The deterrence effect of whistleblowing*

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Abstract

We document that the first leak of customer information from a tax haven bank caused a sudden flight of deposits from tax havens and a sharp decrease in the market value of banks known to be assisting with tax evasion. The loss of market value was largest for the banks most strongly involved in tax evasion. Subsequent leaks had qualitatively similar although smaller effects. Our findings suggest that whistleblowing in tax haven banks deters offshore tax evaders by increasing the perceived risk of committing and assisting with tax evasion.

Keywords: whistleblowing, economic crime, tax evasion, tax havens

JEL codes: G21, H26, K42

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1 Introduction

In the digital age, whistleblowing affairs have become the order of the day. Anyone holding confidential information can easily make it available to the rest of the world by posting it online and organizations like *WikiLeaks* have specialized in receiving, processing and disseminating leaked information. Some celebrate whistleblowers as "the heroes of our time" who are "contributing to ethics and integrity" (UN, 2016) and whose legal protection is therefore an important concern for public policy (Economist, 2015). Others remain ambivalent about the overall benefits of whistleblowing highlighting its inherent unlawfulness (Delmas, 2015); the potential for fraudulent allegations (see Nyrerod and Spagnolo, 2018); and the adverse effect on effort in organizations (Ting, 2008).

At the heart of the positive view is the presumption that whistleblowing does not merely lead to sanctions against the individuals and companies whose illegal or immoral actions are exposed, but affects and improves behavior more broadly. For instance, Yuliya Stepanova revealing the existence of a large-scale Russian doping program may have deterred other athletes from using illicit drugs and former insider Abu Hamed exposing the identities of thousands of secretly enlisted jihadis may have discouraged other radical islamists from joining the Islamic State. Such effects would be consistent with standard economic theories of crime (Becker, 1968) where whistleblowing may deter criminal behavior by increasing the likelihood of legal and other social sanctions. Despite the importance for normative debates about whistleblowing, there is virtually no empirical evidence of such a *deterrence effect*.

In this paper, we provide empirical evidence on the deterrence effect of whistleblowing in the context of offshore tax evasion. Specifically, we investigate whether leaks of customer information from banks in tax havens deter the criminal use of offshore banking services. While bank accounts in tax havens are not illegal *per se*, they often serve to evade taxes, which makes account holders and sometimes also the bankers assisting with the tax evasion, liable to criminal prosecution.[1] Hence, for many owners of tax haven accounts as well as for bankers in tax havens, leaks of customer files involve a risk of legal

[1]Documents published in the context of a court case against the Swiss bank UBS show that around 90% of the bank's US customers were not tax compliant (US Senate, 2008). Besides hundreds of account holders, several UBS bankers were prosecuted for assisting with tax evasion including the whistleblower, Bradley Birkenfeld, and the head of the bank's global wealth management division, Raoul Weil.

sanctions if the information is acquired by the tax authorities and public humiliation if posted online.

Our main results concern the first whistleblowing affair exposing tax evasion in tax havens: customer files from *LGT Bank* in Liechtenstein were extracted by a former computer technician at the bank, Heinrich Kieber, and distributed to tax authorities in several countries.[2] The leak became publicly known on 14 February 2008, when German police raided the premises of Klaus Zumwinkel, the chief executive of Deutsche Post, and detained him on charges of tax evasion. It soon became clear that the charges were based on leaked customer files that also contained incriminating information about hundreds of other German tax evaders. The affair attracted global attention and was prominently covered by media such as The New York Times, Le Monde, Die Welt and El Pais in the following days.

In the first part of the analysis, we use country-level data from the Bank for International Settlements (BIS) to document that the data leak from *LGT Bank* coincided with a significant decrease in foreign-owned bank deposits in tax havens compared to other international banking centers. While cross-border deposits evolved very similarly in havens and non-havens before the leak, we observe a sharp divergence during the first quarter of 2008 with deposits in havens decreasing by more than 10% relative to deposits in non-havens. This striking pattern cannot be explained by concurrent tax enforcement efforts as the major initiatives to reign in offshore tax evasion took off around 6 months after the LGT leak.[3] Moreover, a range of robustness tests suggest that the estimate is not confounded by events related to the financial crisis.[4] Finally, since the BIS data covers almost all cross-border deposits in the world, also when owned through shell companies or trusts, our results are unlikely to reflect shifting of assets to more secretive tax havens or more sophisticated evasion techniques.[5]

[2]Banks in tax havens have been subject to other types of whistleblowing cases, for instance the leak of documents concerning Nazi accounts from the Swiss bank UBS in 1997.

[3]Notably, the legal cases against Swiss banks in U.S. courts, most famously the case against UBS, began in August 2008 and the crucial event in compelling tax havens to exchange information about suspected tax evaders occurred in April 2009 (Johannesen and Zucman, 2014).

[4]The main result is robust to controlling for asset price shocks (e.g. stock prices) and central bank initiatives to reign in the financial crisis (e.g. swap agreements). Moreover, we find no evidence of a decrease in interbank deposits, suggesting that the decrease in customer deposits is not caused by a confounding shock to financial institutions in tax havens.

[5]The LGT leak may have induced individuals holding a bank account in, say, Switzerland, to transfer ownership of the account to a fully-controlled corporation in, say, Panama to add a layer of secrecy

These results are thus consistent with a significant decrease in the use of criminal offshore banking services in response to the leak. Since offshore tax evasion had never previously been exposed in leaks, offshore account owners and bankers most likely did not account for this risk before the leak from LGT Bank.[6] Alternatively, they may have assigned a very small probability to the possibility of a leak and updated their beliefs about this probability the first time a leak occurred. In either case, an increase in the perceived probability of a leak should be expected to deter the demand and supply of criminal offshore banking services and reduce the stock of deposits related to evasion in tax havens. While we cannot exclude that the *LGT leak* also caused a decrease in legitimate foreign accounts, this mechanism does not explain why deposits decreased *differentially* in havens relative to non-havens.[7]

In the second part of the analysis, we study the deterrence effect of whistleblowing by analyzing stock market data. We use a standard event study framework to estimate the effect of the LGT data leak on the stock prices of banks with *known* links to offshore tax evasion. To the extent that the leak deterred the use of offshore accounts, and thus decreased the expected profits associated with criminal offshore services, we should observe an immediate drop in the market value of banks providing such services (Fama, 1991).[8] Since stock prices are available for each individual bank on each day, this data

between themselves and their assets. However, such responses do not affect our results, as the total foreign-owned customer deposits in the bank, the outcome entering our analysis, is unchanged. As we do not observe other asset classes than deposits, our results could, in principle, be explained by a differential change in the composition of portfolios. We note, however, that financial assets such as stocks and bonds do not generally offer better protection against data leaks than deposits, so it seems unlikely that leaks would trigger significant behavioral responses in this dimension. Precious metals, on the other hand, may offer opportunities for anonymous ownership, but account for a tiny fraction of the wealth managed in tax havens; for instance, less than 0.01% of fiduciary transactions conducted by Swiss banks concern precious metals (Swiss National Bank, 2020).

[6]Formal models of choice under uncertainty typically assume that decision-makers are aware of all possible outcomes, but unawareness has been studied theoretically in the literature on bounded rationality (e.g., Dekel et al., 1998).

[7]Some individuals with legitimate foreign accounts may have chosen to repatriate funds in response to the LGT leak because they drew negative inferences about the trustworthiness of their foreign banks. There are two reasons why this is unlikely to be the main mechanism underlying our first set of results. First, many different sources suggest that legitimate accounts constitute a small fraction of the wealth management business in tax havens (e.g. US Senate, 2008; Alstadsæter et al., 2019). Second, it is unclear why the loss of trust would be specific to banks in tax havens, i.e. why a data leak in Liechtenstein would reduce the overall trustworthiness of banks in, say, Luxembourg, Singapore and Bahamas relative to banks in Germany, France and Canada.

[8]A decrease in expected profits could derive either from the offshore banking market's demand side (an inward shift in the demand curve) or supply side (an outward shift of the cost curve), which in both cases would reflect a lower equilibrium quantity of offshore evasion.

source allows us to zoom in on a narrow time window around the data leak and compare individual banks with different involvement in offshore tax evasion, which mitigates concerns about confounding shocks in the analysis of cross-border deposits.

The analysis focuses on banks that have admitted to assisting U.S. taxpayers with tax evasion through offshore shell corporations and undeclared Swiss bank accounts. Starting with the famous case against UBS in 2008, the U.S. government has investigated 16 banks for their complicity in tax evasion leading to settlements with a combined value of more than $5.5 billion. Further, 80 banks have admitted to tax-related criminal activities in the U.S. under the *Swiss Bank Program*, which allows banks to resolve criminal liabilities through full disclosure of their cross-border activities and payment of appropriate penalties. From this gross sample of 96 banks with a known link to offshore tax evasion, our estimating sample includes the 46 banks that are listed on a stock exchange. Around half of the banks are Swiss banks while the remainder are based in other countries while offering wealth management services through a Swiss branch or subsidiary.

Our findings suggest that the LGT leak caused a significant decrease in the market value of banks involved in offshore tax evasion. The 46 banks in our sample tracked the normal return closely in the ten days preceding the leak, but earned an abnormal return of -2.2% over the first four days following the leak. The estimated stock market responses are larger and sharper when returns are weighted by market capitalization. In either case, the cumulative abnormal returns are statistically significant based on standard parametric tests as well as non-parametric tests comparing abnormal returns after the leak to the empirical distribution of abnormal returns in the pre-leak period.

These findings suggest that the leak from LGT Bank lowered expected future earnings of banks assisting foreign customers with tax evasion. This is consistent with markets perceiving the leak as an effective deterrent of offshore tax evasion and with the flight of deposits from tax havens observed in the first quarter of 2008. By contrast, the loss of market value is unlikely to reflect the anticipation of penalties. Since the LGT Bank is not part of our estimating sample, any anticipation in the markets that this bank would face penalties because of the secrets exposed in the leak should not affect our estimates. Moreover, the penalties ultimately paid by the banks were only a minor fraction of the

estimated loss of market value of around $27 billion.

A number of additional empirical tests support our interpretation of the main result. First, probing the robustness of our findings, we show that the estimated drop in stock prices remains when we control for confounding shocks to the Swiss financial sector by including the return earned by Swiss banks with *no* known links to offshore tax evasion in the model. Second, exploring the heterogeneity in stock market responses, we show that stock prices dropped significantly more for banks with a stronger involvement in offshore tax evasion, as measured by two distinct proxies.[9] Both findings are consistent with a causal link between the banks' loss of market value around the time of the LGT leak and their role in offshore tax evasion.

The results concerning the LGT leak raise the question whether subsequent leaks from tax havens had a similar deterrence effect. We study this question by manually searching all front pages of a major Swiss newspaper, *Neue Zürcher Zeitung*, between January 2008 and October 2016 and applying our empirical framework to the 12 other instances where an article covered a newly leaked list of customers at offshore banks or service providers or a significant new dissemination of such a list. These events include the leak from the bank *HSBC Switzerland* (later known as *Swiss Leaks*) and from the law firm *Mosack Fonseca* (known as *Panama Papers*). We find evidence of modestly sized deposit responses but only weak signs of stock market responses to these leaks. Overall, the results are suggestive that the very first leak led offshore account owners and bankers to incorporate the risk of whistleblowing into the calculus of tax evasion whereas subsequent leaks were associated with a much smaller, if any, updating of the beliefs about this risk.

While a number of studies have investigated which conditions are conducive to whistleblowing (Dyck et al., 2010), we are not aware of any existing quantitative evidence on the ability of whistleblowing to deter crime. Most relatedly, a large literature with contributions from scholars in law, economics and criminology explores the role of transparency and public information in deterring criminal behavior more broadly. For instance, legal scholars have argued that the public shaming of criminals is an efficient way to deter white-collar crime (Kahan and Posner, 1999) and economists have documented that pub-

[9] Our two proxies for the extent of a bank's involvement in offshore tax evasion are: (i) that U.S. prosecutors initiated an investigation of the bank and (ii) the ultimate size of the penalties paid to the U.S. government.

lishing individual-level information about reported taxable income reduces tax evasion (Bo et al., 2015).

Our study also contributes to an emerging literature investigating which factors shape offshore tax evasion, for instance, tax rates on capital income (Hanlon et al., 2015), tax enforcement (Johannesen and Zucman, 2014; Menkhoff and Miethe, 2019) and tax amnesties (Johannesen et al., 2020; Langenmayr, 2017). Our results suggest that the emergence of whistleblowers from the ranks of employees in tax haven banks has the potential to curb offshore tax evasion significantly. Some caution is warranted when making inference about the magnitude of the deterrence effect based on our estimates due to deposit shifting across foreign banking centers: To the extent that depositors shifted funds from havens to non-havens in response to the LGT leak, our estimate that deposits in havens dropped by 10% relative to deposits in non-havens overstates the true magnitude of the deterrence effect. For perspective, it is nevertheless useful to compare to the estimated 15% decrease in offshore deposits following the signature of bilateral information exchange treaties found in the literature (Johannesen and Zucman, 2014).

Finally, our study adds to an emerging literature studying how stock prices respond to data leaks and other news about tax aggressive behavior. For instance, O'Donovan et al. (2019) document that firms whose offshore affiliates were exposed in the *Panama Papers* suffered significant losses in market value when the leak was published and Hanlon and Slemrod (2009) show a similar pattern around news stories documenting firms' use of domestic tax shelters. While these papers are suggestive that media exposure of firms' aggressive tax planning may limit these firm's ability to avoid taxes in the future, they do not provide evidence of a broader deterrence effect extending beyond the specific taxpayers exposed in the media.

The paper proceeds in the following way. Section 2 provides background information about the institutional setting and whistleblowing in tax havens. Sections 3 and 4 report the analysis of deposit data and stock market data respectively. Section 5 concludes.

2 Background

2.1 Offshore tax evasion

A recent study estimates, exploiting systematic inconsistencies in international investment positions, that household wealth in tax havens globally amounts to at least $6,000 billion or, equivalently, around 8% of households' total financial assets (Zucman, 2013). Most of this wealth is held in Switzerland but there are other tax havens with major wealth management industries including Luxembourg, Singapore, Hong Kong and the Bahamas. While holding assets in a tax haven is perfectly legal if the account is disclosed to the tax authorities, a recent study finds, using leaked customer data from the bank HSBC Switzerland combined with tax return data from Denmark, Norway and Sweden, that the vast majority of the offshore wealth is, in fact, not disclosed (Alstadsæter et al., 2019). Moreover, the same study finds that the assets hidden in HSBC are extremely concentrated among the wealthiest and that as many as 50% of the Scandinavian households at the very top of the wealth distribution hide assets on offshore accounts. This figure is likely to be even higher in most other countries since Scandinavians own little offshore wealth by international standards (Alstadsæter et al., 2018). Together these studies suggest that offshore tax evasion is a fairly widespread criminal activity, at least in the wealthiest segments of the population, and a major challenge for policy.

