Macro and micro level impulse responses: A survey experimental identification procedure

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June 30, 2015

Abstract

This paper analyzes the effects of macroeconomic shocks at different aggregation levels. We show how to generate firm level impulse responses by incorporating experiments into surveys and how to build aggregate responses using a bottom up approach. We further show that the effects obtained from survey experiments can be mapped into VAR impulse responses. We apply the procedure to oil price shocks using a representative sample of over 1000 Swiss firms. At the aggregate level our findings confirm, with notable exceptions, results from a VAR. At the micro level we analyze the driving forces behind impulse responses, solving existing puzzles.

JEL classifications: C32, C83, C99, E31
Keywords: Survey based impulse responses, survey experiments, macroeconomic shock identification, firm level data, oil price shock

*We are grateful to Klaus Abberger, Andreas Dibiasi, Christian Hepenstrick, Jan Jacobs, Marius Ley, Hashem Pesaran, Alexander Rathke, Frank Schorfheide, Jan-Egbert Sturm, Peter Zadrozny, and seminar and conference participants at CIRET Hangzhou, Bank of Finland, Swiss National Bank, University of Konstanz, and KOF ETH Zurich for helpful comments and discussions. We further thank Florian Eckert, Enes Poyraz, and Theo Süllow for valuable research assistance. All authors: KOF Swiss Economic Institute, ETH Zurich, Leonhardstrasse 21 LEE, CH-8092 Zurich, Switzerland. Authors' e-mails: drechsel@kof.ethz.ch, mikosch@kof.ethz.ch, sarferaz@kof.ethz.ch, and bannert@kof.ethz.ch.

1 Introduction

While aggregate economic outcomes are a composite of individual business activities, firms' decisions in response to macroeconomic shocks are highly complex and manifold. Often the resulting responses at the aggregate level turn out to be ambiguous, hampering the analysis of causal effects. In these situations, identifying the effects of macroeconomic shocks already at the firm level could be fruitful, which, however, is a formidable task given the prevalent non-experimental data available to macroeconomists.

In this paper, we investigate the determinants of responses to macroeconomic shocks on the macro and micro level using a survey experimental procedure.[1] We show that the effects identified with our survey experiment are conceptually equivalent to impulse responses obtained from vector autoregressions (VARs). In contrast to VARs, there is no need to impose parametrical restrictions to identify exogenous macroeconomic shocks. The survey based approach does also not require extensive longitudinal data which can be subject to structural breaks in the data generating process but sets up an on the spot analysis by design. Instead of indirectly deducting causal effects from historical time-series, we retrieve such responses directly by asking firms.

We employ the survey experimental approach to study the effects of oil price shocks at different levels of disaggregation. Oil price shocks are among the most prominent and important macroeconomic shocks (see, e.g., Hamilton, 1988 and Kilian, 2009). Responses to oil price shocks can lead to inflationary pressure and may have real effects on the economy. However, little is known about the effects of oil price shocks at the firm level. We contribute to the existing literature by conducting a survey experiment to identify macroeconomic shocks without any parametric restrictions and thereby generating a revision-free firm-level dataset. More precisely, we attached a special questionnaire to the July 2012 wave of the KOF Swiss Economic Institute Investment Survey, a major statistical survey on firms' financial outcomes and plans in Switzerland. We mimic the official macroeconomic data generation procedure of statistical agencies for, e.g., GDP: In a first step, we collect firm-level data from a representative sample of firms in the Swiss economy. 1037 Swiss firms completed our questionnaire that asked for changes in firms' turnover and sales prices in response to an exogenous shock to the oil price. Thereafter, we aggregate the micro-level data to the industry and economy wide level by using standard national accounting procedures for building of macro time series from micro data.[2]

We compare impulse responses derived from survey experiments to results obtained from a structural Bayesian VAR (BVAR).[3] We find that the BVAR analysis in-

[1]The expression of survey experiments originates from the field of psychology (see reviews by Sniderman and Grob, 1996, Gilens, 2002, and Guterbock and Nock, 2010). See Kuziemko, Norton, Saez, and Stantcheva (2015) for a survey experiment on income inequality and Drechsel, Mikosch, Sarferaz, and Bannert (2015) for a survey experiment on exchange rate shocks.

