Monetary policy through exchange rate pegs: The removal of the Swiss franc-Euro floor and stock price reactions *

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Abstract

The Swiss National Bank abolished the exchange rate floor versus the Euro in January 2015. Using a synthetic matching framework, we analyze the impact of this unexpected (and therefore exogenous) policy change on the stock market. The results reveal a significant level shift (decline) in asset prices following the discontinuation of the minimum exchange rate. As a novel finding in the literature, we document that the exchange-rate elasticity of Swiss asset prices is around -0.75. Differentiating between sectors of the Swiss economy, we find that the industrial, financial and consumer goods sectors are most strongly affected by the abolition of the minimum exchange rate.

Keywords: exchange rates; stock markets; uncertainty; synthetic matching
JEL-Classification: C22; E50; F30; F41
Declarations of interest: none

*Views expressed in this papers are those of the authors. All errors and inconsistencies are solely in our own responsibility.

1 Introduction

Small open economies implement monetary policy not only via interest rate setting but also by managing exchange rates. Exchange rate movements in turn have implications for a country's competitiveness and future growth options. For such economies, it is hence important to know in how far changes in the exchange rate target affect market participants' assessment of future development as reflected in stock market prices. However, tracing these effects is challenging because causality between exchange rate fluctuations and stock market movements can run in both directions (Granger, Huangb & Yang 2000, Hashimoto & Ito 2004). We exploit the unexpected removal of the exchange rate floor of the Swiss franc versus the Euro on January 15, 2015 to analyze the causal effect of the Swiss National Bank's (SNB) policy change on stock markets. As a novelty in the literature, the causal stock market reaction allows us to estimate an exchange-rate elasticity of asset prices of around -0.75.

With the start of the financial crisis, and even more so during the European sovereign debt crisis, Switzerland's status as a safe haven caused an increase in demand for the Swiss franc. To stop the appreciation of the currency, the SNB introduced an exchange rate floor in September 2011.[1] The floor was set at a minimum exchange rate of 1.2 Swiss franc per Euro. On the one hand, this ensured no further appreciation of the Swiss franc against the Euro. On the other hand, monetary policy became less independent as it forced the SNB to accumulate high foreign currency reserves and to increase the amount of Swiss franc in the market. Following the depreciation of the Euro and in the run-up to an announcement of further monetary expansion of the European Central Bank (ECB), the SNB suddenly discontinued the minimum exchange rate on January 15, 2015.

This step was accompanied by a reduction of its benchmark rate by 75 basis points from 0% to -0.75%, in order to ease possible negative consequences of the currency appreciation on the real economy. Hence, the SNB made use of two different instruments to achieve its monetary policy objectives. As both policy decisions were taken simultaneously, we cannot fully distinguish between them. Instead, we capture the effects of the overall change in the monetary policy regime. However, it seems reasonable to assume that the relevant event affecting stock markets was the removal of the exchange rate floor. In that respect, Bonadio, Fischer & Sauré (2019) write that "The SNB's decision to discontinue the floor took financial markets by storm."

[1] Technically, the new policy introduced a one-sided cap on the previously free-floating exchange rate.

For abbreviation purposes, we will talk about exchange rates in the rest of the paper, always implying the combination of both policy tools.

The Swiss setting offers two useful features that help identifying the effect of the change in the SNB's policy on stock markets. First, the removal of the minimum exchange rate was a surprise to markets and economically relevant (Brunnermeier & James 2015, Mirkov, Pozdeev & Söderlind 2016, Wyplosz 2015). Second, it was driven by concerns of the SNB about the independence of its monetary policy and not by stock market developments. This unexpected policy change thus offers an ideal instrument to evaluate reactions of stock market participants in response to monetary policy regime changes (Ramey 2016).[2]

The key element of the regime change was the abolition of the exchange rate floor. Following the "current account channel", exchange rates can affect stock prices through the effect on the profitability of firms; exporting firms will most likely lose given an appreciation, while those that (strongly) rely on imported inputs should benefit. Therefore, the overall effect depends on the composition of importing versus exporting firms in the economy and remains unclear ex ante. Bäurle & Steiner (2015) provide evidence in a structural dynamic factor model that the negative effect through exports should dominate. We thus expect to find a significantly negative reaction of stock markets to the abolition of the minimum exchange rate. Additionally, some sectors may be disproportionately hit due to their larger exposure to exchange rate fluctuations.

In this paper, we employ synthetic matching to trace the effect of the abolition of the exchange rate floor on stock markets because this technique is particularly well suited to analyze the effect of an unexpected policy change on single entities in a relatively heterogeneous group (like countries). The idea of synthetic matching is to build a synthetic counterfactual to Switzerland from a control group of OECD countries that have not been treated. The synthetic counterfactual should be comparable to Switzerland in terms of its general economic environment and its development of stock markets until January 14, 2015. The counterfactual is then used to construct stock market developments after January 15, 2015 that would most likely have occurred in absence of the treatment (Abadie & Gardeazabal 2003, Chamon, Garcia & Souza 2017, El-Shagi, Lindner & von Schweinitz 2016).

Synthetic matching has been used in alternative contexts. For example, Abadie & Gardeazabal (2003) construct a synthetic control group out of other Spanish regions to analyze the effects

[2]Related papers refer to the exchange rate change as a "shock" (Bonadio et al. 2019, Efing, Fahlenbrach, Herpfer & Krüger 2016). We follow the definition of Ramey (2016), which qualifies the removal of the exchange rate floor rather as an instrument than a shock arising due to "primitive exogenous forces".

of terrorism in the Basque country. These authors find that GDP per capita declined around ten percentage points due to terrorism. Abadie, Diamond & Hainmueller (2010) extend the method to study the effects of tobacco control in California. They emphasize that synthetic matching can be a helpful tool and an alternative to case studies to analyze effects at the aggregate level where the number of observational units is limited in most cases. Recently, synthetic matching was used to study the effects of the implementation of the Euro (El-Shagi et al. 2016, Puzzello & Gomis-Porqueras 2018) and the impact of foreign exchange interventions on the exchange rate in Brazil (Chamon et al. 2017). The method is comparable to classical event studies in the sense that we analyse the effect of a one-time treatment. However, stock markets show strong heteroskedasticity over time, especially during the European sovereign debt crisis. Event studies are less likely to deliver correct inference in such a case, because developments around the treatment date have different volatilities than at other times. Synthetic matching is immune to this problem as long as heteroskedasticity is "global" in the sense that data from treated and control group countries are subject to comparable volatility dynamics. The comovement of worldwide asset markets ensures that this is indeed the case.

The results of the synthetic matching model reveal an immediate significant and permanent decline in asset prices in Switzerland as a consequence of the abolition of the exchange rate floor. Breaking down the price index by sectors, we find that the negative growth effect was heterogeneous.[3] The decline in asset price growth relative to the pre-treatment fit was strongest for sectors related to the the financial sector, the industrial sector, followed by the consumer discretionary sector and the consumer staples sector. The unexpected change in the SNB's policy and our estimation method allows to calculate exchange rate elasticities of asset prices. As the causal reactions are both immediate and near-permanent, the estimated elasticities refer to the short and long run at the same time. Our findings imply an elasticity of around -0.75 for the aggregate MSCI index and between -0.55 and -1.35 for all sectors except telecommunication, in line with the export-dominant structure of the Swiss economy (Ma & Kao 1990). This result is likely to reflect fears about reduced competitiveness in international markets, depressed margins, and declines in demand due to an appreciating currency.

The literature on the recent discontinuation of the one-sided Swiss franc-Euro exchange rate floor is relatively scarce. Bannert, Drechsel, Mikosch & Sarferaz (2015) focus on the pass-

[3] An exchange rate survey of the SNB similarly reveals that the appreciation shock affected sectors heterogeneously (Swiss National Bank (SNB) 2015a).

through to firms' costs and profits. Relying on survey-based impulse response analysis, they find that turnover ratios, costs and profits decline. Responses are thereby heterogeneous across firms depending on their export ratio and import share of intermediate goods. A study by Efing et al. (2016) based on firm-level data confirms that effects are heterogeneous. They find that, following the unexpected abolition of the exchange rate floor, firms that are more exposed to foreign currency risk show a larger decline in profitability and sales, and thus decrease investment rates. While our main focus is on the identification of the impact of the unexpected removal of the exchange rate floor on stock markets, we contribute to this literature by breaking down stock market reactions by sector and assessing heterogeneous responses.[4]

In principle, our results—while plausible—are not the only possible outcome. A recent paper by Fauceglia, Lassmann, Shingal & Wermelinger (2015) looks at the effects of exchange rate movements on Swiss exporters. They argue that adverse effects for exporters arising from an appreciation of the Swiss franc are mitigated due to the integration of Switzerland in global value chains. Their results suggest that an appreciation has negative effects but less so for sectors that rely heavily on imported input goods. "Natural hedging" compensates for the effects of a stronger Swiss franc by simultaneously reducing the prices of inputs. Thus, Swiss exporters integrated in global value chains are not forced to strongly increase export prices as a response to a higher value of the Swiss currency to maintain profit margins (see also the theoretical model of Amiti, Itskhoki & Konings 2014).[5]

Exchange rate movements might thus have no relevant effects given the high level of international integration of the typical exporting firm in Switzerland. Efing et al. (2016) also find that financial hedging mitigates the negative effects of currency shocks. However, while there might be mitigating effects for some exporting firms, we provide evidence that the immediate decline in stock prices is likely linked to negative and longer-run implications for the Swiss economy. We show that yields of government bonds decline, with a stronger effect at the short end of the yield curve speaking in favor of a growth shock (Cieslak & Schrimpf 2019). Furthermore, uncertainty following the SNB's policy change not only increases in stock markets but also among the general public and professional forecasters, as well as net equity flows turn negative with potential

[4]The relation between exchange rates, monetary policy, and real effects in Switzerland has, for example, been studied by Bäurle & Menz (2008), Bäurle & Steiner (2015) and Siliverstovs (2016). While adjustments in the real economy are found to take a couple of months, Bonadio et al. (2019) find a fast exchange-rate pass through into prices.

[5]The relation between exchange rates and trade is also studied by Auer & Saure (2012), Berman, Martin & Mayer (2012) and Campa (2004).

negative effects for investment and consumption in Switzerland (Baker & Bloom 2013, Bloom, Floetotto, Jaimovich, Saporta-Eksten & Terry 2018).

The paper is structured as follows. In the following section, we describe the SNB's policy objective and the reasoning behind the introduction and the abolition of the exchange rate floor. Section 3 outlines the synthetic matching methodology and presents the data. Section 4 describes the impact of the discontinuation of the minimum exchange rate on stock markets and discusses results. The final section summarizes the paper.