In response to this challenge, governments have recently enacted a number of enforcement initiatives: in May 2005, the European Union agreed with a number of tax havens to tax the interest income accruing to accounts owned by European residents and remit the revenue to the home country (Johannesen, 2014); in August 2008, the U.S. Department of Justice started a series of legal cases against foreign banks, most famously the UBS, for their role in assisting U.S. citizens with tax fraud; in April 2009, the G20 compelled all tax havens in the world to accept a weak form of cooperation whereby they would lift the banking secrecy and provide information about account holders suspected of tax evasion when requested by foreign tax administrations (Johannesen and Zucman, 2014); and most recently, many tax havens have agreed to provide financial account information about foreign taxpayers on an automatic basis (De Simone et al., 2020; Casi et al., 2020;

Menkhoff and Miethe, 2019; Stolper, 2017; Omartian, 2016; Dharmapala, 2016).[10] In addition, many countries, including the U.S., now operate voluntary disclosure programs under which cooperating tax evaders benefit from reduced penalties and avoid criminal sanctions (Johannesen et al., 2020; Langenmayr, 2017).

2.2 Whistleblowing in tax havens

The offshore secrets of private individuals and multinational firms have been exposed numerous times in recent years by whistleblowers in banks (e.g. HSBC in Switzerland), accounting firms (e.g. PriceWaterHouseCoopers in Luxembourg), law firms (e.g. Mossack Fonsecka in Panama) and governments (e.g. corporate registry in the Bahamas). The secret documents leaked by the whistleblowers range from customer files related to offshore bank accounts and shell corporations to advance tax agreements between multinational firms and tax haven governments. Across the world, the exposures have had tangible consequences in the form of political leaders leaving office, wealthy individuals paying significant tax penalties and some of the world's largest firms facing public shaming over secret tax practices.

The offshore leaks have also sparked political debates about the legal status of whistleblowers. In some countries, in particular the United States, whistleblowers enjoy significant legal protection and can receive substantial monetary rewards from the government when the exposures help uncover tax fraud.[11] In many other countries, notably in tax havens, there is no legal protection of whistleblowers and governments often seek to prosecute them for violation of privacy laws.[12] In the European Union, recent offshore leaks have been instrumental for the decision to adopt a comprehensive protection of whistleblowers in 2019 (Abazi, 2020).

The main focus of this paper is the first instance of whistleblowing involving an offshore bank: the leak of customer data from the Liechtenstein-based LGT Bank. Accord-

[10] Account information is provided to the U.S. under the Foreign Account Tax Compliance Act (FATCA) and to other countries under the Convention on Mutual Assistance in Tax Matters as amended in 2014.

[11] For instance, the former banker and wealth manager Bradley Birkenfeld who blew the whistles on the Swiss bank UBS received a reward of $104 million from the U.S. Treasury because the exposures allowed the collection of more than $5 billion of unpaid taxes from U.S. tax payers (Givati, 2018).

[12] For instance, Heinrich Kieber who blew the whistles on LGT Bank was indicted by the Liechtenstein prosecutor and became "State Enemy Number One" (Time, 2011).

ing to journalistic accounts, the leak occurred in 2002 when a computer technician at the bank, Heinrich Kieber, extracted confidential customer information from the bank's IT systems. After leaving the bank, he approached the German intelligence agency in 2006 and ultimately sold them a CD-rom with information about the bank's customers in Germany for around €4.2 million. The data leak became publicly known on 14 February 2008 when the German police raided the premises of Klaus Zumwinkel, a prominent corporate executive, and detained him on charges of tax evasion after months of secret investigations. The case was immediately picked up by major media outlets, which also reported that the tax evasion scandal involved hundreds of further suspects. On 15 February, several news media reported that the German intelligence service, Bundesnachrichtendienst (BND), was involved in the case and, on 16 February, the German magazine *Der Spiegel* reported that BND had paid a whistleblower for the information leading to the arrest of Klaus Zumwinkel (Spiegel, 2008).

The LGT leak in 2008 was, to our knowledge, the first data leak from a tax haven to expose offshore tax evasion; however, several others followed in the subsequent years. We have systematically collected information about these leaks by manually searching all front pages of a major Swiss newspaper, *Neue Zürcher Zeitung*, published between January 2008 and October 2016. Concretely, we searched each front page for the keywords *Steuer* ("tax"), *Bank* ("bank"), *Info* ("information") and *Daten* ("data") and manually screened the headlines of all articles on the front pages. For every hit, we read the article to determine whether or not it referred to a data leak from a tax haven.[13] Finally, we searched the articles about data leaks for a reference to the date when the leaks became publicly known; when an article does not mention any date, we assume that the leak occurred one calendar day prior to the article's publication date. The implicit assumption underlying this approach is that data leaks with sufficient significance for banks operating in Switzerland to move their stock prices would be reported on the front pages of Swiss newspapers.

As detailed in Table 1, we identified 13 front page articles that concern new data

[13]We excluded all articles about the Hildebrand affair. Philipp Hildebrand is a former president of the Swiss National Bank whose wife bought more than half a million U.S. dollars in August 2011, just one month before the Swiss National Bank capped the exchange rate of the Swiss franc. While the Hildebrand affair was triggered by a bank employee leaking information of this transaction, the data leak was limited to Philipp Hildebrand and was never intended to identify any foreign tax evaders. A list of all other articles can be requested from the authors.

leaks or significant new dissemination of information from existing leaks. Several of the articles reported the major leak from HSBC Private Bank in Switzerland. First, on 30 August 2009, the French budget minister Eric Woerth announced that his ministry was in possession of a list of 3,000 French taxpayers holding a total of €3 billion in Swiss bank accounts, but he did not disclose the source of the leak. Then, on 9 December 2009, French media reported an alleged data theft at HSBC, which was confirmed on 13 December 2009, when *Hervé Falciani* revealed himself as the HSBC whistleblower on French prime time television. Eventually, in February 2015, the *International Consortium for Investigative Journalists* (ICIJ) gained access to the HSBC customer lists and published them as the *Swiss Leaks*, thereby exposing hundreds of prominent tax evaders to public scrutiny.

3 Analysis of deposits

3.1 Data

In this section, we study the deterrence effect of the LGT leak as well as subsequent whistleblowing cases using data from the Locational Banking Statistics of the Bank for International Settlements (BIS). This publicly available data source provides information on foreign-owned bank deposits in 47 international banking centers at a quarterly frequency.[14] Drawing on the list of non-cooperative jurisdictions published by the OECD at the eve of the first global crackdown on tax havens in 2009 (Johannesen and Zucman, 2014; OECD, 2009), we classify 18 of these banking centers as *havens* and the remaining 29 countries as *non-havens*.[15]. To our knowledge, the BIS data on cross-border deposits is the only aggregate statistic that captures activities in the wealth management sector

[14] An important property of the Locational Banking Statistics for our purposes is that it assigns deposits of multinational banks to the residence countries of the appropriate deposit-taking branches and subsidiaries. For instance, deposit accounts at HSBC Switzerland and HSBC London are assigned to Switzerland and the UK respectively.

[15] Our list of tax havens comprises the following countries: Austria, Bahamas, Bahrain, Belgium, Cayman Islands, Curacao, Cyprus, Guernsey, Hong Kong, Isle of Man, Jersey, Luxembourg, Macao, Malaysia, Netherlands Antilles, Panama, Singapore and Switzerland. These are all on the list of jurisdictions that had not implemented the global standard of international cooperation in tax matters published by the OECD prior to the G20 summit in April 2009 except for Macao and Hong Kong, which were omitted from the OECD list due to political pressure from China (see "G20 declares door shut on tax havens," *The Guardian*, 2 April 2009).

in a large number of tax havens.[16]

Importantly, the BIS data distinguishes between cross-border deposits that are owned by banks ("*interbank deposits*") and non-banks ("*customer deposits*"). We focus on customer deposits, which include deposits held by households for tax evasion purposes whether directly or through shell corporations. By contrast, interbank deposits are presumably entirely unrelated to offshore tax evasion. As shown in Table 2, cross-border customer deposits amounted to around $7,700 billion globally just before the LGT leak. Havens such as the Cayman Islands, Switzerland, Singapore and Luxembourg were among the largest banking centers in the world measured by this measure.[17]

3.2 Empirical model

Our goal is to investigate whether whistleblowing affairs in tax havens cause a decline in the use of secret offshore accounts. Our empirical strategy rests on the assumption that secret accounts are concentrated in banking centers where the legal environment enables secrecy and anonymity. This is precisely the defining feature of the 18 tax havens, who, often with reference to bank secrecy laws, refused to provide bank information to foreign tax administrations during our sample period.[18] By contrast, non-havens were generally committed to assisting foreign countries with tax enforcement through various forms of information exchange. The notion that secret accounts are concentrated in havens is consistent with evidence from many different sources that a large share of accounts in havens are not disclosed in the home country (Alstadsæter et al., 2019; US Senate, 2008; Londono-Velez and Avila-Mahecha, 2020)

These considerations motivate a empirical specification where the effect of leaks on deposits is estimated as the *differential* change in customer deposits in havens at the time of the leaks relative to the change in customer deposits in non-havens. The identifying assumption is that deposits in havens and non-havens are affected similarly by other

[16]The measure is used extensively in the emerging literature on offshore wealth (e.g. Andersen, et al. 2020; Casi et al, 2020; Menkhoff and Miethe, 2019; Andersen, et al. 2017; Johannesen and Zucman, 2014; Johannesen, 2014; Zucman, 2013)

[17]Note that assets such as bonds and shares are not included in the figures. The available evidence suggests that deposits account for around 25% of the total financial wealth managed in tax havens (Zucman, 2013)

[18]Many tax havens have later adopted more cooperative policies and are currently involved in automatic information exchange with foreign countries under the Foreign Account Tax Compliance Act (FATCA) and the Convention on Mutual Assistance in Tax Matters (CRS).

shocks (e.g. business cycles, exchange rate movements, monetary policy) and thus exhibit parallel trends absent shocks specific to the use of secret offshore accounts. This idea is formalized in the following baseline model:

$$\Delta \log(deposits_{it}) = \alpha_i + \gamma_t + \beta haven_i \times leak_t + \varepsilon_{it} \tag{1}$$

where $deposits_{it}$ denotes cross-border deposits in banking center i at the time of quarter t; $haven_i$ indicates that banking center i is a tax haven; and $leak_t$ indicates that a leak occurred in quarter t. The dependent variable is the (approximate) percentage change in deposits in a banking center. The banking center fixed effects α_i allow for differential secular trends in deposits across banking centers. The time fixed effects γ_t absorb any shocks to deposits that are common to havens and non-havens. The main coefficient of interest is β, which captures the differential change in haven deposits relative to the change in non-haven deposits at the time of a leak. Standard errors are clustered on banking centers to allow for autocorrelation in the error term.

We also estimate a dynamic version of the model that includes leads and lags of the leak indicator (all interacted with the haven indicator). This is important for two reasons. First, the leaded interactions allow us to assess whether deposits in havens and non-havens are on similar trajectories prior to a leak, as implied by the parallel trend assumption. Second, the lagged interactions inform us about the dynamic effects of a leak.

In robustness tests, we augment the baseline model with additional controls serving to absorb confounding shocks that may potentially affect deposits in havens and non-havens differentially. Notably, the financial crisis is a potential confounder with its severe impact on banks, firms and households through a host of different channels. First, monetary autorities in many countries concluded swap agreements with the U.S. Federal Reserve during the financial crisis to secure local banks' access to liquidity in U.S. dollars. To the extent that non-havens were more likely to conclude such agreements than havens, it may have caused a differential drop in deposits in havens through its effect on depositor confidence in local banking systems. We address this potential confounder by augmenting the baseline model with indicators for having a swap agreement in place interacted with time fixed effects: This allows for a differential effect of any shock depending on whether

a swap agreement is in place or not. Second, household balance sheets were adversely affected by large drops in asset prices, which may have caused a differential change in deposits in havens. For instance, households may have preferred to liquidate loss-making stock portfolios on declared accounts (in non-havens), so that losses could serve as a tax shield for other income, rather than on undeclared accounts (in havens). Similarly, commodity prices were highly volatile through the financial crisis, which may have caused significant shifts in global portfolios of foreign assets; for instance, because autocratic elites controlling oil revenues diverted funds to accounts in havens during the oil price boom (Andersen et al., 2017). We address these potential confounders by augmenting the baseline model with a vector of asset and commodity price changes interacted with the haven indicator.

Finally, it is important to note that, our estimates effectively conflate three conceptually distinct behavioral responses. As the model outcome is *net flows* to deposit accounts in a given banking center in a given period, a negative estimate of β may reflect an increase in *gross flows* out of existing deposit accounts in havens; a decrease in *gross flows* into existing deposit accounts in havens; or a decrease in *gross flows* into new accounts in havens. While we are unable to disentangle these three types of responses, we note that they are all consistent with the incentives created by an increase in the perceived risk of offshore evasion. Reducing the balance on offshore accounts in either of these three ways limits the exposure to tax penalties and criminal sanctions, which are typically an explicit function of evaded taxes with important discontinuities where penalty rates jump or a prison sentence is triggered.[19]

3.3 Results

Raw trends in deposits around the LGT leak

Before reporting the results from the baseline model, we inspect the raw trends in deposits around the LGT leak. For each banking center, we scale customer deposits with the value in 2007q4, immediately before the leak and display the mean value across havens (red line) and non-havens (blue) separately in Figure 1A.[20] Customer deposits evolved very

[19]Consistent with the first type of response, existing studies find that enhanced tax enforcement trigger significant repatriation of offshore funds (Johannesen et al., 2020).

[20]This analysis excludes 7 banking centers that started reporting after the beginning of the two-year

similarly in the two groups before the leak with steady quarterly increases. However, between the end of 2007q4 and the end of 2008q1, we observe a sharp divergence with a continued strong deposit growth in non-havens and close to zero growth in havens. This pattern suggests that the LGT leak deterred the use of offshore accounts for tax evasion purposes. We conduct the same exercise for interbank deposits, which presumably play no role in offshore tax evasion, and display the results in Figure 1B. Interbank deposits evolved very similarly in havens and non-havens throughout the period with no signs of divergence at the time of the LGT leak. If anything, interbank deposits grew slightly faster in havens than in non-havens during 2008q1. This suggests that the differential decrease in the customer deposits was *not* caused by a confounding shock to the financial sector in havens affecting all types of deposits. In the regression framework, we attempt to account for confounding shocks that are specific to customer deposits.[21]

Regression results

We report the main regression results from equation (1) in Table 3. The results imply that data leaks in tax havens are, on average, associated with a differential drop in customer deposits in havens of around 4.6%, as shown in Column (1). When we estimate the effect of the LGT leak and subsequent leaks separately, we find a striking heterogeneity, as shown in Column (2). The LGT leak was associated with a differential drop in customer deposits in havens of around 11.7% whereas the corresponding effect of the subsequent leaks was only, on average, around 3.6%. The difference is statistically significant with a p-value of 0.08 (reported at the bottom of the table).

We probe the robustness of these core results in a number of ways. First, we winsorize the dependent variable (at the 1st and 99th percentiles) and re-estimate the model to investigate whether the results are driven by extreme observations. As shown in Column (3), the point estimates decrease somewhat when the tails are removed, e.g. the estimate of the differential decrease in deposits in havens around the LGT leak falls to around 9.6%, but remains statistically significant. Second, we augment the model to allow for a differential effect of prices on oil prices, stock prices and gold prices on deposits in

window and 2 small banking centers with foreign-owned deposits below $1 billion. Hence, the sample comprises 38 banking centers, of which 15 are havens and 23 are non-havens.