[2]See, e.g., European Commission, 2007.

[3]To achieve such comparability a number of conditions have to be met. The framework of the survey

volving standard identifying assumptions conforms to the results obtained from the experimental survey setup that works without imposing any identifying restrictions. We observe a lot of heterogeneity in impulse responses. In an industry level exercise similar to the approach undertaken in Lee and Ni (2002), we distinguish whether industries' impulse responses to an oil supply shock are dominated by either cost-push or demand channels. We find that high oil share industries are dominated by the cost-push channel. In contrast, for lower oil share industries the demand channel tends to prevail.

We also analyze possible driving forces of the causal effects by regressing firm level impulse responses on a set of covariates such as oil intensity, market power, firm size, industry membership and time effects. We find that market power and firm size do not explain a significant part of firm level responses to an oil price shock, whereas oil intensity is an important and statistically significant influencing factor. We use our firm level data to disentangle industry membership effects from oil intensity. At the industry level, we find little correlation between oil intensity and output responsiveness to an oil price shock, confirming the results in Lee and Ni (2002). However, when controlling for industry membership at the firm level we do find a significant effect of firms' oil intensity on output reactions, thereby solving an existing puzzle in the literature.

Furthermore, we show that usual identification assumptions in VARs imply restrictions on impulse responses. Depending on the prevalent industry structure and magnitude of the underlying firm level response, such imposed restrictions might cause a bias. We suggest an easy way to test for such a bias using the *structural* micro data obtained from our survey experiment.

The remainder of the paper is structured as follows. The following section 2 discusses impulse responses based on survey experiments, shows the linkages between firm level and aggregate impulse responses, and elaborates on survey validity. Section 3 describes the survey setup and experimental design to identify the effects of oil price shocks. Section 4 presents the results obtained from our oil shock macro survey experiment. Section 5 concludes. Technical derivations and more detailed results appear in the appendices.

2 Method

This section describes how survey experiments can be used to measure causal effects of macroeconomic shocks on a firm level basis. Aggregate causal effects are commonly of interest when studying the responses to macroeconomic shocks. Yet, aggregate data are a composite of firm level observations. If one truly aims to understand the driving forces behind economic reactions to macroeconomic shocks, it

experiment should specify the magnitude of the macroeconomic shock, measure the response on a ratio scale, and depict the timing of the effect. Further, a survey experiment should be conducted among a representative sample of firms.

is helpful to study responses on the firm level.

In the following subsection, we explain our procedure to generate firm-level impulse impulses to macroeconomic shocks using survey experiments and highlight several virtues of the approach. Subsequently, we discuss the mapping from firm-level impulse responses to aggregate impulse responses. This analysis sheds light on the implications of aggregate restriction commonly used in VARs for the distribution of firm-level impulse responses. Thereafter, we focus on the process of forming expectations under a scenario and discuss the validity of our survey experiment.

2.1 Generating impulse responses from survey experiments

Survey based impulse responses are generated by mimicking official data collection procedures among representative samples of firms. The following features help to achieve representative and valid outcomes: The survey comes from a respected institution, or the statistical agency itself or an affiliated agency. It is conducted on a regular basis (though the actual questionnaire content may change over time). Further, respondents come from the top management of the firms.

In a first step, we collect firms' expectations (or projections) on key financial figures such as revenues, expenses or investments. These expectations are usually recorded in firms' business information systems and can be easily retrieved. Next, we confront firm respondents with a macroeconomic shock scenario, all other things being equal, and ask them to report their expectations under this scenario.[4] The difference between the expectations in the baseline scenario (= control scenario) and in the shock scenario (= treatment scenario) gives the expected firm-specific causal effect (= treatment effect) of the shock. In a last step, we aggregate the expected firm-specific causal effects over firms to get the expected macroeconomic causal effect of the shock. The aggregation is done with standard procedures used in statistical agencies to build macroeconomic series from micro-level data.