2 The exchange rate floor in Switzerland

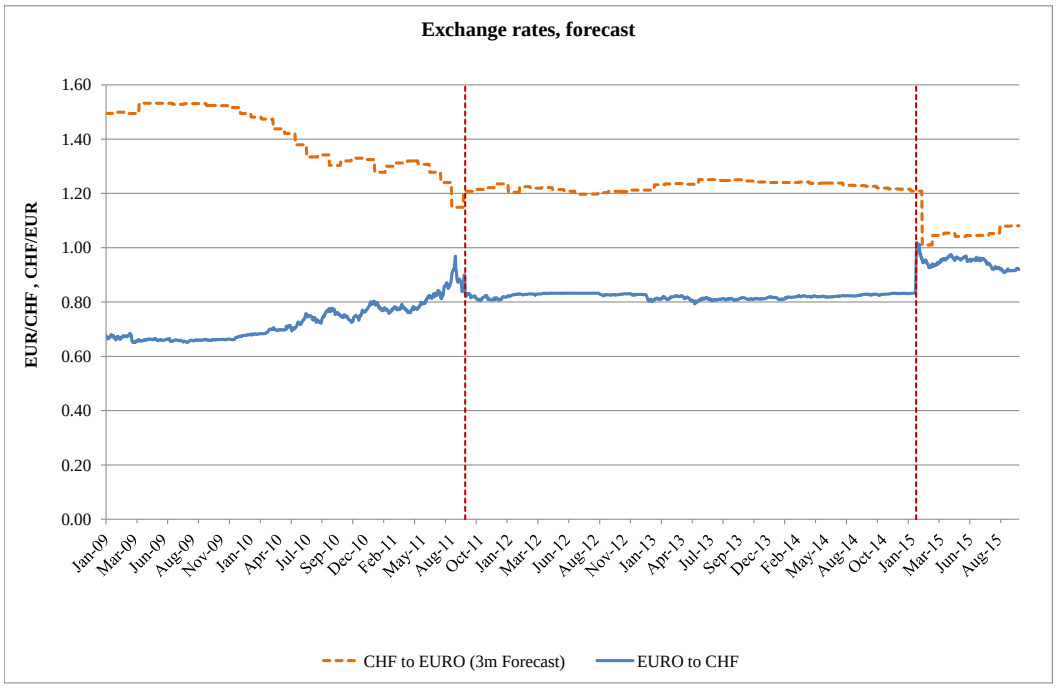
The primary objective of the SNB is the maintenance of price stability as reflected in an annual growth rate of consumer prices of less than 2%.[6] To achieve this objective, the SNB monitors changes in the national consumer price index, makes a quarterly inflation forecast that serves as a decision device, and targets the three-month Swiss franc Libor. The main policy instruments used by the SNB are repo transactions. However, since the change from a fixed to a floating exchange rate in 1973, Switzerland has experienced several periods of increased capital inflows. The consequently increased demand for the Swiss franc has often resulted into an appreciating currency and deflationary pressure, challenging the SNB's monetary policy (Baltensperger 2007, Peytrignet 1999). Stabilizing the currency and price level thus required monetary policy action being based on both exchange rate and interest rate changes.

Used as a monetary policy instrument, the exchange rate floor was introduced by the SNB in September 2011 with a minimum exchange rate of 1.2 Swiss francs per Euro (Swiss National Bank (SNB) 2011c). Figure 1 shows the evolution of the Euro/Swiss franc exchange rate. Prior to the introduction of the exchange rate floor, the Swiss currency was considered as a safe haven. There were several reasons for this, for example, the high level of economic and political stability in Switzerland compared to other countries affected heavily by the financial and the European debt crisis. This caused increased demand for the Swiss franc by international investors and an appreciation of the currency. The appreciating currency led to increasing concerns on the side of Swiss exporters.

Moreover, Swiss inflation and output growth had been at low levels with a depressed economic outlook. The SNB had lowered its inflation forecasts in September 2011 to 0.4% for 2011, -0.3%

[6] See the online reference: `http://www.snb.ch/en/iabout/monpol/id/monpol_strat.`

Figure 1: Exchange rates and forecasts



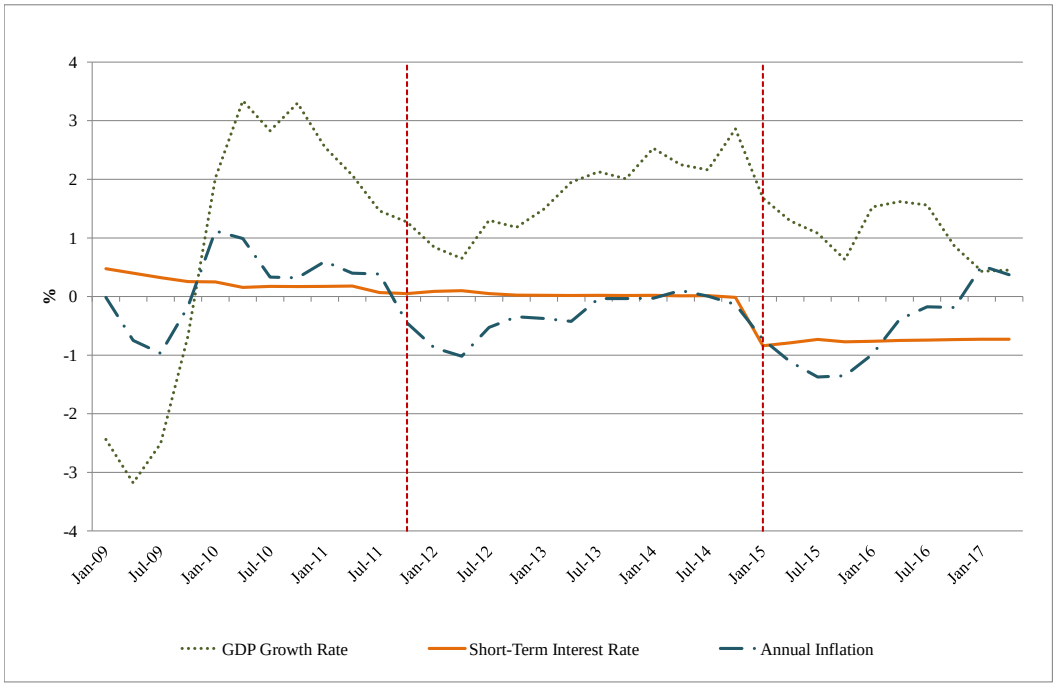
Note: This figure shows the daily exchange rate of the Euro against the Swiss franc (blue, solid line) and the monthly three-month ahead forecast for the exchange rate of the Swiss franc against the Euro (orange, dashed line) for the period from January 2009 to October 2015. The minimum exchange rate with approximately 1.2 Swiss franc per Euro was introduced on September 06, 2011 and abolished on January 15, 2015 (red, vertical lines). Source: Datastream, Consensus Economics.

for 2012, and 0.5% for 2013 and expected stagnating growth for the third and fourth quarter of 2011 (Swiss National Bank (SNB) 2011b), see also Figure 2. To stop the appreciation of the Swiss franc, regain competitiveness and mitigate deflation risk, the SNB adopted the floor and the SNB stated a high commitment to maintain the floor (Swiss National Bank (SNB) 2011b, Swiss National Bank (SNB) 2011a). The maintenance of the floor was mainly executed through an increase in the number of Swiss francs used to buy Euros. Over time, this had the effect of strongly increasing the amount of foreign currency in the SNB's balance sheet to 480 billion US dollar in 2014 or 70% of GDP.[7] Figure 3 documents a strong increase in foreign reserve assets.

For our identification, we use the removal of the exchange rate floor as an instrument to identify the impact of monetary policy regime changes on stock prices (Ramey 2016). This requires that, first, the abolition of the exchange rate floor was unexpected by market partici-

[7]See the online reference: `https://www.economist.com/blogs/economist-explains/2015/01/economist-explains-13`, *accessed May 3rd, 2018.*

Figure 2: Economic developments around the changes in the exchange rate regime



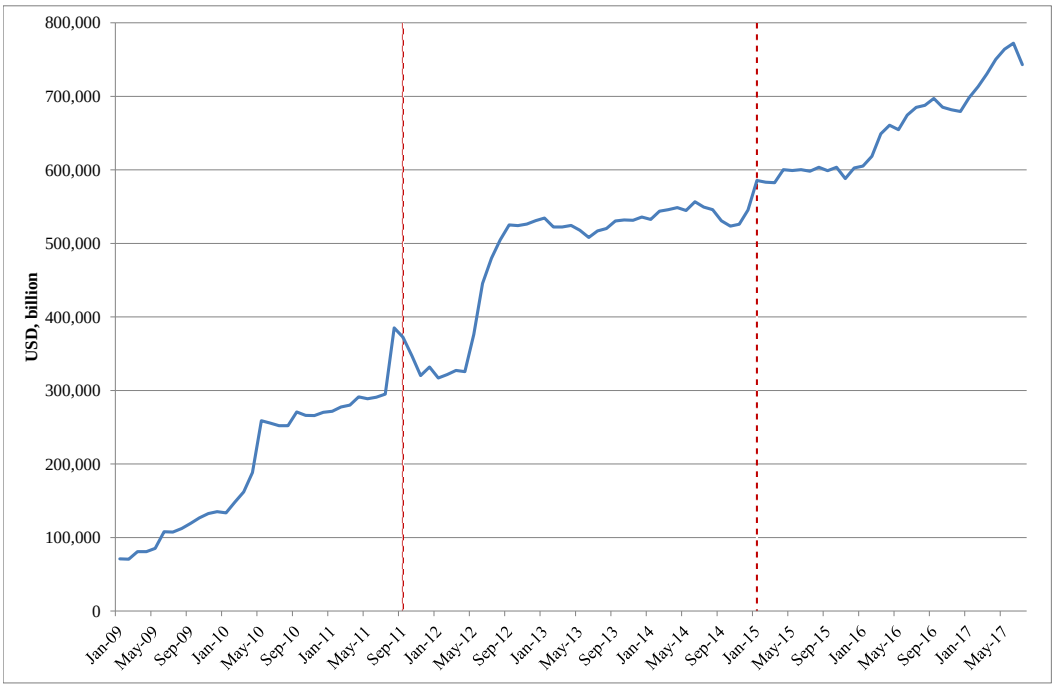
Note: This figure shows the evolution of key quarterly economic indicators in Switzerland including the percentage change in GDP, the short-term interest rate (in %) and the annual inflation rate (in %) from Q1 2009 until Q2 2017. Vertical lines indicate the introduction and abolition of the exchange rate floor. Source: Datastream.

pants. Second, the SNB's decision to abolish the minimum exchange rate should not have been motivated by stock market developments. We comment on this in the following paragraphs.

As concerns the first point, the SNB changed its monetary policy regime on January 15, 2015 as a surprise to market participants, by abolishing the exchange rate floor (Swiss National Bank (SNB) 2015c). The Swiss franc immediately appreciated by around 14% versus the Euro and around 12% versus the US Dollar. This came unexpectedly as the previous SNB's communication showed a high degree of commitment to maintain the exchange rate floor. How unexpected this policy change was can be seen by comparing the current exchange rate and expectations about the three-month ahead exchange rate. Figure 1 plots the three-month ahead forecast by Consensus Economics next to the actual exchange rate. For visibility, we take the reverse of the exchange rate and plot the forecast series for the Swiss franc relative to the Euro.