[21] In Figure A1, we show the raw trend for each tax haven separately. While there is considerable variation across havens, our main results are not driven by a single large haven such as Switzerland.

havens. As shown in Column (4), the estimates barely change when we introduce the quarterly percentage change in the Brent Crude oil spot price interacted with the haven indicator. Similarly, the estimates are robust to introducing the percentage change in the S&P 500, as shown in Column (5), and the gold spot price, as shown in Column (6). When the baseline equation is augmented with all price controls simultaneously, as shown in Columm (7), the estimated effect of the LGT leak is -12%, slightly more negative than the baseline estimate, whereas the estimated effect of the subsequent leaks is 3.3%, slightly less negative the baseline estimate. Finally, the estimates are robust to allowing the effect of shocks to depend on the existence of a swap agreement with the U.S. Federal Reserve in place, as shown in Column (8).

Finally, we turn to the results from the dynamic specification with leads and lags of the leak indicators, each interacted with the haven indicator. As shown in Figure 2A, there is no evidence of a differential change in haven deposits *before* the LGT leak. This is consistent with the counterfactual parallel trends assumption that there would have been no differential change in haven deposits at the time of the LGT leak if the leak had not happened. The estimated differential drop in haven deposits at the time of the LGT leak is around 12% and statistically significant like in the baseline model. In the periods after the LGT leak, deposits in havens and non-havens exhibit similar growth rates, suggesting that the sharp drop observed around the leak was not reversed. As shown in Figure 2B, the qualitative pattern is very similar for the subsequent leaks, but the magnitude of the effects is smaller.[22]

The findings suggest that the first instance of whistleblowing in a tax haven, the leak from LGT, acted as a strong deterrent of offshore tax evasion, presumably by increasing the risk of involuntary exposure as perceived by account holders and banks. The subsequent leaks were also associated with significant behavioral responses, but of a much smaller magnitude. It is intuitive that the first data leak had a larger effect on the perceived risks than subsequent leaks since offshore account owners and bankers most likely assigned a very small - or even zero - probability to the possibility of a leak before this event.

We note that our estimate of the differential decrease in deposits in havens may

[22] We show similar results for interbank deposits in Figure A2 in the Appendix. We find no differential change in interbank deposits in havens, neither around the LGT leak nor around subsequent leak.

overstate the true magnitude of the deterrence effect if some depositors responded to the LGT leak by shifting funds from havens to non-havens. Under the parallel trends assumption, such responses imply that deposits in non-havens grew more than haven deposits would have grown absent the LGT leak. However, deposit shifting from havens to non-havens does not affect our qualitative conclusion. We can reject that deposits in havens and non-havens grew at the same rate, which is the implication of the null hypothesis of no deterrence.

Salience

An alternative explanation for the finding that the LGT leak triggered larger responses than subsequent leaks relates to differences in salience; perhaps the first leak received the most news coverage and was therefore known by more owners of offshore accounts. By construction, all the leaks in our sample were covered on the front page of *Neue Zürcher Zeitung*, but even within this sample of relatively salient leaks, important differences may remain.

To explore this alternative hypothesis, we analyze the volume of internet searches for four keywords relating to data leaks from tax havens: "Tax evasion", "Data leak", "Tax havens", and "Whistleblower". In the Appendix, we use the search volumes to construct a "salience index". While we do not believe that wealthy indivividuals obtain information about the international tax environment through simple searches, the index may capture the overall level of attention directed to the leak by the general public. As shown in the Appendix, the index does not detect any systematic difference in search volumes across the first leak and those that followed, suggesting that salience cannot explain the larger response to the first leak. More generally, we find no evidence that salience can explain heterogenous responses within our sample of leaks: when we augment the baseline model with an interaction between the leak indicator and the salience index, we find no significant difference in the size of the responses across leaks with different salience, as shown in Column (9) of Table 3.

3.4 Discussion

A potential problem with the empirical framework employed in this section is that data leaks from tax havens may correlate with unobserved determinants of cross-border deposits. Specifically, we study a period with prolific policy activity to combat offshore tax evasion both at the national and international levels, from the start of the U.S. case against UBS in August 2008 to the signing of bilateral tax treaties with tax havens in 2009-2010 and the gradual extension of automatic information exchange to tax havens in more recent years (see references above). Data leaks may coincide with enforcement initiatives either by chance or if whistleblowing is triggered by the increased public interest in offshore tax evasion created by enhanced enforcement. While we cannot generally rule out that our estimates are influenced by new enforcement policies targeting offshore evasion, it should be noted that the first leak from LGT Bank in February 2008 occurred 6 months *before* the first major policy event. This essentially rules out this source of endogeneity in the case of the LGT leak, which is our most important event, whereas some concern remains about the subsequent leaks.

Relatedly, the financial crisis in 2008-2009 may confound our results if, for some reason, it induced individuals with foreign assets to withdraw deposits from havens to a larger extent than from non-havens precisely in the quarters where the leaks occurred. The robustness tests controlling for asset prices, commodity prices and swap agreements as well as the analysis of interbank deposits go some way toward addressing this concern. We are less concerned about confounding events related to the financial crisis in the context of the first leak because it occurred several months *before* the collapse of Lehman Brothers in September 2008 and the ensuing meltdown of global financial markets.[23] However, we cannot generally exclude the possibility that unobserved shocks to customer deposits in tax havens affect our results.

In light of these concerns, there are at least two ways to improve the empirical identification of the deterrence effects of data leaks. First, analyzing data at a higher frequency makes it more plausible that no other important events coincided with the leaks. Second, analyzing data for individual banks makes it possible to formulate and test predictions

[23]For instance, as shown in Figure A3 in the Appendix, stock prices were relatively stable through 2008q1-2008q2 and only collapsed in 2008q3.

about the incidence of the leaks across heterogeneous banks, which is interesting in its own right and makes identification of the average effect more credible. Since no data source offers high-frequency information on foreign-owned wealth at the bank-level, the next section turns to another type of outcome that can be observed for each individual bank on a daily basis: stock-market returns.

4 Analysis of stock-market returns

In this section, we study the deterrence effect of whistleblowing by testing whether banks, known to be assisting with offshore tax evasion, suffered negative excess returns in the days following the LGT leak as well as the subsequent data leaks from tax havens. If the leaks caused a significant decrease in the use of secret bank accounts, as suggested by the analysis in the previous section, and if financial markets responded to these behavioral responses, we should expect an immediate decrease in the market value of banks deriving income from offshore tax evasion. In a first step, we discuss how the legal action in the U.S. against banks operating in Switzerland is helpful in delimiting a set of banks that were assisting with offshore tax evasion at the time of the LGT leak. In the next steps, we present the stock market data, develop the empirical methodology and present the results.

4.1 Bank sample

To assess how leaks of customer data affect the profitability of the wealth management industry, it is necessary to delimit a sample of banks with links to tax evasion. This task is not at all straightforward. First, not all banks in tax havens are actively managing the wealth of foreign tax evaders. Notably tax havens like Switzerland and Hong Kong with a sizable domestic economy also have important banks that mainly provide standard financial services to domestic customers. Second, not all banks catering to tax evaders are headquartered in tax havens. Many multinational banks based in non-havens offer wealth management services out of subsidiaries in tax havens, most famously the UK-based bank HBSC whose Swiss subsidiary was the source of the *Swiss Leaks*.

To delimit the bank sample, we exploit the measures taken by the U.S. Department

of Justice against banks suspected of assisting U.S. citizens with tax fraud involving anonymous shell companies and undeclared Swiss bank accounts. The first case, against UBS, ended with a $780 million settlement in February 2009 and another 15 banks were investigated on similar charges in the following years.[24] Eleven of these cases have been settled at the time of writing with combined penalties of $5.54 billion.[25] Subsequently, in August 2013, the U.S. Department of Justice and the Swiss government announced the *Swiss Bank Program,* under which banks not already under investigation could resolve potential criminal liabilities related to undeclared U.S.-owned accounts in Switzerland by satisfying a list of requirements, including full disclosure of their cross-border activities, cooperation with future information requests under the U.S.-Swiss double tax treaty and the payment of appropriate penalties. The program resulted in non-prosecution agreements with an additional 80 banks with combined penalties of around $1.36 billion.[26]

The U.S. enforcement initiatives are useful for our purposes because they identify a group of banks that derived income from assisting customers with offshore tax evasion at the time of the data leak from LGT Bank.[27] Following an increase in the risks associated with offshore tax evasion, we should expect precisely these banks to suffer a decrease in profits. Moreover, the outcomes of the enforcement initiatives allow us to make predictions about the heterogeneity in stock market responses *within* this sample of banks. First, if U.S. prosecutors chose to investigate the banks, which they believed *ex ante* were the most likely to be involved in offshore tax evasion and if market participants had similar beliefs, we should expect investigated banks to suffer larger market value losses than banks subsequently admitting to criminal offences under the Swiss Bank Program. Second, if *ex post* penalties contain a signal about the degree of involvement in offshore tax evasion and if that signal was at least partly observable to market participants at the time of the leak, we should expect market value losses to be larger for banks with higher penalties.

[24]We are not aware of an official list of all 16 banks under investigation, but they are mentioned in numerous news articles. One article that lists all the banks can be found on the Swiss public service news and information platform Swissinfo, see http://www.swissinfo.ch/eng/credit-suisse-fallout_remaining–hit-list–banks-sweat-over-us-verdicts/38637818 (last accessed on 15 February 2017).

[25]The cases against two banks – Pictet and Rahn & Bodmer – are still pending while three of the investigated banks – Wegelin, Neue Zürcher Bank, and Bank Frey – have ceased their operations.

[26]See https://www.justice.gov/tax/swiss-bank-program (last accessed on 15 February 2017).

[27]Of course, Swiss banks also assist taxpayers from other countries in evading taxes. In fact, most Swiss bank deposits are owned by Europeans (Zucman, 2013).

Starting from the gross sample of 96 banks that have been subject to criminal investigations in the U.S. or have participated in the Swiss Bank Program, we arrive at the estimating sample in the following steps. First, our empirical approach requires daily publicly available stock prices, so we disregard banks that are not listed on a stock exchange. When a bank in our sample belongs to a multinational banking group, we include the parent company if listed; for instance, the Swiss bank *HSBC Private Bank* is owned by the UK-based holding company *HSBC Holdings PLC*.[28] This procedure reduces the sample to 49 banks. Second, we exclude three entities that are classified neither as a bank nor as a financial services company under the Industry Classification Benchmark (ICB), as we do not expect the data leaks to be relevant for these firms.[29] Finally, we exclude a few banks for which no stock return can be identified in the week after the event under consideration. These are typically small banks whose stock is not traded every day. This procedure yields an estimating sample of 38 banks for the LGT leak in February 2008 and a similar sample size for other events.

Table A1 in the Appendix contains detailed information about all 46 banks that appear in the estimating sample at some point between 1 January 2007 and 31 October 2016 including an indication of whether banks were subject to criminal investigations or participated in the Swiss Bank Program as well as the size of the resulting penalty. Around half of the banks are based in Switzerland while the remainder are based in countries like Germany, France, Italy, Spain and the U.K., but offering wealth management services through a Swiss subsidiary.

4.2 Data

We use Bloomberg to collect financial information about the 46 banks in our estimating sample for the period 1 January 2007 to 31 October 2016. We calculate the daily return on each stock as the simple rate of return of the stock's total return index, which accounts for dividends as well as capital gains:

[28] The current parent companies of Swiss banks are identified in Bloomberg and any changes to the parent-subsidiary links are identified in an extensive online research using the banks' own homepages, Wikipedia, and http://www.schweizer-banken.info/ (last accessed on 15 February 2017). In case of multiple listed parent companies on different hierarchy levels in the company tree, we selected the lowest ranked listed parent company in order to include as few unaffected entities as possible.

[29] Here, we drop American International Group Inc (insurance), Assicurazioni Generali SpA (insurance) and Italmobiliare SpA (construction & materials).

$$Return_{n,t} = \frac{P_{n,t} - P_{n,t-1}}{P_{n,t-1}} \cdot 100, \tag{2}$$

where $P_{n,t}$ is the value of the total return index of bank n at time t. In the baseline estimations, all stock prices are denoted in Swiss francs to avoid any confounding effects of exchange rate movements, but we conduct robustness using stock prices in local currencies.

We exclude observations for non-trading days in Switzerland to avoid that a small group of banks traded on stock exchanges outside of Switzerland dominates the estimates on specific days, for instance Israeli stocks traded on Sundays but not Fridays.[30] Moreover, we exclude observations if the end-of-day stock price remained constant or was missing for at least five consecutive Swiss trading days because such stale stocks could otherwise introduce a bias toward zero. Finally, we winsorize returns at the 0.1 and 99.9% level to reduce the influence of extreme observations.

Table 4 provides summary statistics on the resulting sample of stock returns: the mean daily return across all banks over the entire sample period is 0.0% with a minimum return of -19.9%, a maximum return of 25% and a standard deviation of 2.3%. We also provide summary statistics on the returns of the portfolios including all banks, unweighted and weighted by market capitalization, as well as a major European broad stock market index, *Stoxx Europe 600*. In the event studies, we choose this index to proxy for the overall market return because almost all the banks in our sample are listed in Europe and because it explains more of the variation in stock returns outside of the event windows than the blue chip index *Stoxx Europe 50* or leading Swiss market indices such as the *Swiss Market Index* or the *Swiss Performance Index*.[31]

4.3 Empirical approach

The aim of the empirical analysis is to estimate how the market values of banks with ties to offshore tax evasion responded to leaks of customer files. For this purpose, we employ a standard event study framework (Kothari and Warner, 2007).

[30] We define Swiss trading days as days when the Swiss Market Index is traded. Non-trading days in Switzerland are typically Saturdays, Sundays, and bank holidays.

[31] These results are not reported.

In a first step, for each event to be considered, we identify an event-specific bank sample and observation period. The bank sample contains those of the 46 banks in the sample for which stock market data is available for the entire week after the event.[32] The observation period includes the event window, consisting of the event date and 10 trading days before and after the event date, and an estimation window consisting of 250 trading days before the event window, which is roughly one calendar year. So for every analysis, we consider 271 trading days $t \in [-260, 10]$ and the event is normalized to take place on $t = 0$.

In a second step, we calculate the daily portfolio return as the average daily stock return across all banks in the event-specific sample:

$$Portfolio\ return_t = \frac{1}{N} \sum_{n=1}^{N} Return_{n,t}, \tag{3}$$

where $Return_{n,t}$ is the return of bank n on day t and N is the number of banks in the event-specific sample. As the dependent variable, we use the portfolio return rather than the returns of individual banks to account for cross-sectional dependence. We also compute a weighted variant of the portfolio return where the daily returns of individual banks are weighted by market capitalization.[33]

In a third step, we regress the portfolio return on the market return and dummies for the symmetric 21-day window around the event:

$$Portfolio\ return_t = \alpha + \beta\ Market\ return_t + \sum_{s=-10}^{10} \delta_s D_s + \varepsilon_t, \tag{4}$$

where $Market\ return_t$ is the return of the Stoxx Europe 600 on day t and D_s is a dummy indicating day s relative to the event.

The parameter β captures the correlation between the portfolio return and the market return in the period before the event window and the term $\alpha + \beta\ Market\ return_t$ thus

[32] The most common reason why stock market data are not available is that the bank went out of business. For multinational banking groups, we also require that the link to the Swiss bank with criminal liabilities in the U.S. is *active* in the week after the event; hence, if a U.K banking group has closed its Swiss branch or sold it to a unlisted investor by the time of the event, it does not enter the event-specific sample.