More formally, the set up can be expressed for firm $i = 1, \dots, I$, period $t = 1, \dots, T$ and horizon $s = 1, \dots, S$ as

$$\psi_{i,t+s} \quad = \quad E_{i,t}(y_{i,t+s}|\eta_{i,t} = 1) - E_{i,t}(y_{i,t+s}|\eta_{i,t} = 0), \tag{1}$$

and

$$\psi_{t+s} \quad = \quad \sum_{i=1}^{I} \omega_i \; \psi_{i,t+s}, \tag{2}$$

where $\psi_{i,t+s}$ is the dynamic expected causal effect for firm i, $E_{i,t}(y_{i,t+s})$ is the firm-specific expectation for horizon s at period t, $\eta_{i,t}$ is the treatment variable with $\eta_{i,t} = 1$ when firm i receives the shock treatment and $\eta_{i,t} = 0$ otherwise, ψ_{t+s} is the dynamic expected macroeconomic causal effect of the shock, and ω_i is the

[4] It is important to phrase the scenario in a way that firm respondents can understand. One cannot assume that respondents understand the word shock in the same way as economists.

aggregation weight of firm i.[5]

The dynamic causal effect described in Equations (1) and (2) are equivalent to the definition of impulse responses in the time series literature, where the treatment is a shock at time t with its effects s periods after the shock has occurred (e.g., Hamilton, 1994). Given this definitional equivalence we refer to the above equations as the firm-level or macroeconomic *survey based impulse response* to the shock.

Survey based impulse responses have several virtues. First, survey based impulse responses provide a convenient way to identify macroeconomic shocks through its experimental design. In fact, shocks do not need to be identified econometrically. They can be extracted by confronting firm executives with a scenario in which their firm is hit by a macroeconomic shock. Thus, survey based impulse responses can be used to test macroeconomic theories without presuming any prior economic theory.[6]

A second strength of survey based impulse responses is their bottom-up structure. They enable to study heterogeneous causal effects on the firm level with relatively modest requirements.[7] By employing an appropriate firm weighting scheme the firm-level impulse responses can be aggregated to the industry, sector or economy-wide level. Thus, impulse responses based on surveys allow for analysis on any desired level of (dis)aggregation and provide the possibility to study the effects of shocks simultaneously on aggregate and disaggregate levels.

Third, survey based impulse responses measure the effect of a shock at the time when the survey was conducted. As a consequence, policy makers can make use of this procedure to determine the effects of shocks "on the spot" in, for instance, times of a suspected structural break.[8]

Survey based impulse responses have yet another virtue: they allow to test for possible biases in aggregate identifying restrictions. The argument is exposed in the next subsection.

[5]By asking the *same* firm representative about a control scenario and a treatment scenario, the set up follows a within subject design (see Charness, Gneezy, and Kuhn, 2012). One might also follow a between subjects design by randomly assigning different scenarios to firms. Both within subject and between subjects designs allow for *multiple* treatment scenarios (effect of shock A, effect of shock B, effect of shock C, ...).

[6]See the discussion in Angrist and Pischke (2010) and the replies by, e.g., Leamer (2010), Sims (2010), and Stock (2010).

[7]Data availability often pose serious obstacles for empirical work on a firm level basis. Survey experiments help to overcome this issue as they create tailored micro data sets for the research questions of interest.

[8]Further, by conditioning on the actual information set of economic agents, the scope of the information set is not an issue for survey based impulse responses (see Rudebusch, 1998). In addition, survey based impulse responses involve no assumptions about the expectation formation of economic agents.

2.2 Firm level vs. aggregate impulse responses

Aggregate level and firm level are linked via the employed aggregation procedure. If the aggregation process is known, aggregate impulse responses to shocks can be decomposed into firm-level impulse responses. A popular workhorse for studying causal effects on the aggregate level are VARs. In order to determine causal effects from VAR analysis, usually identifying assumptions have to be set. Given the connection between aggregate and firm-level data, restrictions on the aggregate level imply certain restrictions on the distribution of firm-level impulse responses. This issue will be discussed in the following.

