*). In columns (7)–(12), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust standard errors clustered at the level of the country pair (*b*, *s*). In columns (1) and (7), the sample only includes observations where country *s* is Panama. In columns (2) and (8) the sample only includes observations where country *s* is the BVI. In columns (3), (5), (9) and (11), the sample includes all countries s that are offshore financial centers except the BVI. In columns (4), (6), (10) and (12), the sample includes all countries *s* that are offshore financial centers except Panama. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

7.3. Compliance

There are two main ways in which the Savings Directive could induce an increase in compliance among tax evaders with deposits in Swiss banks. Either they could keep their funds on a Swiss bank account and allow the bank to disclose the interest income. In this case, no withholding tax applies but the Savings Directive requires the Swiss bank to report information on interest income to the Swiss tax authorities, which automatically transmits this information to the home country. Alternatively, they could repatriate their funds to a domestic bank. In this case, the Savings Directive does not apply but automatic reporting by the domestic bank typically ensures full compliance.

For EU households with financial assets in Switzerland, a dataset published by the Swiss government allows us to compute the fraction of interest income that was disclosed to the home countries under the voluntary disclosure clause of the Savings Directive and the (residual) fraction that was not disclosed and therefore hit by the 15% withholding tax. The average fraction of Swiss source interest income that was voluntarily disclosed across the 15 EU countries in our sample was around 6% in 2005 and gradually increasing to around 11% in 2007. This suggests a rather small compliance effect of the Savings Directive on the voluntary disclosure margin especially if one considers that individuals who were self-reporting Swiss source interest income prior to the Savings Directive are also likely to have activated the voluntary disclosure clause of the Savings Directive to avoid double taxation.

We also investigate to what extent the drop in Swiss deposits represents repatriation. We have no direct information on repatriated deposits and therefore take an indirect approach by exploiting that the tax cost of repatriating deposits varies across households as a function of the tax rate on interest income applied in the home country. For instance, Greece taxed interest income at the marginal rate of 10% in 2005, hence repatriating deposits from Switzerland after the introduction of the 15% withholding tax was associated with a *tax saving* of 5% for Greek households. By contrast, Denmark taxed interest income at rates up to 47%, hence Danish households in the top income tax bracket faced a steep *tax cost* of up to 32% on repatriation. If repatriation were the main explanation for the drop in Swiss deposits, we should expect to see larger drops for countries with low tax rates on interest income than for countries with high taxes. To test this hypothesis, we estimate the baseline model while allowing the effect of the Savings Directive to vary with the tax rate on interest income in the home country.

Results are reported in Table 8. First, we introduce an interaction between the treatment variable $EU_s \times POST_t$ and the top marginal tax rate on interest income. As shown in columns (1) and (2), the coefficient on the interaction term is positive but very far from statistical significance. Based on the point estimates in column (1), the

Table 8
Compliance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	MODEL: log-level	MODEL: log-level	MODEL: log-level	MODEL: log-level	MODEL: Poisson	MODEL: Poisson	MODEL: Poisson	MODEL: Poisson
	Saver: OECD	Saver: OECD	Saver: OECD	Saver: OECD	Saver: OECD	Saver: OECD	Saver: OECD	Saver: OECD
Variables	Bank: Swiss	Bank: Swiss	Bank: Swiss	Bank: Swiss	Bank: Swiss	Bank: Swiss	Bank: Swiss	Bank: Swiss
EU × POST	−0.5439**	−0.5569**	−0.4377***	−0.4020***	−0.5773***	−0.5873***	−0.3606***	−0.3186**
	(0.0446)	(0.0319)	(0.0001)	(0.0005)	(0.0022)	(0.0018)	(0.0005)	(0.0150)
EU × POST × log	0.3186	0.4478			0.6478	0.7713		
(net-of-tax-rate)	(0.6662)	(0.5566)			(0.2384)	(0.2045)		
GDP (in logs)		2.2502**		2.2086**		1.9062		1.7414
		(0.0121)		(0.0130)		(0.2658)		(0.2769)
Trade (in logs)		−0.1950		−0.1999		−0.0228		−0.0196
		(0.5370)		(0.5378)		(0.9289)		(0.9403)
Deposit rate		0.0074		0.0081		−0.0084		−0.0089
		(0.5476)		(0.5079)		(0.6969)		(0.6648)
Real exchange rate		−0.0260**		−0.0253**		−0.0298		−0.0273
		(0.0222)		(0.0263)		(0.1330)		(0.1473)
Net-of-tax rate (in logs)	−1.0386	−0.8122		−0.7332	−0.9851	−1.0502		−0.9874
	(0.2863)	(0.2877)		(0.3032)	(0.2582)	(0.1189)		(0.1260)
EU × POST × lowtax			−0.0087	−0.0684			−0.0712	−0.1257
			(0.9606)	(0.6555)			(0.6533)	(0.3496)
Constant	8.0653***	−46.1064*	7.7479***	−44.9908*				
	(0.0000)	(0.0642)	(0.0000)	(0.0710)				
Observations	500	464	500	464	500	464	500	464
R-squared	0.4493	0.4996	0.4190	0.4951				
Number of panel id	25	24	25	24	25	24	25	24
Country pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Implied response								
-At 10% tax rate	−40.1%	−40.1%			−40.1%	−40.0%		
-At 47% tax rate	−32.6%	−29.3%			−23.9%	−20.1%		
-Tax rate above median			−35.4%	−33.1%			−30.3%	−27.3%
-Tax rate below median			−36.0%	−37.5%			−35.1%	−35.9%