The figure reveals that until the abolition of the exchange rate floor, forecasters did not expect that the SNB would change its exchange rate target. Note that Consensus Economics

Figure 3: Foreign reserve assets around the changes in the exchange rate regime



Note: This figure depicts the pattern of foreign reserves measured by the monthly amount of international reserve assets (in billions of USD). Vertical lines indicate the introduction and abolition of the exchange rate floor. Source: Datastream.

collects assessments from a group of professional forecasters around the 10th of each month, that is, more or less immediately before January 15. The forecast is always close to 1.2, and the forecasters adjusted their expectations only after the abolition of the floor. This evidence is confirmed by Jermann (2017) who shows that the credibility in the exchange rate target established by the SNB was steadily increasing from 2011 onward and reached its highest value in 2014.[8] The results by Mirkov et al. (2016), who study the beliefs of market participants, point to the same direction. They find no evidence for shifts in expectations about the continuation of the exchange rate target by studying option and spot market data. Credibility has been enhanced by speeches given by members of the SNB's Governing Board.

As concerns the second point, there are several reasons for the sudden discontinuation of the minimum exchange rate, which are not related to developments in stock markets. First,

[8]Hanke, Poulsen & Weissensteiner (2015) find that the market's confidence in the exchange rate target has been increasing over time. Cox (2015) writes in The Economist that "the policy was reaffirmed only three days before its repeal. The doffing of the cap surprised and upset the foreign-exchange markets, hobbling several currency brokers [...]." (Source: `http://www.economist.com/node/21640231/.`, *accessed May 3rd, 2018.*)

quantitative easing by the ECB was expected to lead to a further depreciation of the Euro, forcing the SNB to continue to increase their supply of Swiss francs to maintain the floor. Second, by abolishing the floor, the SNB could stop the loss in value of the Swiss franc and counteract previous losses that had occurred in unison with a depreciating Euro. Third, the SNB was not forced any more to acquire euro-denominated assets (mostly sovereign bonds) that carried the risk of a Euro breakup and low returns. By moving away from low-return euro-denominated assets, the SNB could also mitigate political pressure from cantons that benefit from its profits (Brunnermeier & James 2015, Wyplosz 2015). Finally, with the discontinuation of the minimum exchange rate, the SNB could again increase the independence of monetary policy.

However, the unexpected step raised concerns about the consequences for future growth in Switzerland. Consensus Economics shows that the average growth expectations for the current year had been much higher with a lower standard deviation at the beginning of January 2015 (1.86% change in real GDP, st. dev. 0.316) than those after the policy change in February 2015 (0.43% change in real GDP, st. dev. 0.691). The growth expectations for 2016 had as well been lowered from 1.99% in January to 0.89% in February. Additionally, the Swiss National Bank (SNB) (2015b) states that the policy change led to a worsened economic outlook in the short-term with international trade being mostly affected. We assess to what extent the immediate reactions in the stock market mirrored these concerns and whether market participants' uncertainty about future economic developments increased following the abolition of the exchange rate floor.

3 Synthetic matching and data description

To assess the impact of the unexpected change in the SNB's monetary policy – executed by abolishing the Swiss franc-Euro exchange rate floor – on stock markets, we make use of a synthetic matching model. In the following, we describe the synthetic matching model and explain the underlying data.

3.1 Synthetic matching

Our focus is on stock market reactions, whereas we are interested in (i) whether there are significant market responses in stock markets, and (ii) whether sectoral indices are affected to the same extent. The synthetic matching model has the advantage that it allows comparing

the actual development in Switzerland after the unexpected policy change to a counterfactual case where the policy change does not occur (Abadie & Gardeazabal 2003, El-Shagi et al. 2016). The comparison between the actual and counterfactual patterns yields insights into relevant mechanisms of exchange rate targets applied as a monetary policy tool by small open economies.

For our identification, we exploit the fact that the removal of the exchange rate floor occurred unexpectedly (see also Section 2). Making use of this surprise, we identify effects in a synthetic matching framework, which furthermore allows estimating this effect without recourse to previous changes in exchange rates. The analysis is, hence, not limited by an otherwise necessary assumption that today's reaction is similar in all but magnitude to previous reactions to much smaller (and potentially unidentifiable) adjustments of the exchange rate. Instead, the first main identifying assumption of synthetic matching, that is, the exogeneity of the policy change under observation, is clearly fulfilled. The second main identifying assumption is that control group countries are unaffected by the unexpected abolition of the Swiss franc-Euro exchange rate floor. This assumption is also largely unquestionable as Switzerland is a comparably small country with negligible influence on global developments. However, we still subject our results to a robustness check in which we exclude all direct neighbors of Switzerland from the control group.

The matching procedure assumes that prior to the treatment in January 2015, there are no substantial differences between the treated and the control group countries used to construct the synthetic counterpart. The matching procedure creates a counterfactual country to Switzerland that (i) does not experience the unexpected currency appreciation, (ii) is similar along key economic dimensions, namely, the matching criteria mc, and (iii) has a similar development in the stock market series (MSCI index) before January 2015. The choice of countries and economic variables used for the matching is described in Section 3.2. The model that we estimate is as follows:

$$v^* = \min_{v} \left\{ \sum_{t=1}^{T} \left(f(MSCI_{treat,t}) - \sum_{n=1}^{N} w_n^*(v) f(MSCI_{n,t}) \right)^2 \right\} \tag{1}$$

$$\text{s.t.} \quad w^*(v) = \min_{w} \left\{ \sum_{m=1}^{M} v_m \left(mc_{treat,m} - \sum_{n=1}^{N} w_n mc_{n,t} \right)^2 \right\} \tag{2}$$

$$\sum_{n=1}^{N} w_n = 1, \quad \sum_{m=1}^{M} v_m = 1$$

$MSCI_{treat,t}$ is the MSCI index of Switzerland, and $MSCI_{n,t}$ is the MSCI index of a non-treated country n in period t. In our study, we analyze different transformations of the MSCI index as indicated by a generic function $f(\cdot)$. In particular, we look at log-levels, growth rates, and sectoral subindices. The objective function in Equation (1) aims at minimizing the squared difference of the dependent variable between Switzerland, in which the policy change takes place, and the synthetic counterpart before the treatment. Stock market indices of countries in the control group are weighted by country weights $w_n^*(v)$ in order to replicate as close as possible actual stock market developments in Switzerland before the treatment. The objective function is minimized subject to the constraint in Equation (2) that the squared difference between the matching controls $mc_{treat,m}$ (or indicator variables) in the treated country and the weighted controls of the non-treated countries $w_n mc_{n,t}$ in the pre-treatment period is minimized. The constraint accounts for the fact that the importance of criteria for the matching of stock market developments may not be identical for all matching criteria, using importance weights v (or v^* in the optimum).

Having estimated the synthetic counterpart, we forecast the counterfactual series for Switzerland in case the abolition of the exchange rate floor would not have occurred. We then compare the effect of the unexpected change in the exchange rate on the treated country, Switzerland, with the pattern of the synthetic counterparty. This difference is represented in the analysis by the "gap between treated and synthetic series". Additionally, we conduct placebo tests and repeat the matching procedure, treating any other country as if the policy change would have taken place there (Cavallo, Galiani, Noy & Pantano 2013). The treatment effects found in placebo studies should be statistically indifferent from zero, as no actual treatment took place. Thus, the distribution of observed placebo effects can be used (i) as a distribution of the null hypothesis that the treatment has no effect and (ii) to calculate whether treatment effects in Switzerland are significant.

3.2 Data used for the synthetic matching model

Our dependent variable of interest is either the log-level or the growth (return) rate of the stock market index. We base the analysis on the MSCI stock price index and exploit the high frequency of the data series as well as the availability of the index for many potential control group countries. The analysis is conducted for daily values of the MSCI index based on data from the beginning of 2014 to mid-2017. The pre-treatment period spans from January 15, 2014

to January 14, 2015.[9] The series are standard-normalized by country to make them comparable across treatment and control countries. For first visual inspection, we conduct the matching procedure for the MSCI index in log-levels. From there, we move on to an investigation of day-to-day MSCI growth rates. Finally, we make use of the granularity of the index and break it down by sector, which allows tracing heterogeneous responses across sectors. The sectors are classified in ten categories: consumer discretionary, consumer staples, energy, financials, health, industrials, information technology, materials, telecommunication services, and utilities.[10] For robustness tests, we make use of daily data on short-term and long-term government bond yields.

We use one year of data before 2015 for the daily matching procedure. This provides enough observations before the abolition of the exchange rate floor to obtain accurate estimates. The synthetic counterfactual of Switzerland is a weighted average of control group countries with time-invariant weights. Thus, more observations would raise concerns that estimates are distorted by relations that change over time. For example, the introduction of the Euro in 1999 might have had fundamental consequences to the integration of Switzerland in international trade and capital flows. Similarly, we eliminate concerns of confounding factors due to possible structural breaks as a consequence of the start of the financial crisis in 2007/08.

Next to the dependent variable, the matching is based on a set of control variables. To capture key economic developments, we include the annual growth rate of the gross domestic product (GDP), inflation (CPI), short-term interest rates, and general government gross debt (% of GDP). We also control for sectoral contributions to GDP by including the value added by the industrial sector and by the services sector (% of GDP). Given that Switzerland is a small open economy, we also include control variables that approximate competitiveness and integration in international markets, such as the current account (% of GDP), the exports of goods and services (% of GDP), the foreign reserve assets (millions USD), the unit labor costs, and the real effective exchange rate based on the consumer price index. Additionally, as we are interested in the short-run responses in stock markets, we base the matching on variables

[9] In robustness tests, we use *end of month* values of the MSCI index from January 2010 to mid-2017. The pre-treatment period thus spans from January 2010 to December 2014. We do not use monthly averages or beginning of month values because the abolition of the exchange rate floor was in the middle of the month, namely, on January 15, 2015.

[10] Due to limited data availability, we exclude information technology and utilities. Moreover, we cannot use the same group of candidate countries in every estimation for two reasons. First, some MSCI subindices are not available in all countries (see Figure A1). Second, even if they are available, the degree of time variation is sometimes insufficient. The reason for this may be that all firms in the MSCI subindex of one country are not traded for extensive periods of time. More information on the methodology and composition of the sectoral indices can be found in the appendix.

related to developments in financial markets. These include domestic credit provided by the financial sector (% of GDP), the central bank transparency index (Dincer & Eichengreen 2014), and three-month interbank rates (in percentage points).

For all control variables, we include the longest possible series. However, as usual in synthetic matching, we do not match the actual time series of the control variables but rather five-year averages (El-Shagi et al. 2016). Contrary to concerns regarding the long-run matching of the variable of interest, including five-year averages of control variables that are basically unrelated to the current values of the variable of interest is not too problematic because these controls have near-zero importance weights in the matching procedure. The summary statistics of all control variables, shown separately for Switzerland and the control group countries, are reported in Table A1 in the data appendix.