If detailed time series information were available at the firm level, a VAR could be set up for each firm, which allows to obtain dynamic causal effects of shocks at different aggregation levels on firms' key variables, say, output and prices. The firm level VAR for firm i for $i = 1, \ldots, I$ at time t can hence be expressed as follows:

$$y_{i,t} = c_i + \Phi_{i,1} y_{i,t-1} + \Phi_{i,2} y_{i,t-2} + \cdots + \Phi_{i,p} y_{i,t-p} + u_{i,t}, \tag{3}$$

where $y_{i,t}$ is $m \times 1$, c_i is a $m \times 1$ vector of intercepts, $\Phi_{i,p}$ is a $m \times m$ coefficient matrix and $u_{i,t}$ is an $m \times 1$ vector of disturbances with zero mean and variance covariance matrix Σ_i. The reduced form error $u_{i,t}$ can also be written as a linear combination of structural shocks $\epsilon_{i,t}$, hence $u_{i,t} = A_i^{-1}\epsilon_{i,t}$, where A_i is a $m \times m$ nonsingular coefficient matrix and $\epsilon_{i,t} \sim N(0, I)$. The VAR(p) model in its VAR(1) companion form then is:

$$Y_{i,t} = C_i + F_i Y_{i,t-1} + U_{i,t}, \tag{4}$$

where $Y_{i,t} = [y'_{i,t}, y'_{i,t-1}, \ldots, y'_{i,t-p+1}]'$, $U_{i,t} = [u'_{i,t}, 0, \ldots, 0]'$, and F_i is the $mp \times mp$ companion matrix containing the VAR coefficients with

$$F_i = \begin{bmatrix} \Phi_{i,1} & \Phi_{i,2} & \cdots & \Phi_{i,p-1} & \Phi_{i,p} \\ I_m & 0 & \cdots & 0 & 0 \\ 0 & I_m & 0 & 0 & 0 \\ \vdots & & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & I_m & 0 \end{bmatrix}$$

where I_m is an $m \times m$ identity matrix. Given that the VAR follows a stable process, Equation (3) can be rewritten in its infinitely moving average representation

$$Y_{i,t} = \mu_i + \sum_{s=0}^{\infty} F_i^s U_{i,t-s}, \tag{5}$$

where $\mu_i = (I_{mp} - F_i)^{-1} C_i$.[9] Equation (5) can also be written in its more condensed form

$$y_{i,t} = J\mu_i + \sum_{s=0}^{\infty} \Psi_{i,s}\epsilon_{i,t-s}. \tag{6}$$

[9]See, e.g., Hamilton (1994) or Lütkepohl (2005).

where $J = [I_m, 0, \cdots, 0]$ is $m \times mp$ and $\Psi_{i,s} = JF_i^s J' A_i^{-1}$ is the firm specific impulse response matrix at horizon s to a shock in $\epsilon_{i,t}$, i.e. $\Psi_{i,s} = \frac{\partial y_{i,t+s}}{\partial \epsilon_{i,t}}$. Let us assume that we are only interested in aggregate shocks, i.e. in ϵ_t.[10] The impulse response function in this case implies $\Psi_{i,s} = \frac{\partial y_{i,t+s}}{\partial \epsilon_t}$, which is equal to the definition of survey based impulse responses discussed in section 2.1.

Consider now that we aim to aggregate these firm specific variables in $y_{i,t}$ using standard procedures.[11] The aggregate time series created will be a convex combination of the underlying disaggregated series:

$$y_t = \sum_{i=1}^{I} \omega_i y_{i,t}, \tag{7}$$

where $\omega_i \geq 0$ and $\sum_{i=1}^{I} \omega_i = 1$. Substituting (6) into (7) results in the following expression

$$y_t = \sum_{i=1}^{I} \omega_i (J\mu_i + \sum_{s=0}^{\infty} \Psi_{i,s} \epsilon_{t-s}), \tag{8}$$

with the implied aggregated impulse response matrix $\Psi_s = \sum_{i=1}^{I} \omega_i \Psi_{i,s}$ at horizon s to a shock in ϵ_t, i.e. $\Psi_s = \frac{\partial y_{t+s}}{\partial \epsilon_t}$.