Note: The dependent variable is the value of Swiss deposits held by savers of country *s* at the end of quarter *t*. The variable *EU* is a dummy taking the value one when country *s* belongs to EU15. The variable *POST* is a dummy taking the value one for observations after 1 July 2005. The variable GDP measures the gross domestic product of country *s*. The variable Trade measures total trade between Switzerland and country *s*. The variable Deposit rate measures the deposit interest rate in country *s*. The variable Real exchange rate measures the real effective exchange rate in country *s*. The variable net-of-tax rate measures one minus the tax rate in country *s*. The variable *lowtax* is a dummy taking the value one if the tax rate of country *s* is below the sample median. The sample period is 2003q1–2007q4. In columns (1)–(4), the reported results are from OLS estimation of the log-linear model with robust standard errors clustered at the level of country *s*. In columns (5)–(8), the reported results are from pseudo-maximum likelihood estimation of the multiplicative model with robust standard errors clustered at the level of country *s*. In columns (1)–(2) and (5)–(6), the sample consists of all countries, in columns (3)–(4) and (7)–(8) only OECD countries. Constant terms are not reported. Statistical significance levels (p-values) are in parenthesis.

expected drop in Swiss deposits is around 40% when the owner faces a domestic tax rate on interest income of 10% (like Greece) whereas it is around 33% when the domestic tax rate is 47% (like Denmark). Second, we augment the baseline model with an interaction between the treatment variable $EU_s \times POST_t$ and the dummy variable $lowtax_{st}$ which takes the value one when the tax rate on interest income is below the sample median (27%). As shown in columns (3) and (4), the coefficient on the interaction term is essentially zero suggesting that the drop in Swiss deposits owned by households facing tax rates above and below the median is statistically indistinguishable. Finally, as shown in columns (5)–(8), estimating these models in their multiplicative form yields qualitatively similar results.

While these results are difficult to reconcile with the hypothesis that the drop in EU-owned Swiss deposits reflects repatriation of funds, they are perfectly consistent with the alternative hypothesis that it reflects the adoption of strategies to escape the withholding tax, for instance the shifting of deposits to jurisdictions not participating in the Savings Directive, the transfer of formal ownership of deposits to sham corporations, the substitution of deposits with structured finance products etcetera. To see this, note that for an EU household with Swiss deposits, the choice between (i) not responding to the Savings Directive and incurring a withholding tax cost of 15% and (ii) adopting one of the costly strategies to bring the effective tax rate to 0% is the same irrespective of the home country tax rate on interest income.

8. Concluding remarks

The Savings Directive is a European policy initiative, which targets offshore tax evasion by introducing a 15% withholding tax on interest income earned by EU households in Switzerland and a number of other offshore financial centers. The aims of this paper were, first, to estimate the size of the reduction in Swiss bank deposits induced by the Savings Directive and, second, to determine whether the reduction in Swiss deposits mainly reflected repatriation of funds or adoption of strategies allowing households to escape the withholding tax.

In the first part of the empirical analysis, we showed that the Savings Directive caused a sharp 30–40% reduction in Swiss bank deposits owned by EU residents. These estimates correspond to an elasticity of Swiss bank deposits with respect to the net-of-tax rate applying to undeclared interest income in the range of 2–2.5. For other cooperating offshore centers, Luxembourg, Jersey, Guernsey and the Isle of Man, we found that the Savings Directive caused a reduction in bank deposits of 15–30% corresponding to an elasticity in the range of 1–2. To the extent that the empirical deposit measure includes some bank deposits owned by compliant households and firms, both of which had no incentive to respond to the Savings Directive, the estimated elasticities underestimate the true responsiveness of non-compliant households.