A sample of reasonable matching candidates defined by the OECD countries is available to evaluate short-run stock market reactions following the removal of the exchange rate floor in Switzerland. Out of this pool, matching countries are selected according to data availability of dependent and explanatory variables. Therefore, Iceland, Israel, Luxembourg and Slovakia are excluded throughout the analysis.

4 Results of the synthetic matching model

In this section, we first evaluate whether the unexpected abolition of the minimum exchange rate caused significant stock market reactions. Second, we analyze the differential effects across sectors. Finally, we discuss the relevance of the policy change for the broader economy.

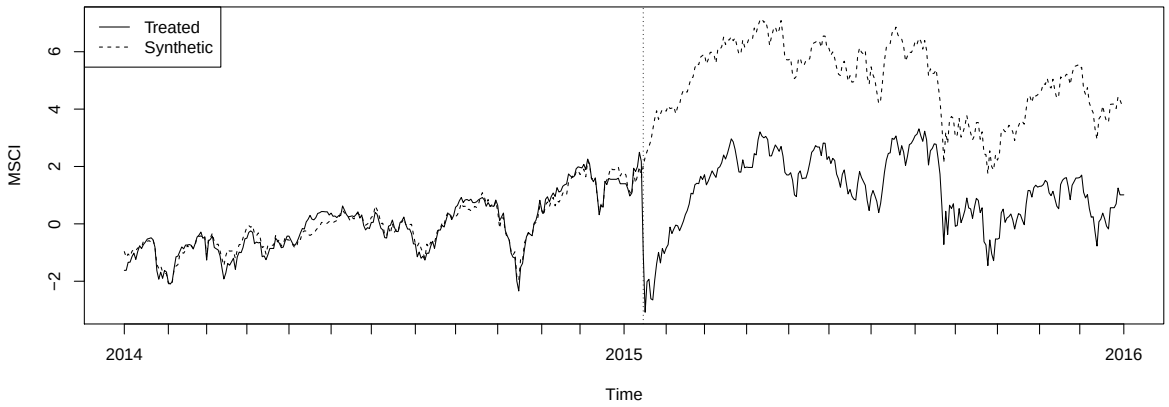
4.1 Do financial markets respond to the abolition of the exchange rate floor?

Figure 4 displays the synthetic matching results revealing the impact of the abolition of the minimum exchange rate on January 15, 2015 on the log-level of the Swiss MSCI index. In the first panel, it can be clearly seen that asset prices drop strongly in January 2015 (solid line), while the same did not happen in the synthetic counterpart (dashed line). Note that we standard-normalize all asset prices based on their pre-treatment subsample. That is, data prior to January 15, 2015 have mean zero and standard deviation one.

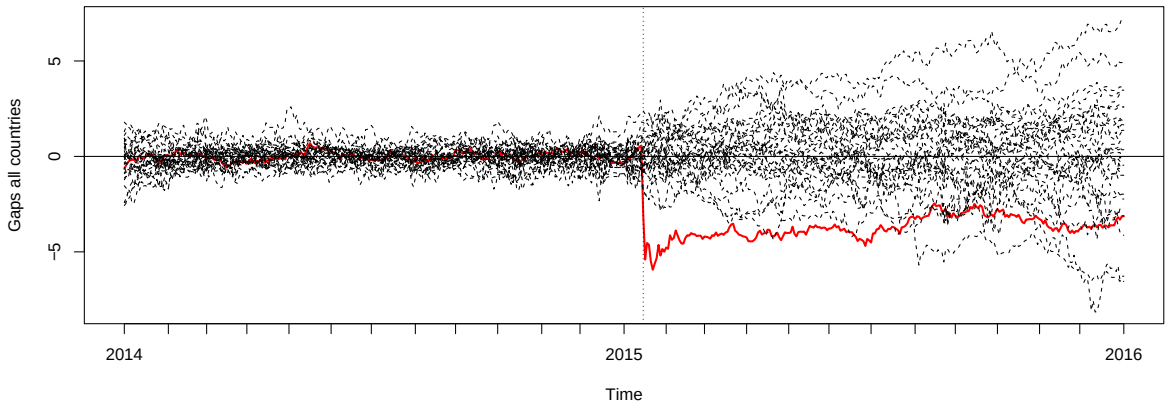
The second panel shows the gap between the treated and the synthetic counterpart of Switzerland (red, solid line). The dotted lines mark the gap for the placebo tests. Prior to treatment,

Figure 4: Synthetic matching result for Swiss MSCI index – Levels

(a) Treated and synthetic control series



(b) Gaps



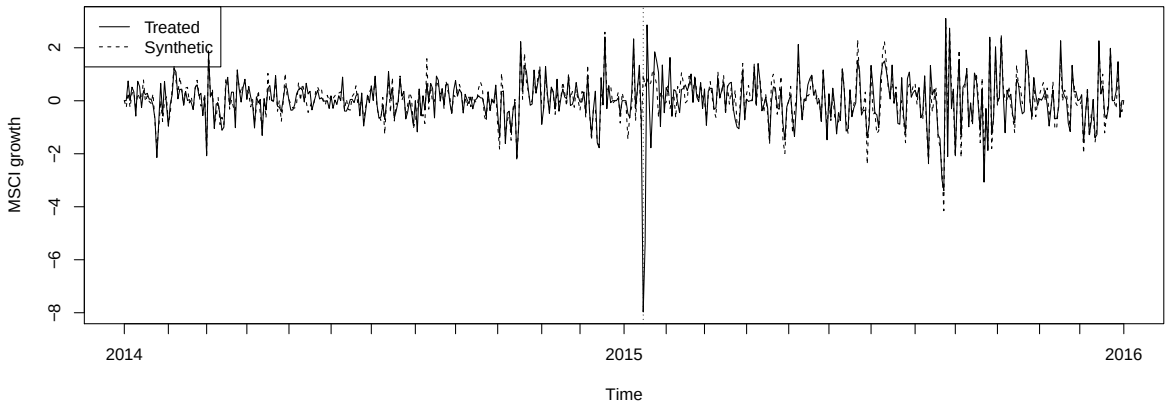
Note: The first panel shows the effect of the abolition of the minimum exchange rate on the MSCI index in Switzerland and in its counterfactual (in levels, standard-normalized by country). The second panel displays the gap (treated-synthetic) between the two series with Switzerland as the treated country (red, solid line) and the gap between treated and synthetic country if any of the other control group countries would have been the treated country (black, dotted lines). The dotted vertical line marks the treatment, that is the abolition of the minimum exchange rate in January 2015. The set of variables and control countries used for the matching procedure is described in Section 3.2 and in the data appendix.

the gap is zero on average (which it should be due to the matching process). Moreover, the average absolute gap is smaller than for any of the placebo tests, which implies that we match Switzerland particularly well. On the treatment day, the gap sharply increases in absolute terms and permanently remains at the new (lower) level. That is, the synthetic MSCI level in Switzerland has a parallel trend to the true MSCI development. A comparison of Switzerland to placebo studies reveals that the Swiss gap is the most negative for a duration of six months

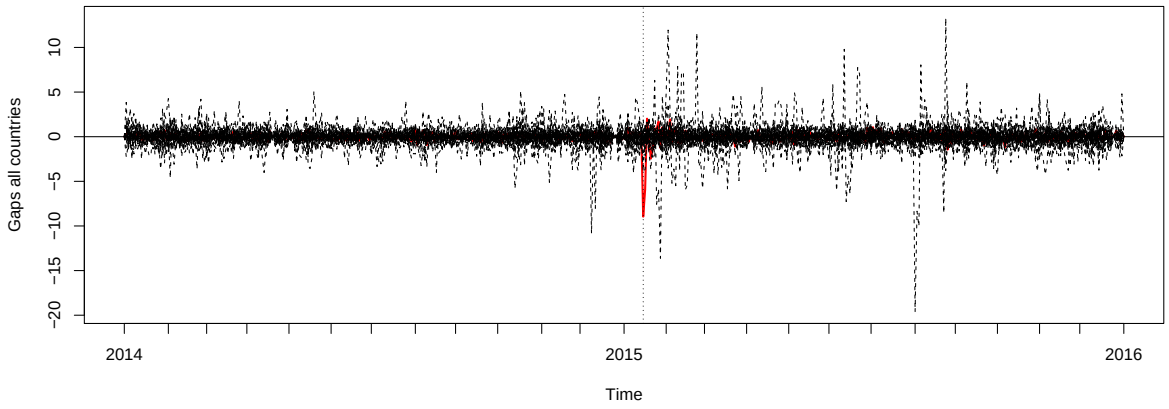
(with the exception of seven trading days), until forecasting uncertainty starts to dominate in some placebo studies. These results suggest that the SNB's policy change caused economically and statistically significant disruptions.

Figure 5: Synthetic matching result for Swiss MSCI index – Growth rates

(a) Treated and synthetic control series



(b) Gaps



Note: The first panel shows the effect of the abolition of the minimum exchange rate on the MSCI index in Switzerland and in its counterfactual (in growth rates, standard-normalized by country). The second panel displays the gap (treated-synthetic) between the two series with Switzerland as the treated country (red, solid line) and the gap between treated and synthetic country if any of the other control group countries would have been the treated country (black, dotted lines). The dotted vertical line marks the treatment, that is the abolition of the minimum exchange rate in January 2015. The set of variables and control countries used for the matching procedure is described in Section 3.2 and in the data appendix.

We proceed by evaluating the effects on daily asset price growth rates, again standard-normalized on the pre-treatment subsample. The result in the first panel of Figure 5 shows that asset price growth in Switzerland drops strongly on January 15, 2015 (solid line). However,

this is not observed for the synthetic counterpart (dashed line). The corresponding treatment effect on impact (i.e., the difference between the Swiss and the synthetic MSCI index in January 2015) is not only large but also highly statistically significant, as seen in the second panel, which again displays the difference between the treated and the synthetic series with Switzerland as the treated country (red, solid line) in comparison to placebo studies (black, dotted lines). We see that growth rates on January 15, 2015 are around nine standard deviations below their synthetic counterpart, which amounts to a 10% drop of asset prices that can be attributed to the abolition of the exchange rate floor. It can be seen that the Swiss gap is a strong outlier at the treatment date. In line with the parallel development of log-level asset prices, we cannot find systematically positive or negative gaps after January 15, 2015.[11]

Table 1 shows statistics of the gap series. In the first row, we report results for the aggregate MSCI index.[12] We find a gap on January 15, 2015 of around nine standard deviations (pre-treatment asset price growth rates) in size in the first column. In the second column, we report the average absolute gap prior to the treatment (0.27), i.e. the absolute estimation errors of the synthetic matching procedure. The third column forms the ratio of the first two columns. It shows that the gap on the treatment day was about 34 times higher than during the pre-treatment estimation sample. That is, the gap was both statistically and economically large and significant. Next, we compare the Swiss results to the results for the placebo studies. Column (4) shows that, on average, gaps on January 15, 2015 where only 1.7 times the mean absolute gap in the pre-treatment estimation sample. Moreover, for the placebo studies, they are insignificantly different from one, indicating that gaps at the treatment day are – by and large – of a similar magnitude as during the pre-treatment estimation sample. In the fifth column, we perform the "small-sample significance test" of Puzzello & Gomis-Porqueras (2018) and show that the Swiss gap is the largest among the 30 countries used in the analysis (Switzerland plus placebo studies). In total, the results confirm that there was a relevant one-time policy change resulting in the abolition of the minimum exchange rate with significant declines in asset price growth on

[11]Results remain robust when excluding neighboring countries of Switzerland from the control group and are available upon request. This is not totally surprising, as neighboring countries have very low weights in the counterfactual Switzerland in the baseline estimation. Information on all weights (of control group countries and matching indicators) can be obtained upon request. It turns out that the Nordic and Benelux countries have the largest weights, meaning that European small open economies are most useful for generating a synthetic counterpart. Nearly all matching variables receive some positive weights, but there is no single indicator that receives a large weight. Hence, changing the set of matching variables should not have huge effects on the results. If at all, variables reflecting openness, such as exports and the current account, receive more weight in matching stock market data.