[33] We use the latest available pre-event information on banks' market capitalization so that the weights are unaffected by the leak. For four banks there is no available information on market capitalization before the leak from LGT Bank (see Table A1 in the Appendix) and these banks are therefore not included in the weighted portfolio return.

expresses the normal portfolio return on day t conditional on the market return. The parameter δ_t captures the abnormal return of the portfolio on day t, $AR(t)$, which is simply the difference between the actual and the normal portfolio return.

The main parameter of interest is the cumulative abnormal return over the first T days after the event, $CAR(T)$, where $T = 1, 2, 3, 4, 5$. The point estimate can be obtained directly from the coefficients estimated in equation (4) as:

$$CAR(T) = \sum_{s=0}^{T-1} \delta_s. \tag{5}$$

However, simply cumulating abnormal returns does not deliver standard errors on the cumulated abnormal returns. In practice, we therefore estimate a re-parameterized version of equation (4), which yields point estimates and standard errors of $CAR(T)$ directly (Salinger, 1992).

4.4 Results

Main results

We start the empirical analysis by estimating the event study model on the baseline sample of banks that have either been under criminal investigation for their role in offshore tax evasion or have admitted to such a role by participating in the Swiss Bank Program.

As illustrated in Figure 3, these banks earned abnormal returns of around -0.5% on the first day of the LGT leak and on each of the subsequent three trading days. The cumulative abnormal return of around -2% over four trading days is statistically significant and remained roughly constant in the remainder of the event window. By contrast, abnormal returns were small and not systematically positive or negative in the ten days before the leak. This reassures us that the negative abnormal returns observed after the leak are not driven by a differential underlying trend. The confidence intervals displayed in the figure are computed under the usual parametric assumptions; however, the cumulative abnormal return remains significant when we take a non-parametric approach to statistical inference.[34]

[34] To test the statistical significance of $CAR(5)$, we compute the cumulative abnormal return for each five-day window in the estimation period (outside of the event window) and plot the empirical distribution in Figure A4 in the Appendix. As illustrated with a vertical line in the figure, our estimate of $CAR(5)$ is around -2.1%, which corresponds roughly to the 1st percentile in the distribution. It

Table 5 reports a number of additional results (reiterating the point estimates from Figure 3 in Column (1) for ease of comparison).[35] First, we re-estimate the model with a portfolio return that weighs the individual bank returns by market capitalization. As shown in Column (2), the estimated stock market responses are both larger and sharper than in the baseline model when the returns are weighted, with the cumulative abnormal return reaching -2% already after two days and stabilizing at roughly -3% after four days.

The asset-weighted results are instructive by providing a sense of the economic significance of the stock market responses. The combined market value of the 37 banks in the portfolio was almost CHF 1,000 billion (around $900 billion) immediately prior to the leak, so the 3% decrease corresponds to a loss in market value of around CHF 30 billion (around $27 billion). Taken at face value, this measures the net present value of the income losses suffered by listed banks due to the deterrence effect of the data leak. Recall that the estimate from the regression analysis of cross-border deposits concluded that the leak was associated with a decrease in foreign-owned wealth managed in tax havens of around 10%, which is equivalent to around CHF 300 billion (around $270 billion) in the case of Switzerland.[36] It follows that the two estimates are consistent under plausible assumptions. Assuming, for instance, that the banks in our sample earn an annual profit margin of 0.5% on assets under management and stock market investors use a discount factor of 5%, a permanent loss of assets under management of CHF 300 billion implies an annual loss of profits of CHF 1.5 billion with a net present value of CHF 30 billion.

Robustness

We test whether the event study results are robust to adding a second factor to the model of the normal return. While the gain from employing multiple factors is typically marginal in event studies with daily stock-market returns and a short horizon, some

follows that the probability of observing a more extreme outcome than $CAR(5)$ under the pre-event distribution of returns is around 2%. In other words, the p-value associated with a two-sided test of the null hypothesis that $CAR(5) = 0$ is around 0.02. Applying the same non-parametric test, we find that $CAR(1)$ is significantly different from zero with a p-value of 0.14, $CAR(2)$ with a p-value of 0.06, $CAR(3)$ with a p-value of 0.02 and $CAR(4)$ with a p-value of 0.00.

[35] The interpretation of the estimated coefficient on the index is that the return of the banks in the sample is expected to change by around 0.66 percentage points when the index changes by 1 percentage point.

[36] Zucman (2013) puts the foreign-owned wealth held in Switzerland by the end of 2007 at US $3.4 trillion. Recall that our estimate that deposits in havens dropped by 10% relative to deposits in non-havens may overstate the magnitude of the deterrence effect if depositors responded to the leak by shifting funds from havens to non-havens.

scholars recommend that the market model is augmented with an industry index in cases where all the firms in the sample belong to the same industry (Campbell et al., 1997). As shown in Columns (3)-(4) of Table 5, both point estimates and standard errors tend to decrease somewhat when we add the major index for the European financial industry, *Stoxx Europe 600 Financials*, to the model. Note that the banks in our sample make up a non-negligible share of the European financial industry, which implies that part of the stock market response to the data leak may be absorbed by the financial index. For that reason, we continue the analysis with the one-factor model.

To address the concern thar our core estimates may be affected by shocks to the Swiss financial sector unrelated to the LGT leak, we also collect stock price data for Swiss banks with *no* links to offshore tax evasion, which we exploit in two ways.[37] First, we apply the baseline model directly to this sample of banks. As shown in Column (5), there is no clear trend in the abnormal returns for these banks around the LGT leak: the cumulative abnormal return stands at 0.1% after four days. These estimates suggest that the sharp drop in stock prices observed in the main sample reflects the deterrence effect of the LGT leak rather than other shocks common to all banks. However, the estimates have large standard errors and should therefore be interpreted with caution. We therefore also re-estimate the baseline model for the main sample while controlling for the return of banks not involved in offshore tax evasion, and thus, purging our estimates for shocks affecting all banks. As shown in Column (6), the estimates remain very similar to the baseline estimates with a statistically significant cumulative abnormal return of around -2% over four trading days. Further, in Column (7), we show that the baseline estimates are robust to using stock prices denoted in original currencies rather than Swiss francs.[38]

Finally, we address the possibility of a confounding shock with a reading of the Swiss newspaper, *Neue Zürcher Zeitung,* for a 2-week period starting at the LGT leak. We identify nine front-page articles about Swiss banks; however, none of them concern events that could conceivably have caused a general decrease in the market value of the banks. Table A2 in the Appendix provides a short description of each article.

[37] We identified this set of placebo banks in the equity screen of Bloomberg. Specifically, we searched for all actively traded banks and asset managers in Switzerland, and excluded all banks that were investigated in the US for assisting in offshore tax evasion or participated in the Swiss Bank Program.

[38] This result is not surprising given that the exchange rate of the Swiss franc was highly stable during the event window as illustrated in Figure A5 in the Appendix.

Heterogeneity

This section explores how stock market responses to the leak from LGT Bank varied across banks within our main sample with different involvement in offshore tax evasion. As a first proxy for involvement, we distinguish between the banks that were investigated by U.S. authorities for complicity in tax crimes and the banks that subsequently disclosed their cross-border activities under the Swiss Bank Program. Assuming that U.S. authorities selected banks for prosecution based on *ex ante* information about the extent of their involvement in offshore tax evasion, we should expect the stock prices of prosecuted banks to be most adversely affected. We estimate the baseline model for the two subsamples separately and plot the results in Figure 4. The results are strikingly different: the cumulative abnormal return after four days was -6.1% for the prosecuted banks, but only -1.2% for the voluntary disclosers. The point estimates from the figure are reported in Columns (1)-(2) of Table 6. As shown in Columns (3)–(4), a similar pattern emerges when returns are weighted by market capitalization, although the difference between the two groups of banks is less stark.

Ultimately, the extent of the banks' involvement in offshore tax evasion should be reflected in the size of the penalties paid in the U.S. We thus split the sample of banks on the size of the penalties and estimate the baseline model for the two subsamples separately. As shown in Columns (5)–(6) of Table 6, the stock market responses to the first leak are stronger for banks with larger *ex post* penalties: the cumulative abnormal return after four days was -3.2% for banks with above-median penalties and -1.4% for those with below-median penalties. As shown in Columns (7)–(8), this pattern also emerges when returns are weighted by market capitalization.

We test whether the heterogeneity in stock market responses is statistically significant and robust to controlling for bank characteristics in a simple cross-sectional model. Specifically, we regress the 5-day CARs, computed separately for each bank in the sample, on our indicators for involvement in offshore tax evasion as well as bank-level control variables. The results are reported in Table 7. As shown in Columns (1)-(2), the difference in abnormal returns between banks subject to criminal investigations and banks disclosing tax-related offences under the Swiss Bank Program is statistically significant and robust to a number of controls (i.e. market value, total assets and indicators for be-

ing headquartered in Switzerland and for being a major international bank). As shown in Columns (3)-(4), the relation between the strength of the stock market response and the ultimate size of the U.S. penalties is also both statistically significant and robust to controlling for bank characteristics.

The finding that banks' loss of market value around the time of the LGT leak varied systematically with the intensity of their involvement in offshore tax evasion, further strengthens the causal link between the leak and the observed decrease in stock prices; it seems unlikely that heterogeneity in this particular dimension would have emerged if the correlation were spurious and stock markets really responded to a simultaneous shock unrelated to offshore evasion.

Finally, we investigate how much different types of banks contribute to the negative stock market performance around the LGT leak by re-estimating the baseline model for five bank types separately. The results are reported in Table 8. We find striking heterogeneity within the group of Swiss banks with very large responses for major Swiss banks, as shown in Column (1), and virtually no response for cantonal and private banks, as shown in Columns (2)-(3). By contrast, we find notable negative responses for both major and non-major banks based outside of Switzerland, as shown in Columns (4)-(5); although, in the former case, the estimates are only bordeline statistically significant. We are hesitant to interpret these differences as reflecting the causal effect of bank type. Rather, they are likely to reflect that different types of banks differ systematically in the extent of their involvement with offshore tax evasion, the causal mechanism studied above. For instance, stock market responses are plausibly small for cantonal banks whose business is centered around households and firms in the local economy and large for major Swiss banks who cater to wealthy international elites where most undeclared financial assets are concentrated (Alstadsæter et al., 2019; Londoño-Velez and Ávila-Mahecha, 2020).

Other whistleblowing events

In the final step of the analysis, we study stock market responses to whistleblowing events other than the leak from LGT Bank. Figure 5 plots the estimated CARs for the LGT leak (red line) as well as for each of the other 12 data leaks identified in our news search individually (gray lines) and pooled (blue line). The latter estimates are derived from

a modified version of the baseline model that includes multiple event windows.[39] The output from each of the underlying regressions is reported in Table A3 in the Appendix. On average, across all the data leaks following the LGT leak, banks with known ties to tax evasion earned negative abnormal returns in the days following the event; however, the magnitude of the effects is modest. The accumulated stock market response is largest on the third day (CAR3 = -0.7%) where the effect is also statistically significant, but then declines again (CAR5 = -0.4%). Three events are associated with relatively large negative stock market responses, in particular the news on 3 November 2009 that the Netherlands joins Germany in buying customer data from tax havens (leak #3); the news on 16 July 2012 that the German state Nord-Rhine-Westphalia acquires customer data from Switzerland despite an agreement between the German and Swiss federal governments that should put an end to purchases of leaked data (leak #8); and the news on 4 April 2016 about a massive data leak from the Panamanian law firm Mossack Fonseca (leak #12). The other leaks were associated with small negative or even positive stock market developments. In accordance with the deposit analysis, we find no systematic relation between the size of the stock market response and the salience of the leaks (results not reported).

The results are suggestive that the data leaks occurring after the first leak from LGT Bank were generally associated with much smaller, if any, reductions in the use of offshore banks. Plausibly, the first leak made offshore account holders and banks aware of the risk that customer information may be leaked whereas subsequent leaks only induced a small, or none at all, upward adjustment in the probabilities assigned to such events. Prior to the first leak, they may have believed that data theft from providers of offshore banking and corporate service was impossible; that employees had no incentive to blow the whistle or that intelligence services and tax authorities were not able or willing to use leaked data to prosecute tax evaders and bankers. While the first leak changed these priors, any effect of subsequent leaks on the perceived risk appears to be quite small and in most cases not statistically detectable.

[39]The observation period of this modified event study model includes all trading days from one year prior to the event window of the first leak until the event window of the last leak. The sample includes all banks that satisfy the requirements outlined above for all leaks under consideration.

5 Concluding remarks

This paper studies the *deterrence effect of whistleblowing* in the context of offshore tax evasion. It documents that the first leak of customer files from a tax haven bank caused a significant decrease in foreign-owned deposits on accounts in tax havens and a decrease in the market value of banks *known* to derive revenues from offshore tax evasion. Our preferred interpretation is that the leak induced a shock to the detection risk as perceived by offshore account holders and banks, which curbed the use of offshore bank accounts and thus lowered the expected future profits of banks providing access to such tax evasion technologies.

It is useful to consider how these empirical results can inform thinking about optimal legal regulation of whistleblowing.[40] Assume that banks and their wealthy customers collude about offshore tax evasion – balancing costs in the form of expected penalties and benefits in the form of lower tax payments – and governments engage in costly efforts to curb this evasion – conducting audits and negotiating with tax havens. In this simple framework, an increased likelihood of whistleblowing deters tax evasion by raising expected penalties and thus enhances welfare. To see the last point, note that the government is, in principle, able to neutralize the adverse effect on banks and their wealthy customers by scaling back costly enforcement measures and distribute the cost savings among all tax payers. This reasoning suggests that whistleblowers provide a public good and that monetary rewards for blowing the whistles can potentially enhance welfare. There are obviously a number of caveats to this argument: it does not account for the inherent unlawfulness of whistleblowing (Delmas, 2015); the potential for fraudulent allegations (see Nyrerod and Spagnolo, 2018); nor the adverse effect on effort in organizations (Ting, 2008). Studying these trade-offs in the design of legal regulation of whistleblowing is a promising avenue for future research

[40] In a recent theory model, the optimal reward is defined as the minimum reward necessary to induce an employee to blow the whistles in case the employer engages in some criminal activity given the economic environment (Givati, 2018). In this model, whistleblowing never happens in equilibrium because the government provides the optimal reward and the employer is thus deterred from engaging in the criminal activity by the threat of whistleblowing.

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Table 1: Events related to data leaks from tax havens. The table provides information about all new data leaks from banks in tax havens, and significant new disseminations of such data, mentioned on the front page of the Swiss newspaper Neue Zürcher Zeitung between January 2008 and November 2016. The date of the event is either the date mentioned in the article or, in the absence of such information, the calendar day before the article was published. The headline is in the author's own translation from German. The front page article about event #8 states that it happened during the weekend 14/15 July 2012, but not the precise date; however, as the event studies are only concerned with trading days, this has no bearing on the estimations.