Similar to the firm level VAR described above, the aggregate VAR with aggregated variables can be expressed as follows

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_p y_{t-p} + u_t \tag{9}$$

with its infinitely moving average representation

$$y_t = J\mu + \sum_{s=0}^{\infty} \Psi_s \epsilon_{t-s}, \tag{10}$$

where the general structure is similar to the one described for the firm level VAR, except for the parameters which are now not firm specific anymore. The aggregate impulse response matrix at horizon s to a shock in ϵ_t hence is $\Psi_s = JF^s J' A^{-1}$, implying again $\Psi_s = \frac{\partial y_{t+s}}{\partial \epsilon_t}$. From (8) it follows that

$$\Psi_s = \frac{\partial y_{t+s}}{\partial \epsilon_t} = \sum_{i=1}^{I} \omega_i \Psi_{i,s}. \tag{11}$$

To identify structural shocks in the aggregated VAR described in (9) requires certain restrictions on the parameter space. Usually either exact or sign restrictions are imposed on the impulse response matrix Ψ_s.[12] In contrast to VARs, to generate

[10] The aggregate shock can also be interpreted as a common shock to all firms. This could be implemented using factor analysis, decomposing the structural errors $\epsilon_{i,t}$ into a common part and an idiosyncratic, firm specific part.

[11] See, e.g., European Commission, 2007.

[12] Zero restrictions on Ψ_0 are similar to restrictions used in Sims and Zha (1998) to identify an SVAR. In case Ψ_0 is a triangular matrix the Cholesky decomposition of Σ is of the form $\Sigma = \Psi_0 \Psi_0'$. It is also possible to impose sign restrictions on Ψ_s for different s as described in, e.g., Faust (1998) and Uhlig (2005).

survey based impulse responses and hence to obtain firm specific impulse responses no parametric restrictions are required.

Define $\psi_{kj,s}$ as the response of the k-th variable in y_t to the j-th shock at horizon s. Assume now that the identification of the system involves a parametric restriction and that this restriction is imposed on the response of the k-th variable to the j-th shock at horizon h. Without loss of generality, assume that the restriction can be expressed as $\psi_{kj,h} = r$. Using the relationship between aggregated impulse responses and disaggregated impulse responses in (11), we obtain the following expression for the restriction imposed:

$$\sum_{i=1}^{I} \omega_i \psi^i_{kj,h} = r, \tag{12}$$

where $\psi^i_{kj,h}$ is the response of the k-th variable to the j-th at the horizon h of firm i. Hence, any deviation of r from the aggregated impulse response function $\sum_{i=1}^{I} \omega_i \psi^i_{kj,h}$ results into a bias. Consider the following quadratic loss function for the restricted elements in Ψ_h

$$(r - \sum_{i=1}^{I} \omega_i \psi^i_{kj,h})^2. \tag{13}$$

The loss function implies that the loss is zero when the different firm specific impulse responses can be combined in way such that they sum exactly to r. More importantly, the degree of the bias imposed by the aggregate restriction depends crucially on the weight put on the biased firms' impulse response function and the magnitude of these impulse responses.

Firm specific impulse responses and survey based impulse responses, respectively, allow to test for the existence of a bias in aggregate restrictions, occurring for instance in VARs. This test could include exclusion restrictions, where r corresponds to a specific value or sign restrictions, where r corresponds to the positive and negative region, respectively. Such a test resembles a two sided student-t test for exclusion restrictions (e.g. Cholesky decomposition, $r = 0$) and a one sided t-test in case of sign restrictions, where $\sum_{i=1}^{I} \omega_i \hat{\psi}^i_{kj,h} = r$ is the relationship to be tested with $\hat{\psi}$ denoting the impulse responses obtained from our survey experiment (see, for example, the results reported in Table 3).