[12]Further rows report results for MSCI subindices, which we address in the next subsection.

impact.

Table 1: Statistics on the gap between treated and synthetic MSCI growth rates

	(1) gap	(2) mean abs gap, pre-treatment	(3) ratio, CH	(4) ratio, placebo	(5) ranking (abs gap)	(6) #obs
MSCI aggregate index	-8.95	0.27	33.58	1.67	1	30
consumer discretionary	-2.99	0.11	26.68	1.22	1	29
consumer staples	-7.19	0.34	20.88	1.30	1	29
energy	-8.33	0.94	8.90	1.97	1	28
financials	-6.45	0.23	27.55	1.76	1	29
health	-8.71	0.46	18.94	1.76	1	27
industrials	-9.53	0.35	27.09	1.19	1	29
materials	-5.71	0.29	19.59	1.74	1	29
telecommunication	0.63	0.43	1.48	0.86	24	29

Note: This table provides information on the difference between MSCI growth rates in Switzerland and their counterfactual. MSCI growth rates have been standard-normalized such that they have mean zero and standard deviation one prior to the treatment day in every country. Column (1) gives the gap (treated-synthetic) on January 15, 2015. Column (2) shows the mean absolute gap prior to the treatment in Switzerland (as a measure of estimation uncertainty). Column (3) reports the ratio between the first and second column (in absolute terms). Column (4) gives the average of the same ratio for all placebo studies. These ratios are all insignificantly different from one. Column (5) reports the rank of the Swiss gap in column (1) with respect to gaps in placebo studies (in absolute terms). A rank of 1 implies that Switzerland is the country with the largest gap (treated-synthetic). Column (6) contains the number of countries (including Switzerland) used in the matching analysis for the respective index.

Relating the sudden abolition of the minimum exchange rate to the treatment effect shown in Figure 5, we can calculate the exchange rate elasticity of stock prices. As the effect of the abolition of the exchange rate floor on asset prices is immediate and near-permanent, elasticity estimates refer simultaneously to the short and long run. The unexpected policy change therefore allows us to provide an estimate for an elasticity that has – to our knowledge – not yet been reported in the literature. The papers that come closest to measuring (long-run) elasticities are based on cointegration analyses like Kim (2003).

Elasticities are given by the ratio of the (non-adjusted) treatment effect and the growth rate of the exchange rate on January 15, 2015. That is, we first have to multiply the treatment effect reported in Table 1 by the pre-treatment standard deviation of daily asset price growth rates before taking the ratio. Table 2 reports the exchange rate elasticities of stock prices for both Euro/CHF and Dollar/CHF exchange rates in the last two columns. For the aggregate MSCI index, we see that elasticities are between -0.70 and -0.82. These estimates are consistent with cointegration relationships estimated in the literature. For example, Kim (2003) finds an

exchange rate coefficient of -0.68 in a cointegration analysis for the US between 1974 and 1998.[13]

Table 2: Exchange rate elasticities of asset prices

	(1) %-Change (Euro/CHF)	(2) %-Change (Dollar/CHF)	(3) asset price effect	(4) elasticity (Euro/CHF)	(5) elasticity (Dollar/CHF)
MSCI aggregate index	14%	12%	-9.81%	-0.70	-0.82
consumer discretionary	14%	12%	-16.19%	-1.16	-1.35
consumer staples	14%	12%	-7.68%	-0.55	-0.64
energy	14%	12%	-11.43%	-0.82	-0.95
financials	14%	12%	-9.97%	-0.71	-0.83
health	14%	12%	-10.07%	-0.72	-0.84
industrials	14%	12%	-10.03%	-0.72	-0.84
materials	14%	12%	-9.24%	-0.66	-0.77
telecommunication	14%	12%	0.84%	0.06	0.07

Note: This table reports Swiss exchange rate elasticities of asset prices for the MSCI aggregate index and its subcomponents. Columns (1) and (2) give the percentage change of Euro/CHF and Dollar/CHF exchange rates on January 15, 2015. Column (3) reports the asset price effect that can be attributed to this policy change (i.e., the gap between treated and synthetic series, accounting for standard-normalization of the data in the calculation). Columns (4) shows the Euro/CHF exchange rate elasticities of asset prices, i.e. the ratios of Column (3) over Column (1). Column (5) gives the same elasticity for the Dollar/CHF exchange rate.

For robustness, we repeat the analysis for the MSCI index at a monthly frequency. Even when we eliminate short-run noise out of the data by aggregating to the monthly frequency, the large and significant decline in asset price growth can be confirmed (Figure 6).[14] The exchange rate elasticity of asset prices estimated at a monthly frequency is slightly stronger than the ones reported in Table 2 (around -1). This emphasizes again that the strong stock-market reaction persists for a long time. Furthermore, to see the impact of the abolition of the floor on the excess return of a foreign investor that fully hedges currency exposure, we test whether results change quantitatively if one looks at changes in stock returns in excess of a risk-free rate (approximated by daily returns of short-term government bonds). Results are shown in Table 3 for the aggregate index and by industry and remain nearly unchanged.[15] If at all, there is some evidence that for most MSCI series the gap is larger in absolute terms for the unadjusted series. Hence, even a

[13] Our estimation controls for many possible covariates. It is therefore related to settings in which cointegration relationships are estimated after controlling for additional variables like industrial production. These control variables are needed to robustly identify cointegration between asset prices and exchange rates, as documented extensively by Nieh & Lee (2001) for G7 countries.

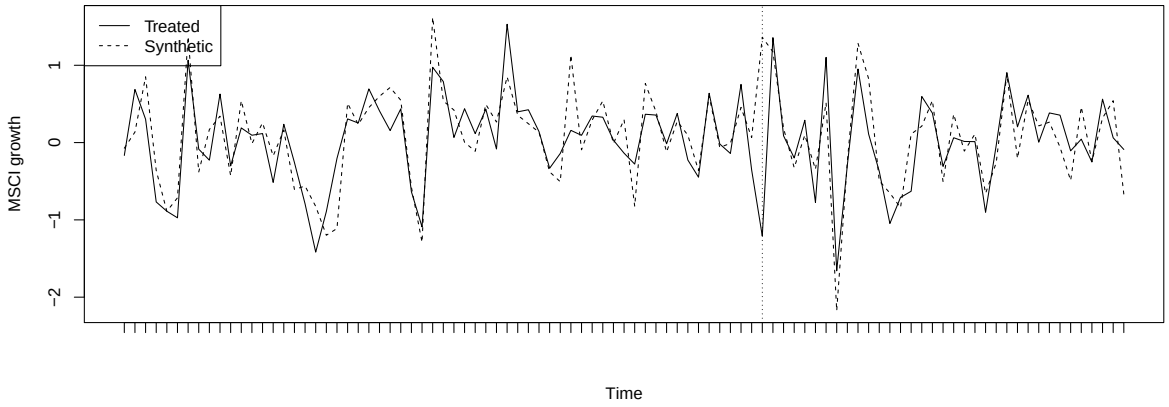
[14] Among the placebo studies, there is only one with a larger gap than the Swiss treatment effect.

[15] Gaps are measured as standard deviations of the underlying asset prices. In terms of absolute numbers, the MSCI index in the baseline estimation dropped by 9.8% due to the removal of the exchange rate floor. This number is very similar for the excess returns, as the variation of short-run government bond yields in Switzerland is orders of magnitudes smaller than the variation of asset prices.

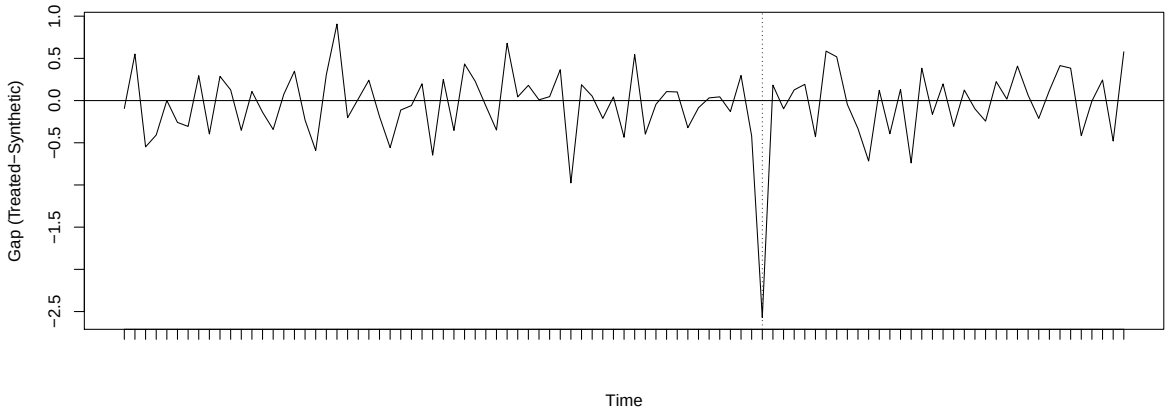
fully hedged investor experiences negative returns, which might be due to the underlying growth shock as demonstrated in Section 4.3.

Figure 6: Synthetic matching result for Swiss MSCI index – Monthly data

(a) Treated and synthetic control series



(b) Gaps



Note: This graph shows in the upper panel the effect of the abolition of the minimum exchange rate on the MSCI index (aggregated to the monthly level) in Switzerland and in its counterfactual (in growth rates, standard-normalized by country). The lower panel shows the gap between the treated and the synthetic series. The dotted vertical line marks the treatment, that is the abolition of the minimum exchange rate in January 2015. The set of variables and control countries used for the matching procedure is described in Section 3.2 and in the data appendix.