Event number	Date of event	Date of front page article	Headline
#1	14/02/2008	16/02/2008	Head of Deutsche Post trips over tax affair: eyeing further hundred suspects
#2	30/08/2009	31/08/2009	France wants to collect the evaded taxes: 3,000 client data received from Switzerland
#3	-	03/11/2009	Also the Netherlands buy bank data: a blow against tax evasion
#4	-	10/12/2009	Data theft at the HSBC in Geneva: part of the tax evaders list?
#5	01/02/2010	02/02/2010	All set to buy data: Germany risks new tax dispute
#6	-	08/02/2010	The data theft affair draws circles: new data CDs surfaced
#7	17/01/2011	18/01/2011	Elmer appears with Julian Assange: whistleblower delivers bank information
#8	14/07/2012	16/07/2012	Blow against the tax agreement: North-Rhine-Westphalia acquired bank-data-CD from Switzerland
#9	04/04/2013	05/04/2013	The expulsion from the tax paradise: revelations about tax havens have further large repercussions
#10	-	17/04/2013	Germany acquires another CD with bank data: raids against clients
#11	-	10/02/2015	"Swissleaks" hitting massive headlines: HSBC client information evaluated
#12	03/04/2016	04/04/2016	Network of offshore companies revealed: allegedly, around two billion dollars from the vicinity of the Russian president
#13	14/04/2016	15/04/2016	Stolen bank data distributed across the EU: North Rhine-Westphalia passes on financial account information from Switzerland

Table 2: Cross-border customer deposits by banking center ($billion). The table lists all international banking centers that were contributing to the Locational Banking Statistics on 31 December 2007 and for each banking center reports the value of deposits held in its banks by non-bank foreigners on this date. Banking centers categorized as tax havens are printed in italics. Source: Bank For International Settlements, Locational Banking Statistics, Table A2.

United Kingdom	1,686	Greece	62
United States	1,078	*Isle of Man*	58
Cayman Islands	771	Canada	50
Switzerland	548	Italy	46
Germany	445	Denmark	42
Belgium	324	Portugal	35
Ireland	303	Taiwan	35
Netherlands	286	Sweden	34
Singapore	231	*Antilles*	12
Jersey	220	Norway	12
Luxembourg	208	*Malaysia*	12
France	176	*Panama*	10
Bahamas	171	*Macao*	9.4
Japan	169	Brazil	4.5
Hong Kong	162	Finland	4.4
Australia	142	South Korea	4.2
Spain	103	Chile	4.0
India	70	Bermuda	2.1
Guernsey	69	Mexico	0.7
Bahrain	65	Turkey	0.4
Austria	65	**Total**	**7,729**

Table 3: The effect of data leaks on customer deposits. The table reports the results from the deposit model where the dependent variable is the log-difference in foreign-owned customer deposits in a given banking center. All specifications include banking center fixed effects and time fixed effects. The explanatory variables are indicators for the banking center being a tax haven (Haven); for a leak occuring in the quarter (Any leak); for the LGT leak occurring in the quarter (LGT Leak); for another leak occurring in the quarter (Other leak); the log difference in oil prices, stock prices and gold prices; and a measure of the salience of a given leak (see Appendix). In Column (8), the time fixed effects are interacted with an indicator of a dollar swap line with the U.S. Fed being the place. Standard errors are robust and clustered at the country-level.

VARIABLES	(1) All leaks	(2) Split leaks	(3) Winsorizing	(4) Oil prices	(5) Stock prices	(6) Gold prices	(7) All prices	(8) Swap lines	(9) Salience
Haven × Any leak	-0.046***								-0.039**
	(0.015)								(0.016)
Haven × LGT leak		-0.117**	-0.096**	-0.113**	-0.119**	-0.119***	-0.120***	-0.116**	
		(0.046)	(0.038)	(0.046)	(0.046)	(0.043)	(0.043)	(0.049)	
Haven × Other leak		-0.036**	-0.028**	-0.034**	-0.036**	-0.036**	-0.033**	-0.047***	
		(0.015)	(0.011)	(0.016)	(0.015)	(0.015)	(0.016)	(0.017)	
Haven × Δlog(Oil price)				-0.037			-0.040		
				(0.028)			(0.029)		
Haven × Δlog(Stock price)					-0.015		-0.003		
					(0.053)		(0.056)		
Haven × Δlog(Gold price)						0.010	0.040		
						(0.077)	(0.079)		
Haven × Any leak × Salience									-0.001
									(0.001)
P-value for LGT leak = Other leak	-	.083	.087	.095	.073	.084	.096	.15	-
Observations	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560
R-squared	0.085	0.086	0.112	0.086	0.086	0.086	0.086	0.093	0.085
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 4: Summary statistics on stock returns. The table provides summary statistics for the stock market returns of the 46 Swiss banks in our estimating sample and for the return of the major European stock market index. All statistics are for the period between 1 January 2007 and 31 October 2016. The first line refers to the sample of individual banks; the second line to the portfolio return computed as the simple average of individual bank returns; the third line to the portfolio return computed as the average of individual bank returns weighted by their market capitalization; the fourth line to the stock market index Stoxx Europe 600.

	Mean	Standard deviation	Minimum	Maximum
Individual banks	0.0	2.3	-19.9	25.0
Portfolio of banks, unweighted	0.0	1.2	-8.2	8.9
Portfolio of banks, weighted by market capitalization	0.0	2.1	-12.1	18.7
Stoxx Europe 600	0.0	1.6	-11.7	11.3

Table 5: Main event-study results. The table shows the results from the event study model applied to the LGT leak on 14 February 2008. In Columns (1), (3), (5), (6) and (7), bank returns are unweighted. In Columns (2) and (4), returns are weighted by market capitalization. In Columns (3) and (4), the baseline model is augmented with a stock market index for financial firms. In Column (5), the outcome is the portfolio return of Swiss banks with *no* known link to offshore tax evasion. In Column (6), the outcome is again the portfolio return of Swiss banks with *known* links to offshore tax evasion, but the baseline model is augmented with a control for the portfolio return for Swiss banks with *no* link to offshore tax evasion. In Column (7), returns of individual banks are computed in original currencies before entering the portfolio return. All regressions include a set of event time dummies as described in the main text.

	Baseline model		**Two-factor model**		**Other Swiss banks**		**Original Currencies**
	Main sample		Main sample		Other Swiss banks	Main sample	Main sample
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Unweighted	Unweighted
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CAR 1	-0.5	-1.1*	-0.2	-0.2	-0.3	-0.5	-0.7*
	(0.4)	(0.6)	(0.3)	(0.3)	(0.7)	(0.4)	(0.4)
CAR 2	-1.1**	-2.1**	-0.6	-0.9**	0.7	-1.2**	-1.0*
	(0.5)	(0.8)	(0.4)	(0.4)	(1.1)	(0.5)	(0.5)
CAR 3	-1.5**	-2.2**	-1.2**	-1.4***	-0.6	-1.4**	-1.5**
	(0.6)	(1.0)	(0.5)	(0.5)	(1.3)	(0.6)	(0.7)
CAR 4	-2.2***	-3.0**	-1.9***	-2.2***	0.1	-2.3***	-2.2***
	(0.7)	(1.2)	(0.6)	(0.5)	(1.5)	(0.7)	(0.8)
CAR 5	-2.1**	-2.9**	-2.0***	-2.7***	-0.3	-2.0**	-2.0**
	(0.8)	(1.3)	(0.7)	(0.6)	(1.7)	(0.8)	(0.9)
Stoxx Europe 600	66.5***	108.2***	11.8**	-28.1***	65.0***	56.5***	61.2***
	(1.7)	(2.7)	(5.2)	(4.5)	(3.5)	(2.5)	(1.8)
Stoxx Europe 600 Financials			48.1***	120.2***			
			(4.4)	(3.8)			
Other Swiss banks						15.3***	
						(3.0)	
Constant	-0.0	-0.0	0.0	0.0	0.1	-0.0	-0.0
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	271	271	271	271	271	271	271
R-squared	0.9	0.9	0.9	1.0	0.6	0.9	0.8
Portfolio size	38	38	38	38	7	38	38

Table 6: Event-study results, by involvement in offshore evasion. The table shows the results from the main event study specification applied to the LGT leak first on 14 February 2008. In Columns (1)-(2) and (5)-(6), bank returns are unweighted. In Columns (3)-(4) and (7)-(8), bank returns are weighted by market capitalization. In Columns (1) and (3), the portfolio only includes Swiss banks that have been subject to criminal investigations in the U.S. for their role in offshore tax evasion. In Columns (2) and (4), the portfolio only includes Swiss banks that have admitted to criminal tax-related offences under the Swiss Bank Program. In Columns (5) and (7), the portfolio only includes Swiss banks that have paid penalties above the sample median. In Columns (6) and (8), the portfolio only includes Swiss banks that have paid penalties below the sample median. All regressions include a set of event time dummies as described in the main text.

	Heterogeneity by legal intervention				Heterogeneity by size of penalty			
	Criminal investigations	Swiss Bank Program	Criminal investigations	Swiss Bank Program	High penalty	Low penalty	High penalty	Low penalty
	Unweighted		Weighted		Unweighted		Weighted	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CAR 1	-1.0	-0.4	-1.9***	-0.6	-0.5	-0.6	-1.3*	-0.3
	(0.7)	(0.4)	(0.7)	(0.6)	(0.5)	(0.3)	(0.7)	(0.6)
CAR 2	-2.3**	-0.8	-3.1***	-1.5	-1.4*	-0.8*	-2.3**	-1.2
	(0.9)	(0.5)	(0.9)	(0.9)	(0.8)	(0.5)	(0.9)	(0.8)
CAR 3	-4.3***	-0.8	-3.1***	-1.7	-2.4**	-0.7	-2.6**	-0.5
	(1.2)	(0.7)	(1.1)	(1.1)	(0.9)	(0.6)	(1.2)	(1.0)
CAR 4	-6.1***	-1.2	-4.6***	-2.1	-3.2***	-1.4**	-3.4**	-1.4
	(1.3)	(0.8)	(1.3)	(1.3)	(1.1)	(0.7)	(1.3)	(1.2)
CAR 5	-6.2***	-1.0	-4.1***	-2.2	-3.3***	-0.9	-3.3**	-1.4
	(1.5)	(0.9)	(1.5)	(1.4)	(1.2)	(0.8)	(1.5)	(1.3)
Stoxx Europe 600	69.7***	65.7***	92.0***	117.9***	85.6***	47.0***	108.3***	108.1***
	(3.1)	(1.8)	(3.0)	(3.0)	(2.5)	(1.6)	(3.1)	(2.7)
Constant	-0.0	-0.0	-0.1*	-0.0	-0.0	0.0	-0.1	0.0
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	271	271	271	271	271	271	271	271
R-squared	0.7	0.9	0.8	0.9	0.8	0.8	0.9	0.9
Portfolio size	8	30	8	30	19	19	19	19

Table 7: Cross-sectional results. The table shows the results from a cross-sectional regression where the dependent variable is the 5-day CAR after the LGT leak at the level of individual banks. The sample is the 38 banks that have been investigated for their role in offshore tax evasion in the U.S. or have admitted to tax-related criminal activities in the U.S. under the Swiss Bank Program. The explanatory variables are: a dummy for having been under criminal investigation in the U.S. (Criminal investigation); the penalty paid in relation to assistance with offshore tax evasion (Penalty); the total market capitalization of the bank (Market Capitalization); the total assets of the bank (Total assets); an indicator for being headquartered in Switzerland (Swiss Bank); and an indicator for being a major international bank (Major Bank).

	Heterogeneity by involvement with evasion			
	(1)	(2)	(3)	(4)
Criminal investigation	-5.1***	-5.5***		
	(1.6)	(1.8)		
Penalty (in logs)			-0.7*	-1.0*
			(0.4)	(0.6)
Market capitalization (in logs)		0.2		0.7
		(1.3)		(1.4)
Total assets (in logs)		0.4		0.1
		(1.1)		(1.2)
Swiss Bank		2.3		3.3*
		(1.5)		(1.7)
Major Bank		-3.0		-1.7
		(4.0)		(4.5)
Constant	-1.0	-7.3	0.1	-7.5
	(0.7)	(8.0)	(1.3)	(9.8)
Observations	38	37	38	37
R-squared	0.2	0.3	0.1	0.2

Table 8: Event-study results, by bank type. The table shows the results from the main event study specification applied to the LGT leak on 14 February 2008 by bank type. Column (1) only includes major international banks based in Switzerland; Column (2) only includes Swiss cantonal banks; Column (3) only includes Swiss private banks; Column (4) only includes major international banks based outside of Switzerland; Column (5) only includes other banks based outside of Switzerland.

	Swiss Major Banks (1)	Swiss Cantonal Banks (3)	Swiss Private Banks (5)	Non-Swiss Major Banks (7)	Non-Swiss Minor Banks (9)
CAR 1	-4.2***	-0.4	0.7	-0.5	-0.7
	(1.0)	(0.5)	(0.7)	(0.6)	(0.7)
CAR 2	-5.0***	0.0	-0.1	-1.7*	-1.3
	(1.4)	(0.7)	(1.1)	(0.9)	(1.0)
CAR 3	-6.1***	-0.2	0.8	-1.7	-3.1**
	(1.7)	(0.8)	(1.3)	(1.1)	(1.2)
CAR 4	-9.6***	0.1	0.2	-2.2*	-4.5***
	(2.0)	(1.0)	(1.5)	(1.3)	(1.4)
CAR 5	-8.0***	0.1	0.9	-2.3	-4.6***
	(2.3)	(1.1)	(1.7)	(1.4)	(1.6)
Stoxx Europe 600	106.3***	20.6***	35.9***	113.3***	64.7***
	(4.7)	(2.2)	(3.4)	(2.9)	(3.3)
Constant	-0.1	0.0	0.0	-0.0	-0.0
	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	271	271	271	271	271
R-squared	0.7	0.3	0.4	0.9	0.6
Portfolio size	38	38	38	38	38

Figure 1: Trends in cross-border deposits around LGT leak. The figure displays the raw trends in cross-border customer deposits (Panel A) and interbank deposits (Panel B) in havens (red line) and non-havens (blue line) around the LGT leak. For each banking center, we have scaled deposits by the value in 2007q4, the quarter immediately before the LGT leak. The figure shows averages of these scaled values taken across all banking centers in a given group in a given quarter.