In the second part of the empirical analysis, we presented evidence suggesting that the large decrease in Swiss deposits was driven by substitution toward untaxed alternatives to Swiss deposits rather than increased compliance. First, our preferred specifications indicated that the Savings Directive caused a considerable increase in EU-owned bank deposits in Panama and Macao suggesting that the reduction in Swiss bank deposits partly reflects shifting of deposits to offshore centers outside the Savings Directive. Second, we found that the Savings Directive caused a significant increase in Swiss deposits recorded as belonging to Panama suggesting that the reduction in Swiss deposits partly reflects shifting from directly held accounts to accounts owned through Panama holding structures. Finally, we found no significant correlation between the home tax rates of EU countries and the size of the behavioral response to the Savings Directive suggesting that repatriation plays a limited role in explaining the estimated reduction in EU-owned Swiss deposits.

Besides informing current debates about the Savings Directive, we believe that the results have more general implications for the fight against offshore tax evasion, notably by representing quantitative evidence that different offshore evasion strategies are highly substitutable. This is of large practical importance because many policies against offshore tax evasion take a partial approach and thus leave considerable scope for substitution. For instance, the Savings Directive applies only to specific types of evaded income (i.e. interest income) generated by assets held in specific ways (i.e. directly owned) in specific offshore centers (i.e. Switzerland and others). The empirical analysis showed clear signs of behavioral responses exploiting the latter two of these three margins to avoid the withholding tax. This suggests that substitution between evasion strategies can severely limit the effectiveness of policy measures with a narrow scope and thus suggests that governments should adopt anti-evasion measures with as broad a scope as possible.

Appendix

Table A1
List of BIS-reporting countries.

BIS reporting countries	Bilateral deposit data available	Reporting as of 1 July 2005	Cooperating under Savings Directive	Offshore Financial Center
In the sample:				
Australia	Yes	Yes	No	No
Austria	Yes	Yes	Yes	No
Belgium	Yes	Yes	Yes	No
Brazil	Yes	Yes	No	No
Canada	Yes	Yes	No	No
Chile	Yes	Yes	No	No
Denmark	Yes	Yes	Yes	No
Finland	Yes	Yes	Yes	No
France	Yes	Yes	Yes	No
Germany	Yes	Yes	Yes	No
Great Britain	Yes	Yes	Yes	No
Greece	Yes	Yes	Yes	No
Guernsey	Yes	Yes	Yes	Yes
India	Yes	Yes	No	No
Ireland	Yes	Yes	Yes	No
Isle of Man	Yes	Yes	Yes	Yes
Italy	Yes	Yes	Yes	No
Jersey	Yes	Yes	Yes	Yes
Luxembourg	Yes	Yes	Yes	Yes
Macao	Yes	Yes	No	Yes
Mexico	Yes	Yes	No	No
Netherlands	Yes	Yes	Yes	No
Panama	Yes	Yes	No	Yes
Portugal	Yes	Yes	Yes	No
Spain	Yes	Yes	Yes	No
Sweden	Yes	Yes	Yes	No
Switzerland	Yes	Yes	Yes	Yes
Taiwan	Yes	Yes	No	No
Turkey	Yes	Yes	No	No
United States	Yes	Yes	No	No
Not in the sample:				
Bahamas	No	Yes	Yes	Yes
Bahrain	No	Yes	No	Yes
Bermuda	No	Yes	No	Yes
Cayman Islands	No	Yes	Yes	Yes
Cyprus	Yes	No	Yes	Yes
Hong Kong	No	Yes	No	Yes
Malaysia	Yes	No	No	No
Netherlands Antilles	No	Yes	Yes	Yes
Norway	No	Yes	No	No
South Africa	Yes	No	No	No
South Korea	No	Yes	No	No

Note: The table shows that countries reporting to the BIS are excluded from the sample either because bilateral deposit data are not available (column 1) or because reporting started after 1 July 2005. The classification of countries as offshore financial centers follows Hines (2010) except that Ireland is not considered as an offshore financial center.

Table A2
Data sources and summary statistics.