4.2 Are responses heterogeneous across sectors?

We repeat the analysis for sectoral subcategories of the MSCI index. Sectors might respond differently to the discontinuation of the exchange rate floor (Bäurle & Steiner 2015, Fauceglia et al. 2015), as investors might judge policy changes to be of different relevance for individual

Table 3: Statistics on the gap between treated and synthetic MSCI growth rates (excess return)

	(1) gap	(2) mean abs gap, pre-treatment	(3) ratio, CH	(4) ratio, placebo	(5) ranking (abs gap)	(6) #obs
MSCI aggregate index	-8.91	0.27	33.56	1.55	1	29
consumer discretionary	-2.94	0.11	26.73	1.31	1	28
consumer staples	-7.27	0.35	20.87	1.34	1	28
energy	-7.32	1.09	6.72	1.78	1	27
financials	-6.29	0.23	27.39	1.79	1	28
health	-8.74	0.46	18.92	1.21	1	26
industrials	-9.51	0.34	27.65	1.09	1	28
materials	-5.68	0.29	19.62	1.69	1	28
telecommunication	0.54	0.44	1.23	0.79	24	28

Note: This table provides information on the difference between MSCI growth rates in Switzerland and their counterfactual. MSCI growth rates minus a risk-free rate (approximated by daily returns of short-term government bonds) have been standard-normalized such that they have mean zero and standard deviation one prior to the treatment day in every country. Column (1) gives the gap (treated-synthetic) on January 15, 2015. Column (2) shows the mean absolute gap prior to the treatment in Switzerland (as a measure of estimation uncertainty). Column (3) reports the ratio between the first and second column (in absolute terms). Column (4) gives the average of the same ratio for all placebo studies. These ratios are all insignificantly different from one. Column (5) reports the rank of the Swiss gap in column (1) with respect to gaps in placebo studies (in absolute terms). A rank of 1 implies that Switzerland is the country with the largest gap (treated-synthetic). Column (6) contains the number of countries (including Switzerland) used in the matching analysis for the respective index.

firms and distinct sectors. Nonetheless, a significant decline in asset growth in some sectors would support the drop in the aggregate index. The MSCI index of Switzerland consists of approximately 40 constituents. It covers more than 80% of market capitalization.[16] Among the largest firms in the index are Nestle (consumer staples), Roche Holding Genuss (health), Novartis (health), UBS Group (financials), and the ABB Group (industrials). In 2016, the sectors with the largest weights in the MSCI index are health, financials, and consumer staples.

Table 1 reveals the magnitude of the gap between the growth rate of the MSCI series for the treated country (Switzerland) and the synthetic counterpart for the subindices. Except for the *telecommunications* sector, all sectors show negative gap values that are (in absolute terms) larger than in any of the placebo tests (Table 1, columns (1) and (5)). This result holds even for the energy sector despite the bad fit of the synthetic series.[17] The fourth column reveals that, similar to the results for the aggregate index, the placebo studies have a gap between the observed and synthetic series that is comparable to pre-treatment gaps, with gap ratios

[16]See the document on the "MSCI Switzerland Index" provided by MSCI INC that can be found here: `https://www.msci.com/documents/10199/f0f13c98-d5fd-43f3-8908-9f12c2fb3a4a`

[17]Column (2) indicates that the mean absolute pre-treatment gap is 0.94, and therefore about as large as the variation of the growth rate of the MSCI index for the energy sector in Switzerland.

insignificantly different from one.

The third column of Table 1 sets the treatment effects in relation to the pre-treatment fit of synthetic growth rates. The largest drops in asset price growth can be found in the *financials*, *industrials*, *consumer discretionary* and *consumer staples* sector. In terms of absolute effects, the *consumer discretionary* sector suffers by far the most, with a drop in asset prices of around 16%, see the third column of Table 2.

The strong negative response in asset price growth in the *industrials* and *consumer* related sectors might be driven by fears about the reduced competitiveness of exporting goods in the course of an appreciating Swiss franc following the abolition of the floor. For example, before the introduction of the exchange rate floor, the Swiss National Bank (SNB) (2011b) stated that internationally active firms suffered from declines in margins due to the appreciating Swiss franc. The biggest players in these indices are highly active in international markets and include, for example, ABB, an industrial company that specializes in power and automation technologies. Compared to the consumer discretionary sector, which includes luxury goods such as watches or jewelery (the largest constituent in the sectoral index is Richemont, a company that encompasses various brands of luxury goods), the decline for the consumer staples sector is a bit smaller. This finding suggests that despite an appreciation of the currency and potentially reduced export opportunities, market participants do not judge the consumer staples to be as affected as the consumer discretionary sector. One potential reason is that the price elasticity of demand for luxury goods is higher.

The *financials* sector also shows a strong decline in asset price growth relative to the pre-treatment fit. On the one hand, this might represent fears about reduced growth in Switzerland and a worsening of economic conditions. Moreover, financial firms generate a high share of their earnings abroad, which are worth less after a surprise appreciation of the Swiss franc. On the other hand, financial firms may have better diversification and hedging possibilities due to their integration in international capital markets. We find the financial sector to be strongly affected despite these counteracting forces.

The remaining sectors related to *materials* and *health* show a ratio below 20, while the *energy* and *telecommunication* sectors seem to be more shielded from negative responses.

We also calculate the exchange rate elasticities for all sectors and report them in Table 2. We find elasticities between -0.55 and -1.35. These are in the ballpark of elasticities based on the aggregate index. The telecommunications sector is – again – an exception.

In summary, our results suggest that the sudden removal of the exchange rate floor by the SNB caused significant reactions in stock markets. Based on the overall MSCI index, we find that the abolition of the floor had a negative effect on asset price growth for the treated compared to the counterfactual series. However, heterogeneities arise across sectors: particularly, export-oriented sectors with higher demand elasticities seem to have been affected most (industrials, consumer discretionary, financials). This might be due to fears about reduced competitiveness given an appreciating domestic currency. In contrast, a sector with mostly national relevancy, such as the telecommunications sector, showed no significant downward response.

4.3 Does the decline in stock prices after the abolition of the exchange rate floor relate to worsened growth prospects?

Previous results have established that stock markets in Switzerland responded significantly to the abolition of the exchange rate floor. The negative response of stock market participants may be due to different reasons.[18] First, a reduction in the value of the firms' foreign assets (as measured in Swiss franc) implies a one-to-one reduction of asset prices. Second, worsened expectations about the future economic outlook should also imply a one-off drop in asset prices. Third, and interacting with economic outlooks, increased uncertainty about future economic activity implies a decrease in asset prices but would also be reflected in a temporarily larger variation of asset prices. We provide four pieces of evidence to show that the negative stock price reaction in response to the unexpected change in the SNB's policy might relate to reduced growth prospects.

As a first piece of evidence, we follow Cieslak & Schrimpf (2019) and compare changes in stock market prices around the abolition of the exchange rate floor with those of government bond yields.[19] Similar to stock returns, bond yields show a negative reaction (Table 4). The gap has a size of around eight standard deviations of the pre-treatment gap (see column (3)), and it is among the largest gaps in comparison to the placebo treatments in other countries. The positive co-movement of stock prices and bond yields is consistent with either growth or risk premium shocks. To differentiate further between those two, Cieslak & Schrimpf (2019) argue that the term spread (i.e., the difference between long-term and short-term yields) should

[18] Campbell, Giglio & Polk (2013) show that stock market declines can have different reasons. While the 2000-2002 crisis resulted in an increase of discount rates with only temporary repercussions for investors, the 2007-2009 crisis was rooted in a downward revision of rational expectations about future profits resulting in long-term losses.

[19] We thank the referee for this suggestion.

increase for growth shocks, while it should decrease for risk shocks. Thus, the reaction of government bond yields provides evidence that the stock market reaction was mostly due to lower growth prospects.[20]

Table 4: Statistics on the gap between treated and synthetic returns of bond yields

	(1) gap	(2) mean abs gap, pre-treatment	(3) ratio, CH	(4) ratio, placebo	(5) ranking (abs gap)	(6) #obs
Short-term govt. bond yields	-2.49	0.28	8.75	1.87	2	31
Long-term govt. bond yields	-1.50	0.19	8.00	2.08	3	31
Term spread	0.57	0.29	1.99	1.87	24	31

Note: This table provides information on the difference between government bond yields (daily changes, for different maturities and the term spread) in Switzerland and their counterfactual. Changes in bond yields have been standard-normalized such that they have mean zero and standard deviation one prior to the treatment day in every country. Column (1) gives the gap (treated-synthetic) on January 15, 2015. Column (2) shows the mean absolute gap prior to the treatment in Switzerland (as a measure of estimation uncertainty). Column (3) reports the ratio between the first and second column (in absolute terms). Column (4) gives the average of the same ratio for all placebo studies. These ratios are all insignificantly different from one. Column (5) reports the rank of the Swiss gap in column (1) with respect to gaps in placebo studies. A rank of 1 (31) implies that Switzerland is the country with the largest negative (positive) gap (treated-synthetic). Column (6) contains the number of countries (including Switzerland) used in the matching analysis for the respective series.

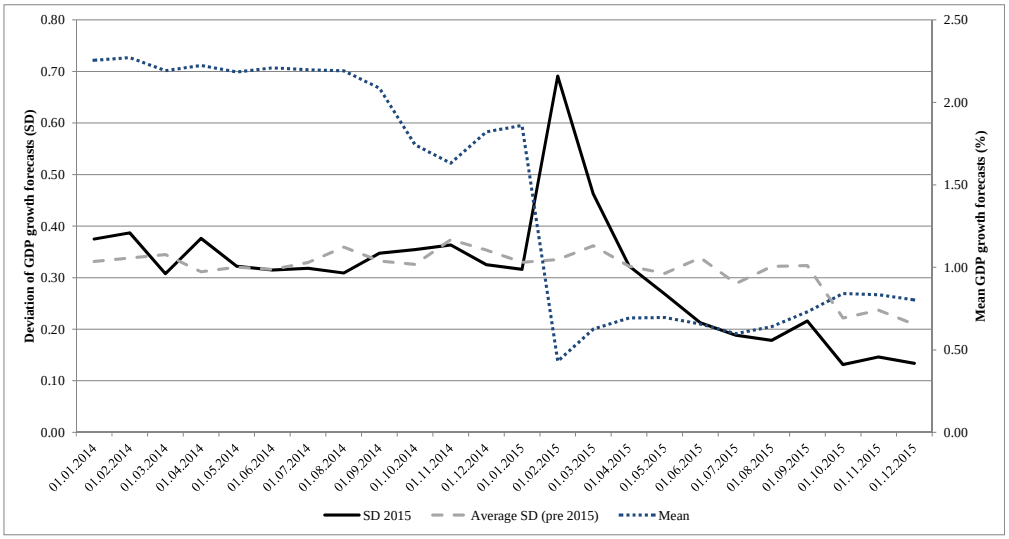
Our second piece of evidence on potential real effects is related to GDP forecasts around January 2015, which would incorporate all potential channels from the sudden change in the exchange rate to GDP growth. Here, we look at Swiss GDP forecasts as provided by Consensus Economics. Consensus Economics collects current- and next-year forecasts from a large group of professional forecasters on a monthly basis. The forecasts are always collected around the 10th day of the month. That is, the abolition of the exchange rate floor was unknown when the forecasts were collected in January 2015 but known a month later in February. We mainly employ the mean and standard deviation of these forecasts for GDP growth in 2015. The standard deviation of forecasts can be seen as a measure of disagreement between forecasters.