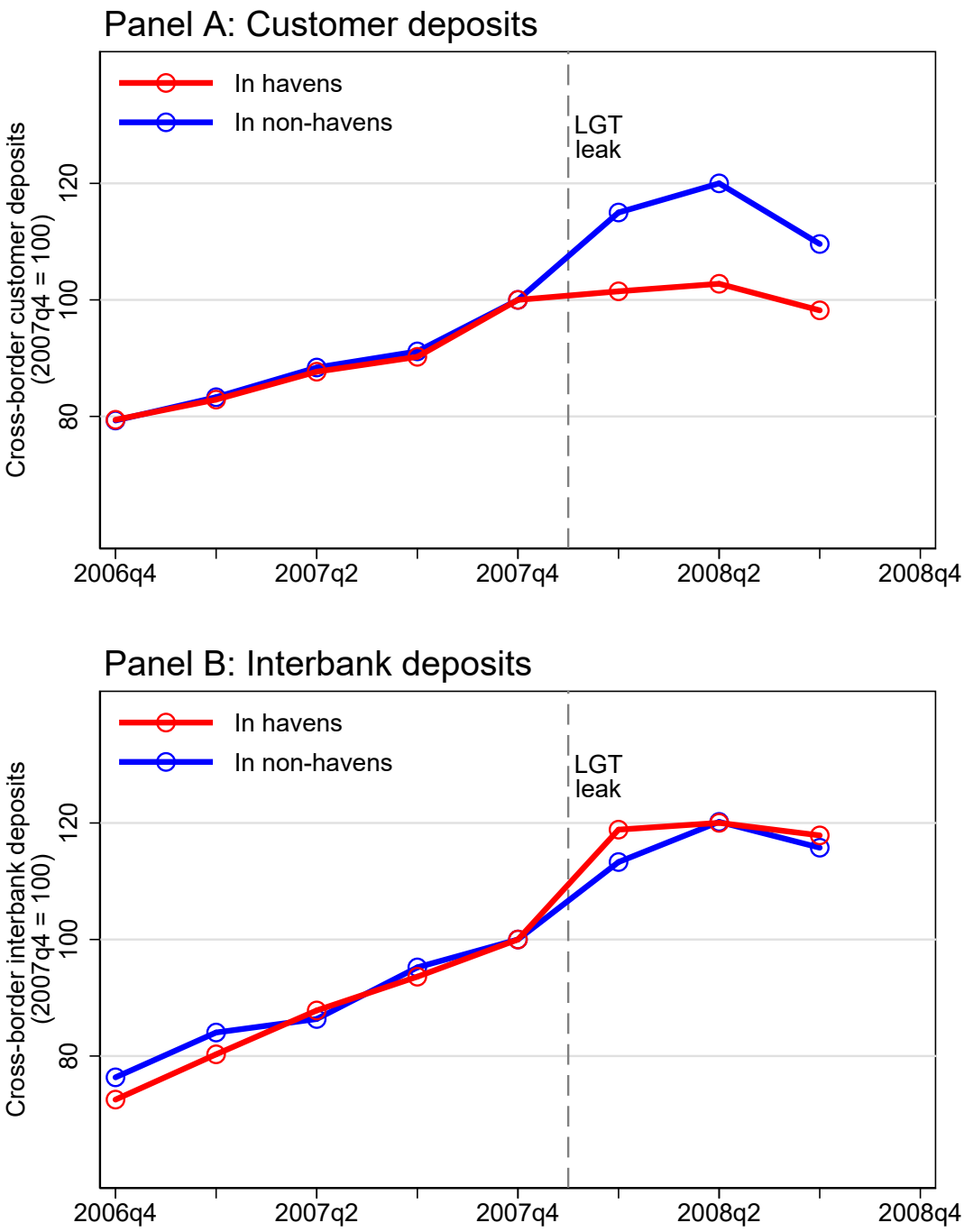


Figure 2: Dynamics regression results. The figure shows dynamic results for customer deposits for the LGT leak (Panel A) and other leaks (Panel B). The green dots show the estimated coefficients on leak indicators as well as their leads and lags. The vertical lines show the 95% confidence intervals based on standard errors clustered at the level of banking centers.

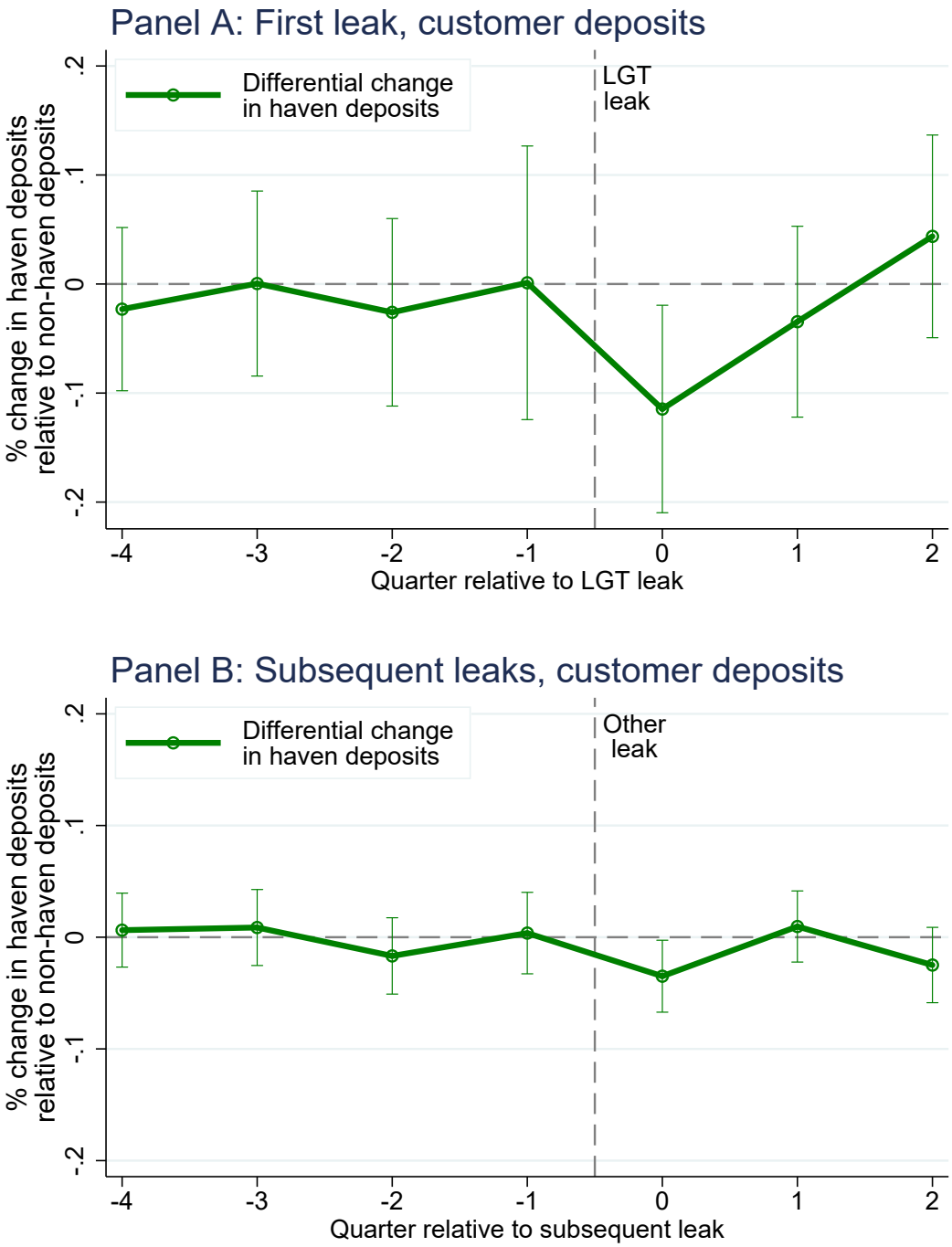


Figure 3: CAR around the LGT leak. The figure illustrates the results from the main event study specification applied to the first event, the leak from LGT bank on 14 February 2008. The blue line shows the estimates of the cumulative abnormal return for the main sample of banks with known links to offshore tax evasion. The vertical lines indicate 95% confidence intervals of the estimates.

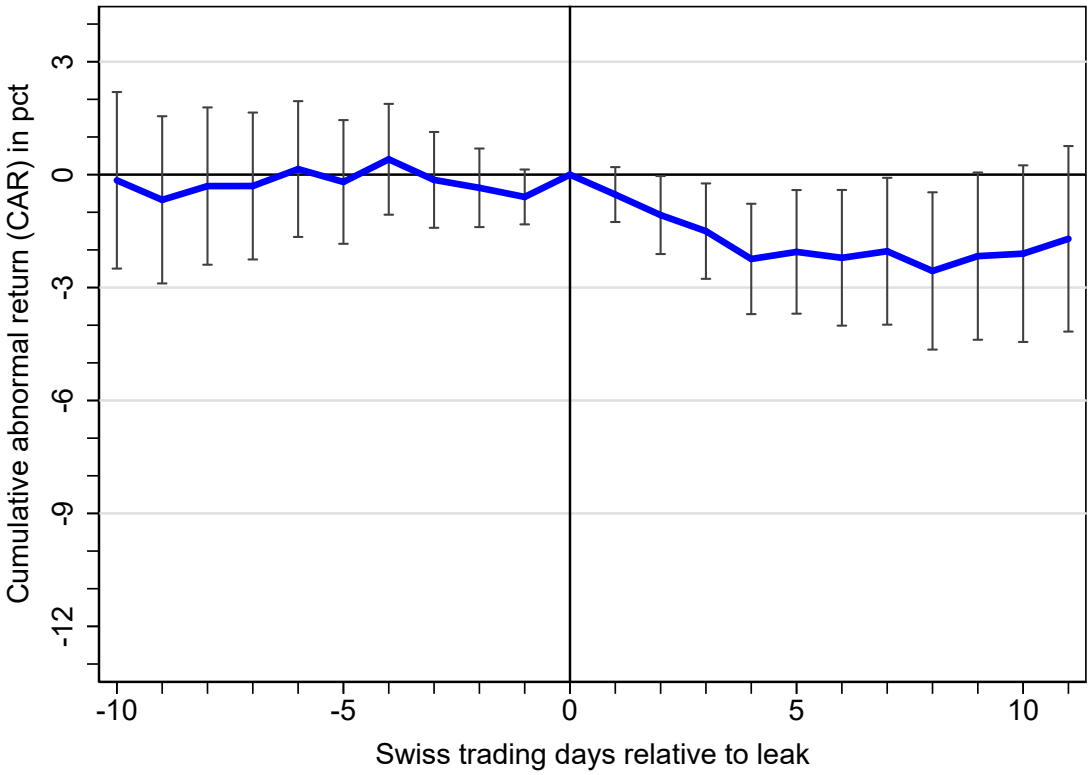


Figure 4: CAR heterogeneity around the LGT leak. The figure illustrates the results from the main event study specification applied to the first event, the leak from LGT bank on 14 February 2008. The lines show the estimates of the cumulative abnormal return for the sample of Swiss banks that have been subject to criminal investigations in the U.S. for their role in offshore tax evasion (blue) and for the sample of Swiss banks that have admitted to criminal tax-related offences under the Swiss Bank Program (red) respectively. The vertical lines indicate 95% confidence intervals of the estimates.

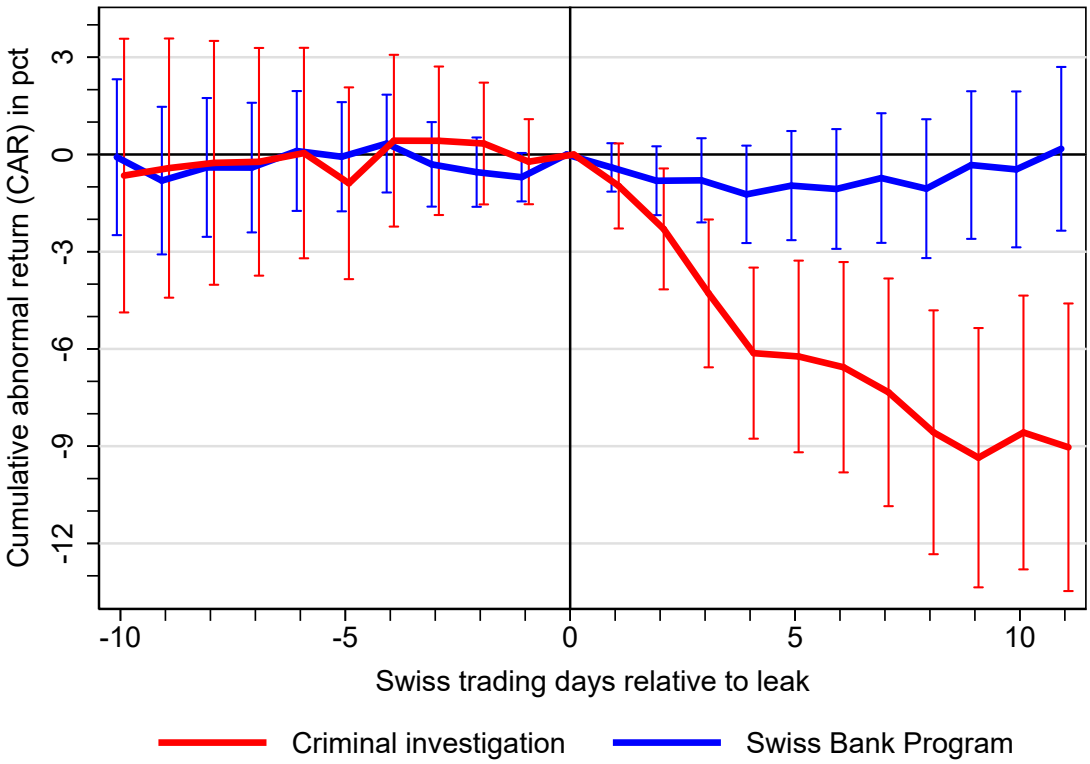
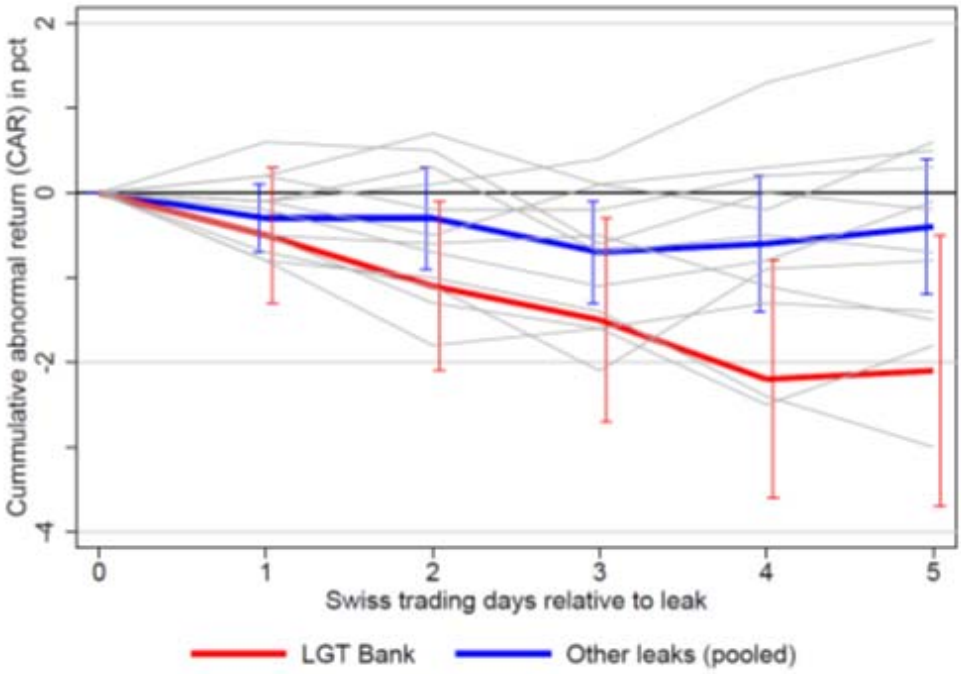


Figure 5: CARs around all data leaks. The figure illustrates the estimated CARs around the LGT leak (red line), around each of the other 12 data leaks (gray lines) and the average around the other leaks estimated in a single regression using the entire sample period and pooling all the leaks (blue line).