2.3 Validity of the survey experiment

The following section takes a closer look at the process of forming expectations for both the baseline and the scenario. In the case of our survey firms should form expectations on operating figures under the current situation as well as under the assumption of an exogenous shock. We can write the model process of forming baseline expectations as:

$$E_{i,t}(y_{i,t+s}) = \sum_{k=0}^{K} g(y_{i,t-k}) + \sum_{j=1}^{J} p_{i,j} f_{i,j}(\pi_{j,t}), \tag{14}$$

with $\sum_{j=1}^{J} p_j = 1$, where $g()$ is a function of firm i-th lagged K operating figures and $f()$ is a function of J possible states of a firm's environment.π_j denotes the j-th state a firm expects to come true in the future. Then p_j is the probability that the j-th state actually comes true. The states π capture all of the firms believes about the future and are thus mutually exclusive.

Given that companies are able to form expectations which are consistent with realizations of their operating figures, we are confident that firms are able to assess a ceteris paribus scenario which is much less complex than the baseline situation described above. When setting an exogenous shock and explicitly ruling out other events, a firm is locked in on one single scenario π_z such that the expectation formulation is exogenously changed with $p_{j=z} = 1$ and $p_{j \neq z} = 0$. Hence the process of forming expectations under the scenario of exogenous shock can be written in the following much simpler form:

$$E_{i,t}(y_{i,t+s}) = \sum_{k=0}^{K} g(y_{i,t-k}) + f_{i,z}(\pi_z) \tag{15}$$

This process is arguably much simpler as participants do not have to build expectations for multiple states nor do they have to assess the probabilities of their occurrence. Further, only one single functional form $f_{i,z}(\pi_z)$ needs to be considered. Hence, we conclude that if firms are able to form baseline expectations that are in line with baseline realizations firms should be able to form reasonable expectations under a much simpler scenario. It is important for this conclusion to be made that the treatment scenario must be realistic in the sense that respondents have been confronted with similar scenarios already in the past and/or that they already considered the scenario and its effects before (see Gaines, Kuklinski, and Quirk (2006)).[13] Thus, we believe that if firms' forecast errors with respect to the realizations of their baseline scenarios are on average zero, firms should also be able to make conditional forecasts. Appendix 6.1 provides a robustness check on this particular assumption. Further robustness checks such as non-response analysis can also be found in Appendix 6.1.

3 An application to oil price shocks

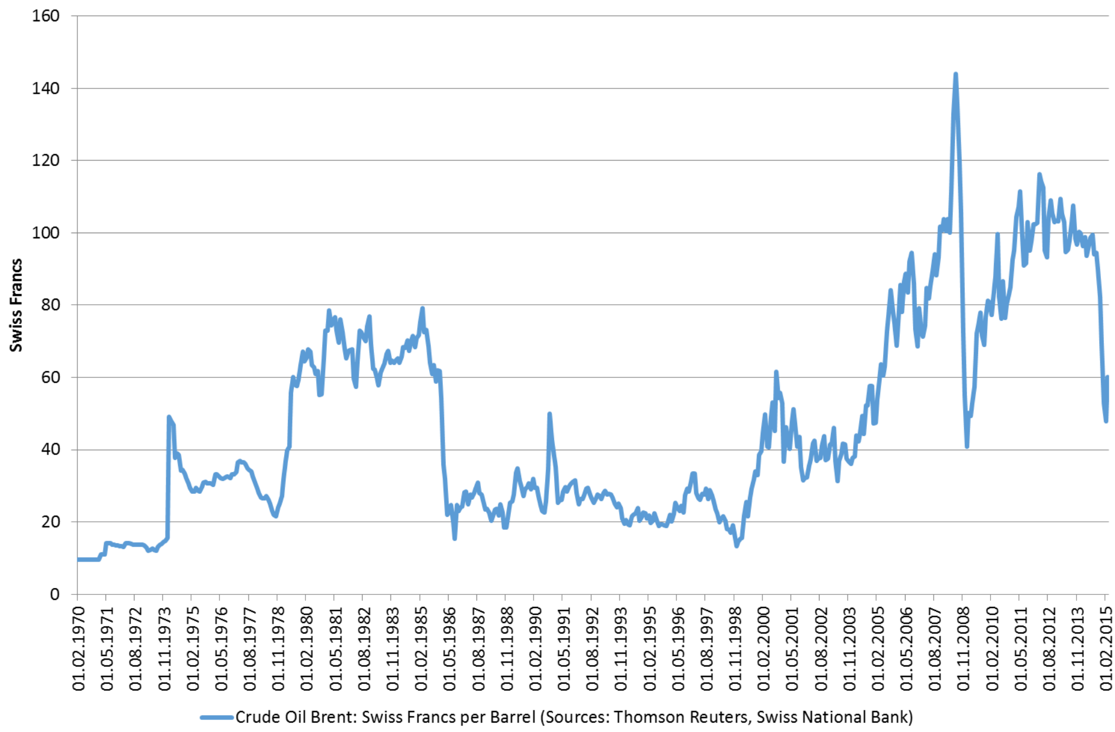
The previous section has described the procedure to generate survey based impulse responses. This section presents an application to oil price shocks (see, e.g., Hamil-