Figure 7 shows these series. The horizontal axis refers to the forecast waves from January 2014 to December 2015. The mean forecast for GDP growth for 2015 (blue, dotted line) drops from close to 2% (forecast made in January 2015, prior to the abolition of the exchange rate floor) to 0.5% (February 2015) and remains permanently at a much lower level afterwards. Looking at historical forecast developments, this adjustment is far from normal. In other words, forecasters

[20] In contrast to the results for stock prices, Switzerland does not show the largest gap compared to the placebo studies but it still has one of the highest negative values for bond yields and one of the highest positive values for the term spread.

strongly revised their belief about 2015 growth downward around the time of the SBN policy change, that is the abolition of the minimum exchange rate.

Figure 7: Uncertainty about future GDP growth among professional forecasters



Note: This graph shows the mean GDP growth forecasts made in 2014 and 2015 for the year 2015 by professional forecasters (in %; blue, dotted line, right axis) as well as the standard deviation of the GDP growth forecasts made in 2014 and 2015 for the year 2015 (SD; black, solid line). The gray, dashed line shows the average across the standard deviations of GDP growth forecasts made in year t-1 and year t for year t. The average is taken across standard deviations of forecasts made in 1999 and 2000 for the year 2000 until those made in 2013 and 2014 for the year 2014. Source: Consensus Economics, own calculations.

As a third piece of evidence, we provide evidence of higher uncertainty for professional forecasters, in stock markets and the general public around January 15, 2015. The standard deviation across forecasts (black, solid line) was relatively constant and nearly identical to the average standard deviations for other forecast years until January 2015. In the wave following the discontinuation of the exchange rate floor, there is a strong outlier. The increased disagreement among professional forecasters about the real economic outlook corroborates earlier results. Moreover, the effect of the policy change on the standard deviation of forecasts was comparable to the effect of the largest economic disruptions between 2000 and 2014. To visualize this, Figure 7 also provides the average standard deviation of growth forecasts from forecasts related to GDP growth in the years from 2000 to 2015. Consistent with stock market and public

uncertainty, disagreement abates from March 2015 onwards. Forecasters begin to have a more uniform opinion on low growth rates. In fact, the decrease in disagreement was relatively strong when comparing it to the average standard deviations of GDP forecasts made over the years 2000-2014 (gray, dashed line).

Higher uncertainty in stock markets could be reflected by a higher variation in asset prices. We find this to be the case for around three weeks both in the development of Swiss asset prices and in the gap between observed and synthetic series. Uncertainty by itself could already have more widespread economic implications by hampering investment and consequently economic growth (Bloom, Bond & Van Reenen 2007).

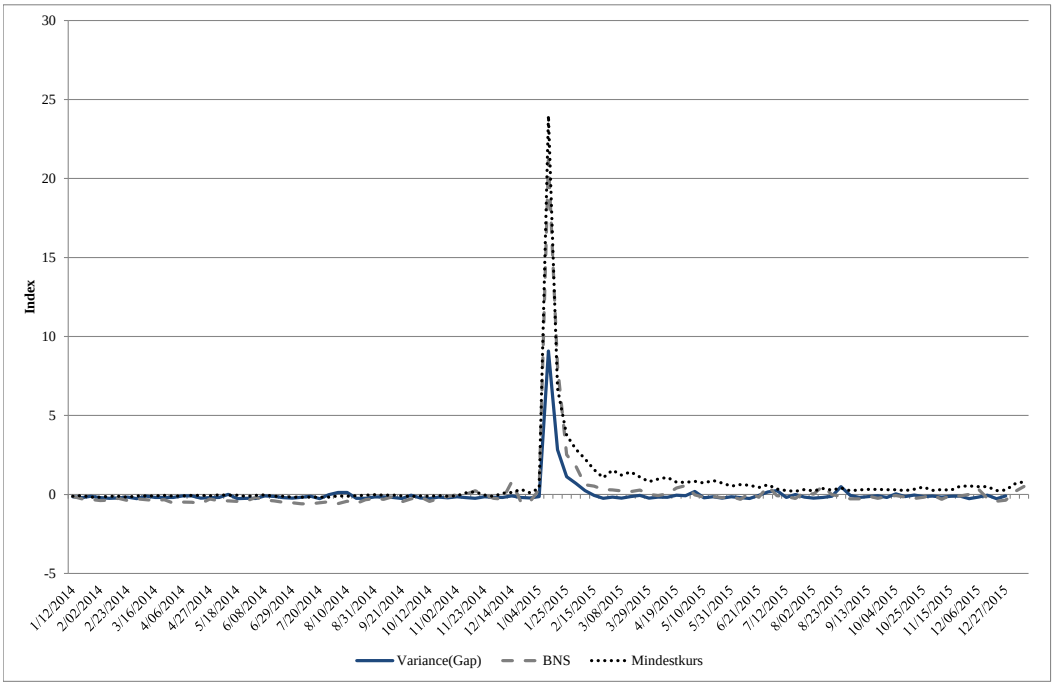
Furthermore, we link stock market volatility to public uncertainty as measured by Google search queries. We start by calculating the weekly variance of the daily gap series between the treated and synthetic group (excluding January 15th, 2015 in the calculation of the variance of that week). The variance of the daily gap series prior to the abolition of the exchange rate floor (where it was negligible) can be interpreted as the volatility of Swiss stock markets that cannot be explained by international comovement. Figure 8 reveals that the variance of the gap series clearly has a peak around the abolition date of the exchange rate floor and only returns to lower values after approximately three weeks.[21] The much larger variance after the treatment is induced by the abolition of the minimum exchange rate floor and reflects a higher degree of uncertainty in stock markets.

We then make use of Google Correlate, restricted to queries from Switzerland, to assess to which search items the variance of the gap series matches best. Figure 8 shows that correlations of the variance of the gap series and the most frequent search items used over the time period are highest for the terms "BNS" (Banque Nationale Suisse) as well as "Mindestkurs" (floor). In fact, the overwhelming majority of search items with a correlation coefficient above 0.95 can be linked to exchange rate (policy) or the Swiss National Bank. This reveals that not only was stock market uncertainty elevated (as indicated by uncharacteristically large variations of gaps) but also public uncertainty about the central bank's policy had increased as implied by the strongly elevated need to collect relevant information.

The final piece of evidence draws on the uncovered equity parity (UEP) literature (Cappiello & De Santis 2005, Cappiello & De Santis 2007, Hau & Rey 2004). Following UEP, higher

[21] Note that the variance in the gap series cannot be driven by global developments, as all shocks affecting treated and control countries alike are extracted when taking the difference between the treated and the synthetic series.

Figure 8: Uncertainty in gap series and among general public



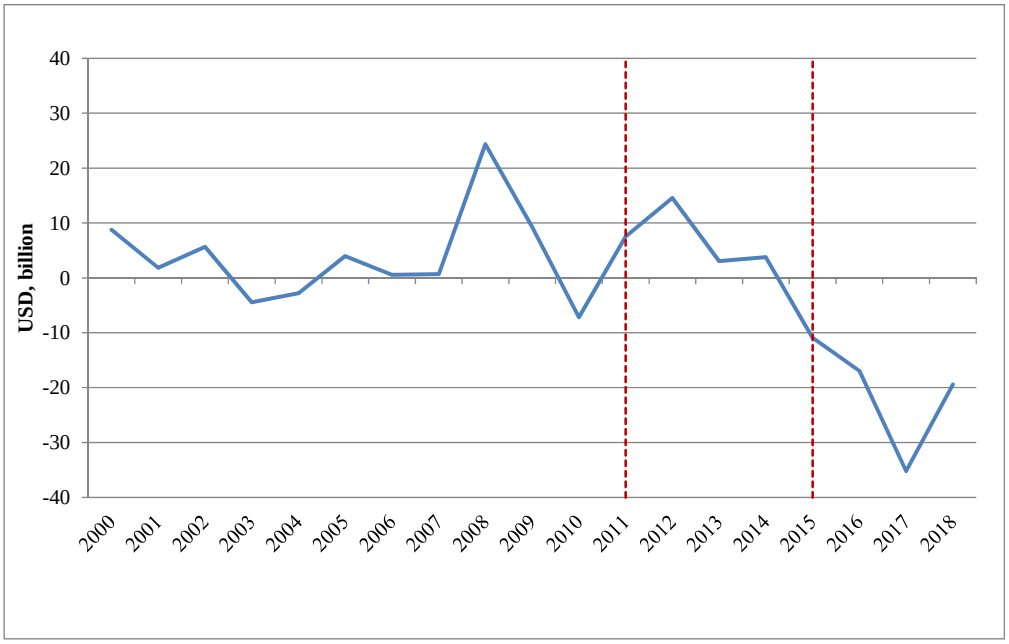
Note: This graph shows an index of google search entries for the items that best match the pattern of the weekly variance of the daily gap series (blue, solid line). January 15th is excluded in the calculation of the variance of that week. Google transforms the variance series of the gaps to an index and then compares it to search indices of other terms. Best matches include "BNS" (Banque Nationale Suisse) (gray, dashed line) and "Mindestkurs" (black, dotted line). Source: Google Correlate (`http://correlate.googlelabs.com/`).

returns in a foreign country (e.g. US) compared to a home country (e.g. Switzerland) induce a depreciation of the foreign currency due to portfolio rebalancing (Cenedese, Payne, Sarno & Valente 2016, Curcuru, Thomas, Warnock & Wongswan 2014). Curcuru et al. (2014) state that domestic investors might repatriate foreign equity in such a case to lower exchange rate risks. In line with UEP, Hau & Rey (2006) find evidence for net equity inflows into the country in which the currency appreciates. Hence, following UEP, one would expect net equity inflows into Switzerland. If instead net equity outflows can be observed, investors rather worry about worsened growth prospects in Switzerland instead of currency exposure.[22] Figure 9 shows that net inflows of portfolio equity into Switzerland have been positive during the period of the

[22]Results on UEP are mixed (Cappiello & De Santis 2005, Cappiello & De Santis 2007, Hau & Rey 2004, Kim 2011). For example, Cenedese et al. (2016) find limited evidence that stock markets predict exchange rate movements. Curcuru et al. (2014) show that investors change portfolios in line with UEP, however not to lower exchange rate risk, but to tactically increase expected returns by investing in markets that are likely to outperform.

minimum exchange rate floor but turned negative with the abolition in 2015. This supports the claim that the decline in stock markets is accompanied by a downward revision of growth prospects resulting in capital outflows. These outflows, in turn, might lower investment and affect economic growth negatively.

Figure 9: Net inflows of portfolio equity around the changes in the exchange rate regime



Note: This figure depicts the pattern of yearly net inflows of portfolio equity for Switzerland (in billions of USD). Vertical lines indicate the introduction and abolition of the exchange rate floor. Source: The World Bank.

In sum, our results show that the decline in stock prices after the abolition of the exchange rate floor can be interpreted as a reaction to worsened growth prospects. We find that the policy change can be labeled as a negative growth shock and that it decreased growth forecasts. We further provide evidence for possible drivers of reduced economic growth in the longer run, such as increased uncertainty and capital outflows.