ONLINE APPENDIX

Salience index

To explore the hypothesis that the LGT leak triggered larger responses than subsequent leaks, we use the volume of internet searches for four keywords, all relating to data leaks from tax havens, as a measure of salience. The assumption is that the volume of internet searches reflects the overall level of attention directed to a leak and thus provides information about the salience of the leak.[41] Specifically, we use monthly indicators of global search volumes from Google Trends scaled to 100 in the sample month with the highest volume. As shown in Figure A6, searches for "Tax evasion" peaked in April 2016, when leaked files from Mossack Fonseca were published as the *Panama Papers* whereas the highest search volumes for the remaining three keywords coincided with events not directly related to data leaks from tax havens: "Data leak" with the leak from a website facilitating extramarital affairs in July 2015; "Tax havens" with the G20 Summit cracking down on tax havens in April 2009; and "Whistleblower" with the leak of NSA files by *Edward Snowden* in June 2013.

For each of the four keywords, Table A4 reports raw values from Google Trends and, to account for time trends in search volumes, also residuals from regressions of the raw values on year dummies. Specifically, the table reports averages for the months where no leak occured (first row), the months where one of the 13 leaks in the sample occurred (second row), the month where the LGT leak occurred (third row) and the months were one of the other 12 leaks occurred (fourth row). Two patterns stand out. First, search levels for the four keywords were generally higher around the data leaks in our sample. The residualized indeces were on average 4 percentage higher in months where data leaks occurred than in months where they did not. The difference, which is statistically significant with a t-value of 3.3, provides some reassurance that internet search volumes are a suitable measure of salience in this context. Second, there is virtually no difference in search volumes between the first leak and those that followed suggesting that the larger responses to the LGT leak was not driven by higher salience.

In the analysis of cross-border deposits, we explore the role of salience by interacting our preferred salience measure, the average of the residualized indeces across the four

[41] Several papers in finance use internet search volumes to measure the attention of investors, for instance Da et al. (2011).

keywords, with our main variable of interest, the interaction between the haven and leak indicators. The results are reported in Column (9) in Table 3.

Table A1: Banks with known links to offshore tax evasion. Note: This table provides information about all the banks in the main sample. Except for the name of the entity in the Swiss Bank Program and the source of identification, all information may vary over time as ownership links sometimes change. This table states the latest information for each bank before the first leak from LGT bank.

Name of listed Swiss bank or its listed parent	Source	Penalty ($ million)	Market capitalization ($ million)	Name of Swiss entity in the Swiss Bank Program	Start of holding period	End of holding period	Country	Sector
Credit Suisse Group AG	Criminal investigation	2,600	66,248	-	-	-	CH	Bank
Bank Hapoalim BM	Criminal investigation	875	6,380	-	-	-	IL	Bank
UBS Group AG	Criminal investigation	780	84,725	-	-	-	CH	Bank
Julius Baer Group Ltd	Criminal investigation	547	-	-	-	-	CH	Bank
Bank Leumi Le-Israel BM	Criminal investigation	270	7,576	-	-	-	IL	Bank
Mizrahi Tefahot Bank Ltd	Criminal investigation	195	2,016	-	-	-	IL	Bank
HSBC Holdings PLC	Criminal investigation	192	192,547	-	-	-	UK	Bank
Basler Kantonalbank	Criminal investigation	60	3,453	-	-	-	CH	Bank
Liechtensteinische Landesbank AG	Criminal investigation	24	3,098	-	-	-	LI	Bank
BTG Pactual Group	Swiss Bank Program	211	-	BSI SA	14/07/2014	22/02/2016	BR	Financial services
Credit Agricole SA	Swiss Bank Program	99.2	50,893	Crédit Agricole (Suisse) SA	-	-	FR	Bank
Bank J Safra Sarasin AG	Swiss Bank Program	85.8	2,930	Bank J. Safra Sarasin AG	-	31/07/2012	CH	Bank
Royal Bank of Scotland Group PLC	Swiss Bank Program	78.5	80,371	Coutts & Co Ltd	-	-	UK	Bank
St Galler Kantonalbank AG	Swiss Bank Program	60.3	2,770	Multiple	14/12/2007	27/06/2013	CH	Bank
BNP Paribas SA	Swiss Bank Program	59.8	89,516	BNP Paribas (Suisse) SA	-	-	FR	Bank
Edmond de Rothschild Suisse SA	Swiss Bank Program	45.2	3,555	Edmond de Rothschild (Suisse)	-	-	CH	Financial services
Banque Cantonale Vaudoise	Swiss Bank Program	41.7	4,381	Banque Cantonale Vaudoise	-	-	CH	Bank
Deutsche Bank AG	Swiss Bank Program	31.0	66,499	Deutsche Bank (Suisse) SA	-	-	DE	Bank
EFG International AG	Swiss Bank Program	30.0	4,840	EFG Bank European Financial Group	-	-	CH	Bank
Societe Generale SA	Swiss Bank Program	19.2	59,832	Multiple	-	-	FR	Bank
KBC Group NV	Swiss Bank Program	18.8	48,165	KBL (Switzerland) Ltd.	-	10/10/2011	BE	Bank
Rothschild & Co	Swiss Bank Program	11.5	1,318	Rothschild Bank AG	-	-	FR	Financial services
Luzerner Kantonalbank AG	Swiss Bank Program	11.0	2,233	Luzerner Kantonalbank AG	-	-	CH	Bank
CIC	Swiss Bank Program	10.5	12,004	Multiple	-	-	FR	Bank
Banco Bilbao Vizcaya Argentaria SA	Swiss Bank Program	10.4	83,604	BBVA Suiza S.A.	-	-	ES	Bank
Schroders PLC	Swiss Bank Program	10.4	6,252	Schroder & Co. Bank AG	-	-	UK	Financial services
Dexia SA	Swiss Bank Program	9.7	30,516	Banque Internationale à Luxembourg	-	20/12/2011	BE	Bank
Standard Chartered PLC	Swiss Bank Program	6.3	49,060	Standard Chartered Bank (Switzerland)	-	-	UK	Bank
Vontobel Holding AG	Swiss Bank Program	5.4	2,763	Finter Bank Zurich AG	04/09/2015	-	CH	Bank
Berner Kantonalbank AG	Swiss Bank Program	4.6	2,122	Berner Kantonalbank AG	-	-	CH	Bank
Bank Linth LLB AG	Swiss Bank Program	4.2	399	Bank Linth LLB AG	-	-	CH	Bank
Zuger Kantonalbank AG	Swiss Bank Program	3.8	1,067	Zuger Kantonalbank	-	-	CH	Bank
Graubuendner Kantonalbank	Swiss Bank Program	3.6	2,550	Graubündner Kantonalbank	-	-	CH	Bank
Valiant Holding AG	Swiss Bank Program	3.3	3,057	Valiant Bank AG	-	-	CH	Bank
Bank Coop AG	Swiss Bank Program	3.2	1,347	Bank Coop AG	-	-	CH	Bank
Walliser Kantonalbank	Swiss Bank Program	2.3	-	Banque Cantonal du Valais	-	-	CH	Bank
Aabar Investments PJSC	Swiss Bank Program	1.8	1,285	Falcon Private Bank AG	01/12/2008	12/07/2010	AE	Financial services
BHF Kleinwort Benson Group	Swiss Bank Program	1.8	1,165	BHF-Bank (Schweiz) AG	07/07/2011	27/11/2015	BE	Financial services
SB Saanen Bank AG	Swiss Bank Program	1.4	-	SB Saanen Bank AG	-	-	CH	Bank
Mercantil Servicios Financieros CA	Swiss Bank Program	1.2	1,637	Mercantil Bank (Schweiz) AG	-	-	VE	Bank
Irish Bank Resolution Corp Ltd/Old	Swiss Bank Program	1.1	11,747	Hyposwiss Private Bank Genève	-	14/12/2007	IE	Bank
Banque Cantonale du Jura SA	Swiss Bank Program	1.0	192	Banque Cantonale du Jura SA	-	-	CH	Bank
Medibank	Swiss Bank Program	0.8	76	MediBank AG	-	-	CH	Bank
Hypothekarbank Lenzburg AG	Swiss Bank Program	0.6	359	Hypothekarbank Lenzburg AG	-	-	CH	Bank
Banco di Desio e della Brianza SpA	Swiss Bank Program	0.3	1,458	Credito Privato Commerciale	-	08/06/2012	IT	Bank
Banca Intermobiliare SpA	Swiss Bank Program	-	1,433	Banca Intermobiliare di Investi	-	-	IT	Financial services

Table A2: News stories about banks around the LGT leak. The table lists the news stories about banks on the front page of Neue Zürcher Zeitung in a two-week window around the LGT leak.

Date	Headline
14 February 2008	Jerker Johannsson takes over the investment banking at UBS
15 February 2008	UBS struggles with crisis of confidence: Another drop in the stock price
16 February 2008	The subprime crises approaches its bottom: the CEO of Credit Suisse Brady Dougan interviewed
19 February 2008	Northern Rock nationalized reluctantly
20 February 2008	Credit Suisse in the subprime vortex: billions written-off in the first quarter
21 February 2008	Convertible loan of UBS was valued fairly
22 February 2008	UBS stands by Marcel Ospel
25 February 2008	Yes for the business tax reform II
27 February 2008	Petition against excessive management compensation filed: much support from the left

Table A3: Regression results, other events. The table shows the results from the main event study specification applied to each of the data leaks from tax havens individually (Columns 1-13) and to all of the data leaks at once (Column 14).

	Leak #1	Leak #2	Leak #3	Leak #4	Leak #5	Leak #6	Leak #7
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CAR 1	-0.5	-0.7	-0.8	-0.1	0.2	-0.5	-0.1
	(0.4)	(1.0)	(0.9)	(0.8)	(0.7)	(0.7)	(0.4)
CAR 2	-1.1**	-1.1	-1.8	0.3	-0.2	-0.6	0.1
	(0.5)	(1.4)	(1.3)	(1.1)	(1.0)	(0.9)	(0.5)
CAR 3	-1.5**	-2.1	-1.6	-0.7	-0.2	-0.5	0.4
	(0.6)	(1.7)	(1.6)	(1.3)	(1.2)	(1.1)	(0.7)
CAR 4	-2.2***	-0.9	-2.5	-0.5	0.2	-1.1	1.3*
	(0.7)	(1.9)	(1.9)	(1.6)	(1.4)	(1.3)	(0.8)
CAR 5	-2.1**	-0.8	-1.8	-0.7	0.3	-1.5	1.8**
	(0.8)	(2.2)	(2.1)	(1.7)	(1.6)	(1.5)	(0.9)
Stoxx Europe 600	66.5***	73.5***	73.4***	81.2***	89.8***	84.1***	71.7***
	(1.7)	(2.2)	(2.6)	(2.6)	(2.7)	(2.5)	(1.7)
Constant	-0.0	0.1	0.1	0.1**	0.1**	0.1**	0.0
	(0.0)	(0.1)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	271	271	271	271	271	271	271
R-squared	0.9	0.8	0.8	0.8	0.8	0.8	0.9
Portfolio size	38	38	39	40	37	40	39

Table A3 (continued): Regression results, other events. The table shows the results from the main event study specification applied to each of the data leaks from tax havens individually (Columns 1-13) and to all of the data leaks at once (Column 14).

	Leak #8	Leak #9	Leak #10	Leak #11	Leak #12	Leak #13	All leaks pooled
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CAR 1	-0.8	0.2	0.6	-0.2	-0.5	-0.1	-0.3
	(0.6)	(0.5)	(0.5)	(0.3)	(0.4)	(0.4)	(0.2)
CAR 2	-1.0	0.7	0.5	-0.7	-1.3**	-0.5	-0.3
	(0.8)	(0.7)	(0.7)	(0.5)	(0.6)	(0.6)	(0.3)
CAR 3	-1.4	0.1	-0.6	-1.1*	-1.6**	0.1	-0.7**
	(1.0)	(0.9)	(0.9)	(0.6)	(0.7)	(0.7)	(0.3)
CAR 4	-2.4**	0.3	-0.0	-0.8	-1.3	-0.2	-0.6
	(1.2)	(1.0)	(1.0)	(0.7)	(0.8)	(0.8)	(0.4)
CAR 5	-3.0**	0.5	-0.2	-0.1	-1.4	0.6	-0.4
	(1.3)	(1.1)	(1.1)	(0.7)	(0.9)	(0.9)	(0.4)
Stoxx Europe 600	74.5***	70.7***	71.3***	62.4***	58.1***	58.6***	78.6***
	(2.0)	(3.2)	(3.3)	(1.6)	(1.8)	(1.8)	(0.8)
Constant	-0.0	0.0	0.0	-0.0	0.0	0.0	0.0
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	271	271	271	271	271	271	2,321
R-squared	0.9	0.7	0.7	0.9	0.8	0.8	0.8
Portfolio size	36	36	36	36	36	36	29

Table A4: Google searches for keywords related to data leaks in tax haven banks. The table summarizes trends in the global number of Google searches for four keywords, "Data leak" (Columns 1-2), "Tax evasion" (Columns 3-4), "Tax Havens" (Columns 5-6), "Whistleblowing" (Columns 7-8) and the average over the four keywords (Columns 9-10) over the 10-year period 2007m1-2016m12. For each keyword, the month with the highest number of searches takes the value 100 and the number of searches in other months is measured relative to this index. The reported statistics are raw index numbers (Columns 1, 3, 5, 7, 9) and the residuals from regressions where raw index numbers are regressed on year dummies (Columns 2, 4, 6, 8, 10). The table reports averages for the months where no leak occured (first row), the months where one of the 13 leaks in the sample occurred (second row), the month where the LGT leak occurred (third row) and the months were one of the other 12 leaks occurred (fourth row). Source: Google Trends and own computations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	"Data leak"		"Tax evasion"		"Tax havens"		"Whistleblowing"		Average	
	raw	residuals	raw	residuals	raw	residuals	raw	residuals	raw	residuals
No leaks	19.1	-0.4	39.3	-0.5	17.4	-0.6	20.5	0.1	24.1	-0.4
All leaks	23.7	4.4	45.3	5.5	28.5	6.9	17.0	-0.9	28.6	4.0
- LGT leak	17.0	0.3	41.0	8.1	26.0	7.8	10.0	-0.4	23.5	4.0
- Other leaks	24.4	4.9	45.8	5.2	28.8	6.8	17.8	-0.9	29.2	4.0

Figure A1: Customer deposits around the LGT leak, by haven. The figure shows the trend in foreign-owned customer deposits in around the LGT leak for each haven reporting to the BIS Locational Banking Statistics. The figure shows the value of foreign-owned customer deposits scaled by the value at the end of 2007:q4 for all tax havens (full red line), Switzerland only (dashed red line) and for each of the other tax havens (fray lines).