[13] We consider this condition to be fulfilled in our application in Section 3. This notwithstanding, those economists who belief that economic agents build rational expectations should generally have no reason to mistrust impulse response generated from survey experiments.

ton, 2008 and Kilian, 2008 for comprehensive reviews of the literature). Oil price shocks are well suited to illustrate survey based impulse responses. They are easily conceivable for survey respondents and have been prevalent in the past.

The oil price development can be seen in Figure 1. Since the late 1990s the oil price in Swiss Francs (CHF) has shown volatile behavior around an upward trend. Prior to the recent financial crisis oil prices have peaked at more than 140 CHF per barrel Brent. In the aftermath of the financial crisis the oil price dropped by more than 50%, while recovering swiftly afterwards. During winter 2014/15 and spring 2015 prices collapsed again with a slight recovery at the current edge.

Figure 1: Price of crude oil



3.1 Survey setup

Our data stem from a questionnaire attached to the semi-annual KOF Swiss Economic Institute Investment Survey during the summer 2012 wave.[14] The characteristics of the underlying sample are representative of the Swiss economy. Detailed information on the sampling procedure can be found in Appendix 6.2.

1037 Swiss firms completed the additional set of questions out of which 85 are from the construction sector, 434 from manufacturing and 518 from services. Firms' responses in KOF surveys come mostly from CEOs and CFOs.[15] Respondents are

[14]The survey was conducted as a multi-mode survey: Part of the survey has been paper based, the other part was conducted online using a self-hosted instance of LimeSurvey (`www.limesurvey.org`).

[15]See, e.g., Abberger, Bannert, and Dibiasi (2014).

taking part in KOF enterprise surveys on a regular basis and are accustomed to KOF questionnaire design. In order to ensure relevance of our questions to practitioners we conducted an interviewer pre-test among a group of selected firms. We adjusted our questionnaire according to the feedback.

The participating firms received an invitation letter and the questionnaires in paper and electronic format in order to facilitate participation. Anonymity of responses has been guaranteed. All KOF surveys are subject to Swiss statistics law. If addressed participants did not respond within 18 days they received a reminder. Firms that did not participate after being reminded were reminded via phone after an additional two weeks. Questionnaires were sent out in German, French and Italian according to firms' preferences.

3.2 Experimental design

This section explains the design of our macro survey experiment. Prior to asking scenario questions, participants stated their key financial figures for past (2010, 2011), present (1st half of 2012) and future (2nd half of 2012, 2013). This task is helpful in setting the benchmark for the survey experiment.