5 Conclusion

During the financial and sovereign debt crisis, international capital has flown to safe havens such as Switzerland, exposing these countries to substantial exchange rate pressure. As a response,

Switzerland introduced a minimum exchange rate of the Swiss franc with the Euro, which was suddenly discontinued in January 2015. The following appreciation of the Swiss currency has raised uncertainty about the future growth pattern. We exploit the unexpected change in the SNB's monetary policy to analyze the impact of (policy-induced) currency appreciation on stock market reactions.

We make use of a synthetic matching model and the unexpected character of the policy change to identify treatment effects. The estimation setup also allows us to calculate exchange-rate elasticities of asset prices. Our results show that the abolition of the exchange rate floor caused significant declines in asset price growth in Switzerland compared to the synthetic counterpart, with elasticities being around -0.75. After a few days, the stock market indices stabilized at a lower level and standard-normalized growth rates returned to zero. Comparing the results across sectors reveals that the negative impact on asset prices was heterogeneous. The financial sector, the industrial sector and the consumer discretionary sector showed the strongest declines relative to pre-treatment fit. This might be due to fears about reduced competitiveness in international markets due to a stronger Swiss franc.

While the unanticipated policy change offers an ideal setting for identification, it also has its limitations as concerns the analysis of the underlying channels and the possible long-term consequences in the real sector. However, first evidence shows that the negative effect of the abolition of the exchange rate floor also prevails in government bond markets. In addition, uncertainty within stock markets and about future developments of the real economy increased as well as Switzerland experienced negative net equity flows. This can transmit into lower investment and consumption and result into a decline in long-term economic growth. Determining such channels and implications for sectoral competitiveness and economic growth in more detail would thus be an interesting avenue for future research.

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Data appendix – Synthetic matching model

Countries included

The control group includes all OECD countries excluding some with low data availability. Specifically, we include Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, South Korea, Spain, Sweden, Turkey, the United Kingdom, the United States.

Dependent variable

MSCI country index: The MSCI country indices at the daily frequency are obtained from Datastream. For robustness test, we use end of month values to aggregate the index to the monthly level. The design of the MSCI country indices implies that they capture the performance of the larger segments of the respective country's market. The individual constituents come from different sectors, like industrials or financials, and in sum capture a large share of the country's equity market. The index is constructed based on the "MSCI Global Investable Market Indexes (GIMI) Methodology". Information on the classification of the sectors and the calculation method can be found here: `https://www.msci.com/index-methodology;https://www.msci.com/gics`.
MSCI country-sector index: We make use of the sectoral indices at the daily frequency for each country that can also be obtained from Datastream. The composition of the ten sectors is determined by the "Global Industry Classification Standard (GICS)" and allows a comparison across sectors. The classification has a hierarchical structure including 10 sectors, 24 industry groups, 67 industries, and 156 sub-industries. The sectors are classified and composed of the following industry groups as follows:[23]

- consumer discretionary: automobiles & components; consumer durables & apparel; consumer services; media; retailing
- consumer staples: food & staples retailing; food, beverage & tobacco; household & personal products
- energy: energy

[23]For a detailed breakdown into industry groups, industries, and sub-industries, see MSCI (2016). Our analysis excludes the sectors information technology and utilities due to data availability.

- financials: banks; diversified financials; insurance; real estate
- health: health care equipment & services; pharmaceuticals, biotechnology & life science
- industrials: capital goods; commercial & professional services; transportation
- information technology: software & services; technology hardware & equipment; semiconductors & semiconductor equipment
- materials: materials
- telecommunication: telecommunication services
- utilities: utilities

Alternative dependent variables: For robustness tests, we make use of daily short-term and long-term government bond yields. Data are obtained from Thomson Reuters Datastream. Short-term refers to a maturity of 1-year (2-years in case of Finland). Long-term refers to a maturity of 10-years (9-years in case of Australia, Italy, Portugal and Spain).

Matching variables

GDP growth: Quarterly data on the annual growth rate of the gross domestic product, seasonally adjusted (Datastream).

Inflation: Monthly data on consumer price index (2010=100, year-on-year change) (Datastream).

Interest rates: Quarterly data on short-term interest rates in % (Datastream).

Public debt: Annual data on general government gross debt in % of GDP (Datastream).

Sectoral share (Industry): Annual data on value added by the industrial sector in % of GDP (Datastream).

Sectoral share (Services): Annual data on value added by the services sector in % of GDP (Datastream).

Current account: Quarterly data on the current account balance in % of GDP, seasonally adjusted (Datastream).

Exports: Annual data on exports of goods and services in % of GDP (Datastream).

Foreign reserves: Monthly international reserve assets in millions USD (Datastream).

ULC: Quarterly data on unit labor costs (2010=100, year-on-year change), seasonally adjusted (Datastream).

REER: Monthly data on real effective exchange rate based on the consumer price index (2010=100, year-on-year change) (Datastream).

Domestic credit: Annual data on domestic credit provided by the financial sector in % of GDP (Datastream).

CBT: Annual data on central bank transparency index with range 0-15 (Dincer and Eichengreen 2014).

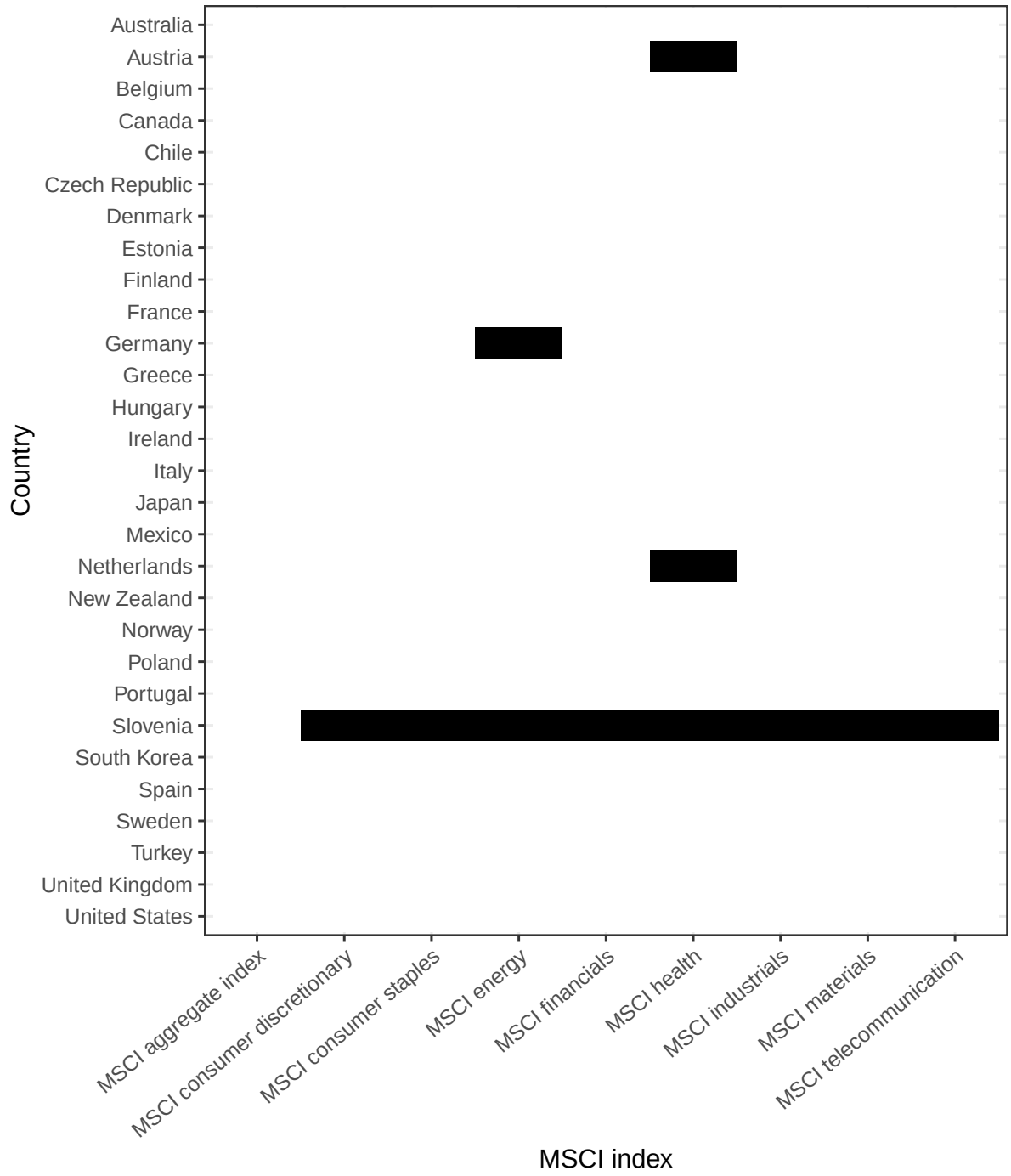
Interbank rate: Monthly data on three-month interbank rates in percentage points (Datastream).

Table A1: Summary statistics control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Switzerland				Control group			
Variable	1995-1999	2000-2004	2005-2009	2010-2014	Mean	SD	Min	Max
GDP growth	-0.37	-0.34	-0.17	-0.28	-0.07	0.53	-2.20	2.05
Inflation	NA	-0.72	-0.70	-1.14	0.13	0.79	-1.38	2.77
Interest rates	NA	-0.60	-0.61	NA	0.10	1.19	-0.88	8.63
Public debt	NA	0.08	-0.07	-0.27	-0.01	0.99	-1.33	4.41
Sectoral share (industry)	NA	NA	-0.18	-0.27	0.00	0.96	-2.24	2.16
Sectoral share (services)	NA	NA	0.39	0.48	0.06	0.77	-1.46	2.00
Domestic credit	0.99	0.88	1.06	NA	0.07	1.06	-1.68	3.50
Current account	NA	NA	1.70	1.76	-0.22	1.07	-3.42	2.62
Exports	0.02	0.22	0.51	0.82	0.01	1.02	-1.23	5.19
Foreign reserves	-0.64	-0.62	-0.58	1.32	-0.02	1.11	-1.91	3.53
ULC	NA	-0.15	0.05	-0.30	0.01	0.48	-1.94	1.56
REER	0.09	-0.43	-0.70	1.42	-0.01	0.85	-1.82	2.24
CBT	-0.94	-0.17	0.36	NA	0.02	0.99	-2.57	2.32
Interbank rate	NA	-0.56	-0.57	NA	0.10	1.00	-0.84	6.88

Note: This table shows summary statistics for the control variables as explained in the data appendix. The data is transformed into 5-year standardized averages for the estimations. Columns (1)-(4) show the 5-year standardized averages for Switzerland by 5-year interval. Columns (5)-(8) show descriptive statistics for the countries in the control group over the different time intervals.

Figure A1: MSCI coverage across sectors and countries



Note: This figure depicts the coverage of the aggregate MSCI index and the sub-indices across countries. Black bars denote that no data is available. Source: Datastream, own calculations.