Variable	Description	Availability	Mean	S.d.	Source
GDP	Gross domestic product	199 countries	283 billion	1110 billion	World Development Indicators
Swiss trade	Sum of exports to Switzerland and imports from Switzerland	207 countries	142 million	525 million	OECD Monthly Statistics of International Trade
Trade	Sum of exports and imports to the rest of the world	195 countries	59 billion	145 billion	World Development Indicators
Deposit rate	Deposit interest rate	174 countries	8.158	10.669	World Development Indicators complemented with the European Central Bank when available
Real exchange rate	Real effective exchange rates	178 countries	100.779	31.22	Darvas (2012)
Home country tax rate	Top marginal tax rate on interest income for a domestic household receiving interest income from a domestic bank	34 countries	0.283	.1377	International Bureau of Fiscal Documentation

Table A3
Time trends in Swiss deposits-regression output.

	Time dummy		Time dummy × EU	
Date	Coefficient	p-value	Coefficient	p-value
1995q4	−0.3340	0.0001	−0.0112	0.9350
1996q1	−0.3190	0.0001	−0.0190	0.8890
1996q2	−0.3500	0.0000	−0.0328	0.8140
1996q3	−0.3660	0.0000	−0.0111	0.9340
1996q4	−0.3140	0.0002	−0.0181	0.8950
1997q1	−0.2770	0.0007	−0.0691	0.6140
1997q2	−0.3120	0.0001	−0.0592	0.6600
1997q3	−0.2910	0.0001	−0.0393	0.7760
1997q4	−0.2880	0.0001	−0.0590	0.6570
1998q1	−0.2650	0.0006	−0.0799	0.5330
1998q2	−0.2990	0.0001	−0.0125	0.9240
1998q3	−0.2370	0.0014	−0.0324	0.8060
1998q4	−0.2190	0.0024	−0.0467	0.6920
1999q1	−0.1230	0.0692	0.0330	0.7780
1999q2	−0.1560	0.0185	0.0439	0.7040
1999q3	−0.0697	0.3120	−0.0539	0.6040
1999q4	−0.1090	0.0789	−0.0148	0.8710
2000q1	−0.2440	0.0005	0.0991	0.3790
2000q2	−0.3060	0.0000	0.0481	0.5890
2000q3	−0.2950	0.0000	−0.0283	0.7440
2000q4	−0.2460	0.0001	−0.0238	0.8040
2001q1	−0.1850	0.0006	−0.0556	0.5360
2001q2	−0.1790	0.0006	−0.1240	0.1740
2001q3	−0.1730	0.0008	−0.0677	0.4480
2001q4	−0.2020	0.0001	−0.0920	0.2530
2002q1	−0.2260	0.0000	−0.0880	0.1910
2002q2	−0.1890	0.0001	−0.0858	0.2220
2002q3	−0.1730	0.0006	−0.0771	0.3040
2002q4	−0.1180	0.0242	−0.1080	0.1290
2003q1	−0.1300	0.0065	−0.0599	0.3580
2003q2	−0.1340	0.0037	−0.0427	0.5090
2003q3	−0.1170	0.0034	−0.0213	0.7170
2003q4	−0.0975	0.0192	0.0091	0.8550
2004q1	−0.1110	0.0061	0.0143	0.7830
2004q2	−0.0941	0.0122	0.0176	0.7060
2004q3	−0.0798	0.0557	0.0255	0.6280
2005q1	−0.0141	0.6530	−0.0307	0.3660
2005q2	0.0082	0.8650	−0.1980	0.0006
2005q3	0.0502	0.3010	−0.3890	0.0000
2005q4	0.0786	0.0780	−0.4210	0.0000
2006q1	0.1070	0.0196	−0.4520	0.0000
2006q2	0.2110	0.0001	−0.5050	0.0000
2006q3	0.2610	0.0000	−0.5470	0.0000
2006q4	0.3460	0.0000	−0.5260	0.0000
2007q1	0.3880	0.0000	−0.5320	0.0000
2007q2	0.4290	0.0000	−0.5120	0.0000
2007q3	0.4690	0.0000	−0.4850	0.0001
2007q4	0.5270	0.0000	−0.4750	0.0002
2008q1	0.5730	0.0000	−0.4190	0.0012
Observations	7411			
R-squared	0.202			
Number of panel id	160			

Note: Columns (2) and (3) report point estimates and p-values (based on robust and clustered standard errors) for the time dummies. Columns (4) and (5) report point estimates and p-values (based on robust and clustered standard errors) for the time dummies interacted with the dummy variable *EU*. Constant terms not reported.

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