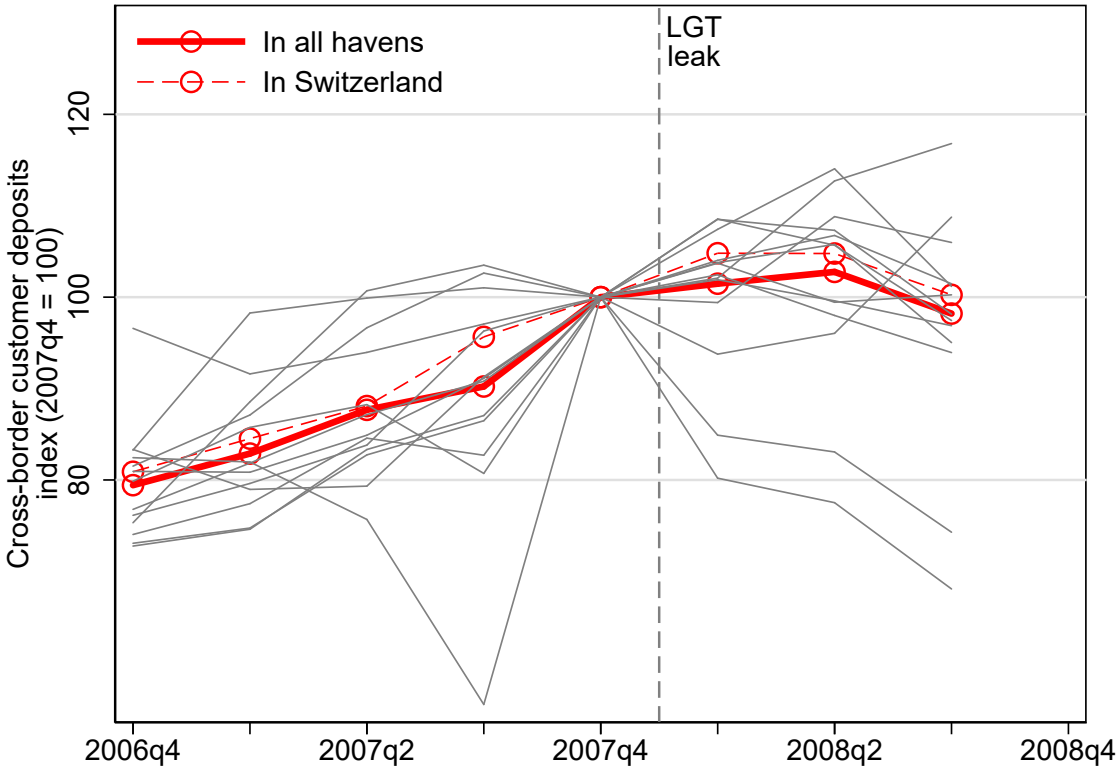


Figure A2: Dynamics regression results, interbank deposits. The figure shows dynamic results for interbank deposits for the LGT leak (Panel A) and other leaks (Panel B). The green dots show the estimated coefficients on leak indicators as well as their leads and lags. The vertical lines show the 95% confidence intervals based on standard errors clustered at the level of banking centers. Two countries with very small stocks of foreign deposits (below $1 billion) are excluded from the analysis (Mexico and Turkey).

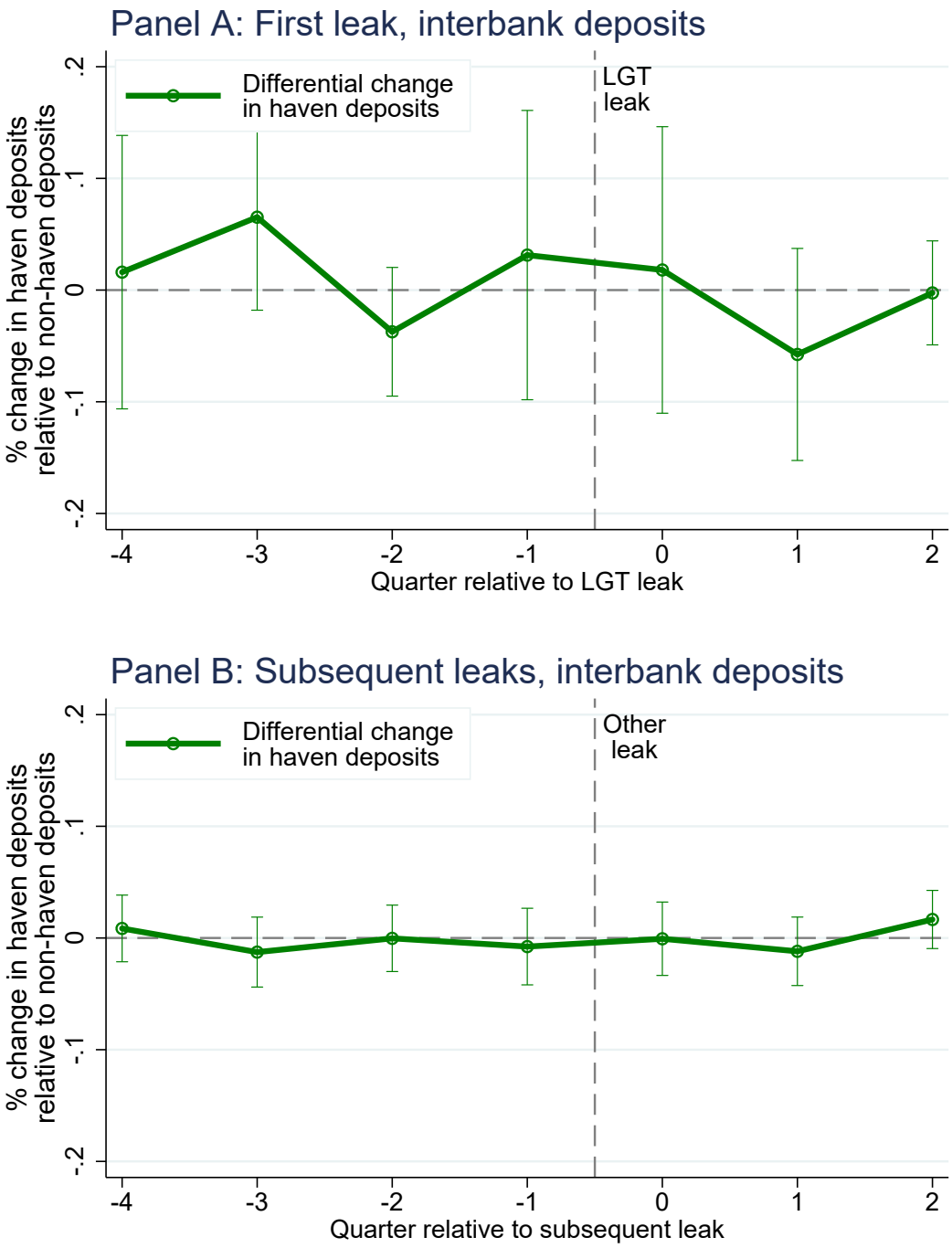


Figure A3: Stock market development around the LGT leak. The figure shows the S&P 500 stock market index around the LGT leak in February 2008. The gray area indicates 2008q1 where the LGT leak occurs.

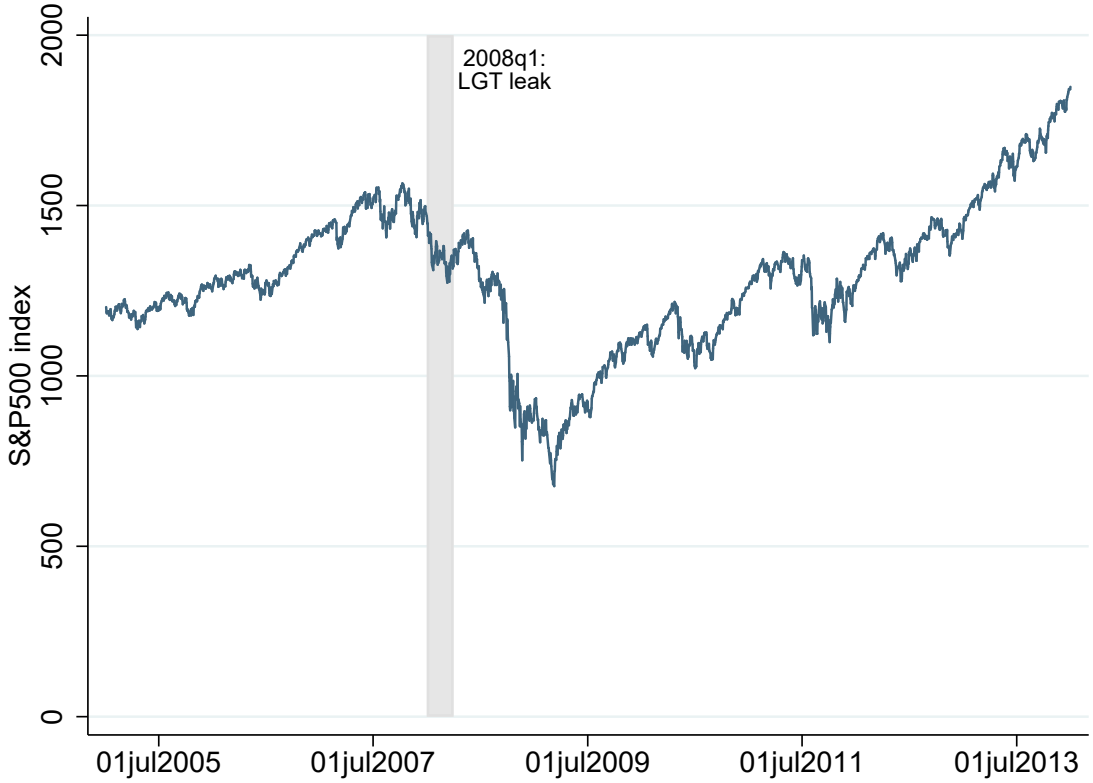


Figure A4: Distribution of 5-day CARs. The figure shows the distribution of cumulative abnormal returns for all 5-day windows in the estimation period (outside of the event window) of the first leak. The vertical line indicates the estimated cumulative abnormal return in a 5-day window starting at the event, that is CAR(5).

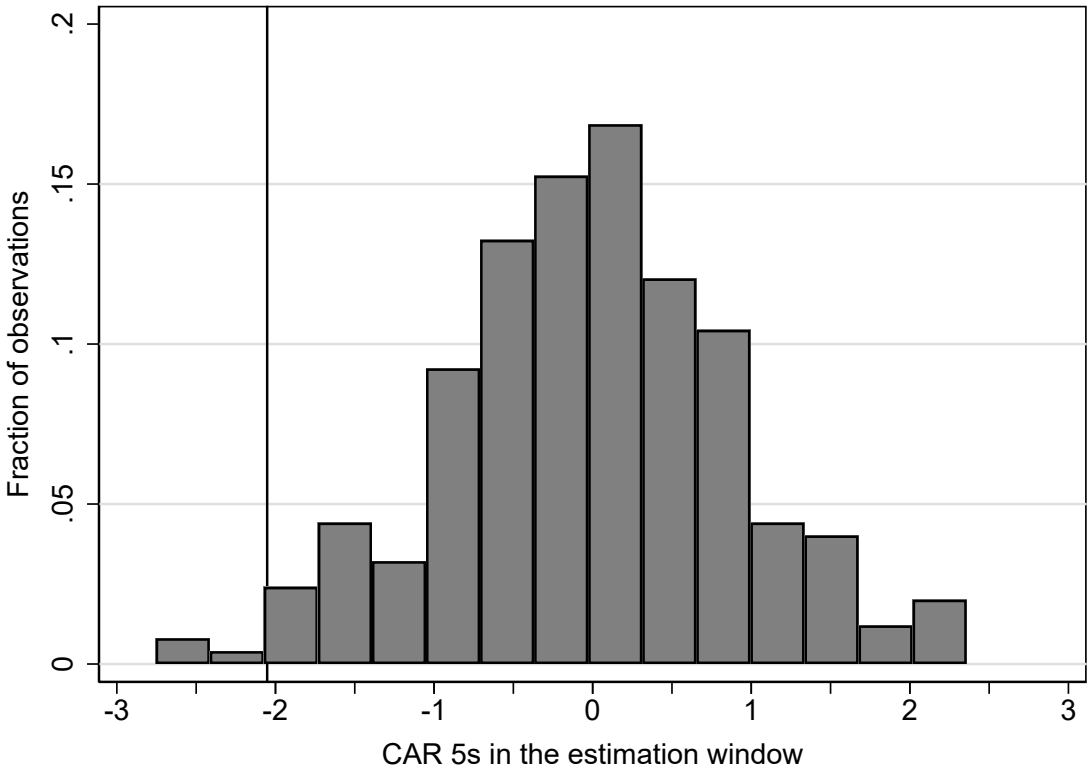


Figure A5: Exchange rates around the LGT leak. The figure shows the exchange rate between Swiss franc and Euro around the LGT leak in February 2008. The gray area indicates the event window used in the event study.

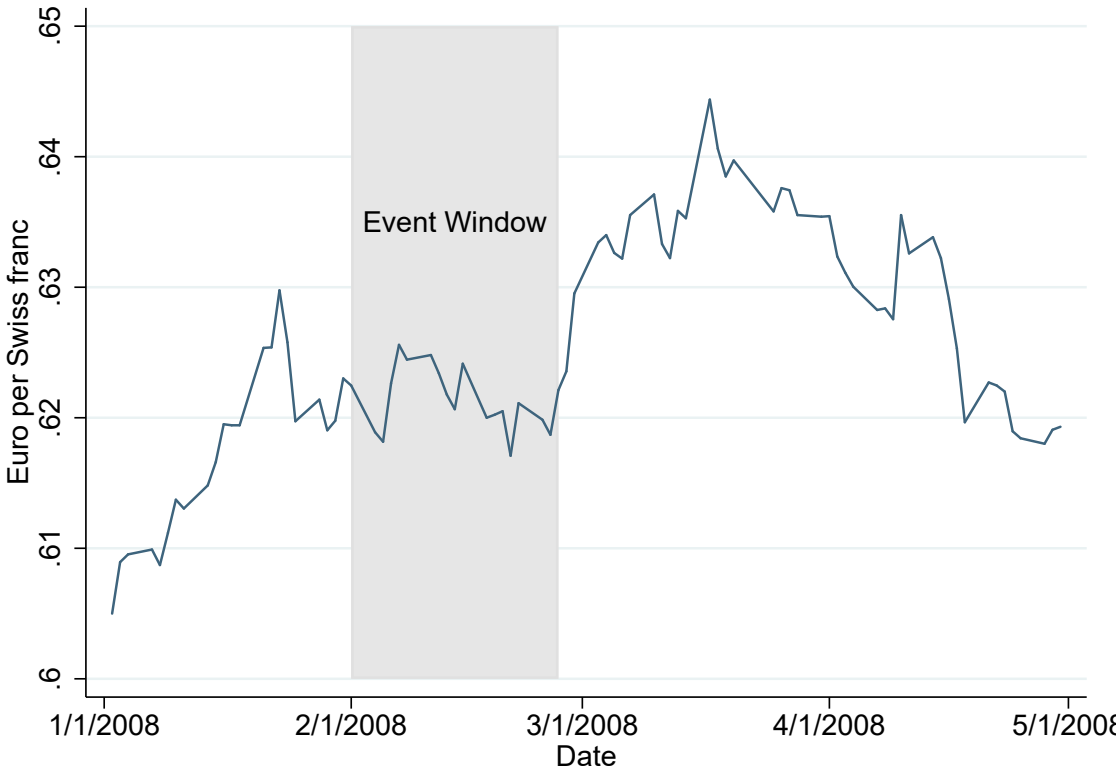


Figure A6: Google searches for keywords related to data leaks in tax haven banks. The table shows the trends in the global number of Google searches for five keywords, "LGT bank", "Data leak" , "Tax evasion", "Tax Havens", "Whistleblowing" over the 10-year period 2007m1-2016m12. For each keyword, the month with the highest number of searches takes the value 100 and the number of searches in other months is measured relative to this value. The label "G20 tax haven crackdown" refers to the G20 summit in London in April 2009; "Edward Snowden" to the leak of NSA files in June 2013; "Ashley Madison" to the leak of customer data from a website facilitating extra-marital affairs in July 2015; "Panama Papers" to the leak from the law firm Mossack Fonseca in April 2016. Source: Google Trends.