Thereafter, the questionnaire confronts participants with the counterfactual situation of an oil price shock and asks them to re-evaluate their answers under the new hypothetical scenario:

> Suppose, the oil price increases by 30% within the next month under else constant economic circumstances and will remain 30% above your previous expectations regarding the oil price development. Please indicate how your financial figures change compared to your previous expectations regarding these figures.[16]

The oil price shock constitutes a level shift to firms' expectations on the future oil price path. Figure 2 illustrates this graphically: firm i expects the oil price to remain unchanged, whereas firm j expects a further downward drift. The shock shifts both projected paths upwards. As an excerpt of the questionnaire, the answer options for total turnover are as follows (the complete questionnaire can be found in Appendix 6.3):

2nd Term 2012

⩽-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	⩾7.5%	N/A
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

[16] The base level for the oil price shock is the price of oil shortly before sending out the survey. The jump in the oil price is set to one standard deviation of the monthly price series (barrel crude oil Brent). This guarantees comparability with the VAR literature in which most applications of impulse response functions are generated for a shock of one standard deviation.

2013

⩽-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	⩾7.5%	N/A
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

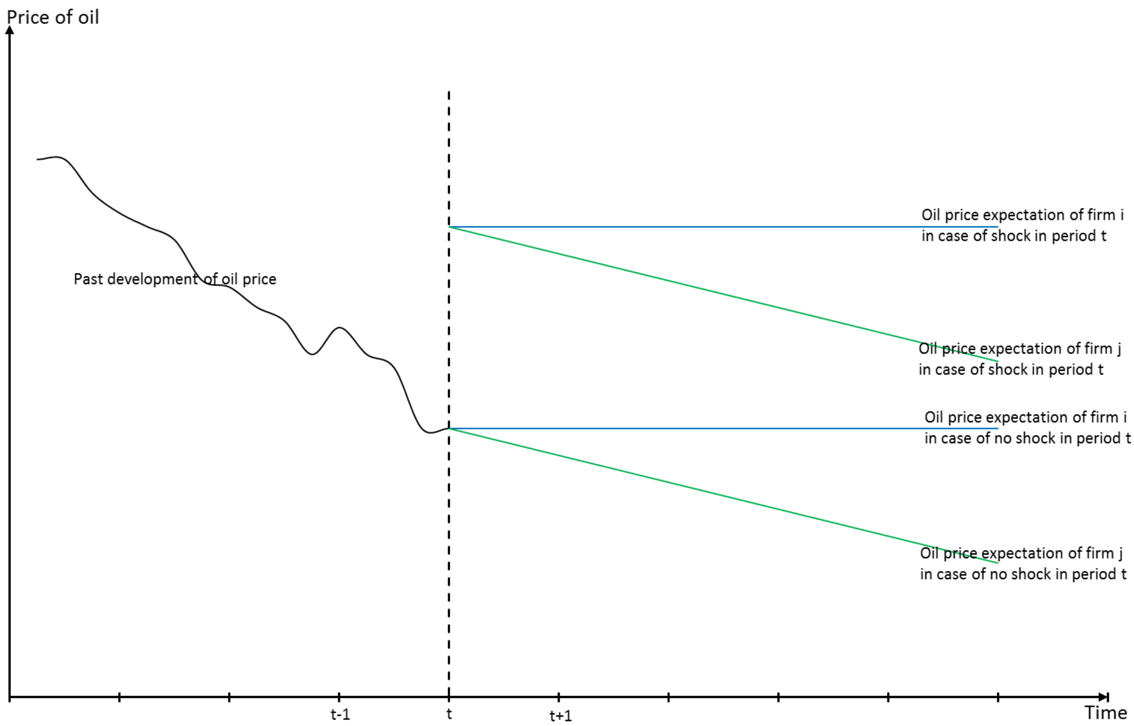
Importantly, the above scenario question is designed such that answers equal the firm-specific dynamic causal effect of the oil price shock ("treatment effect"). Accordingly, Equation (1) can be specified as

$$\psi_{i,t+s} = E_{i,t}(y_{i,t+s}|\eta_t = 1) - E_{i,t}(y_{i,t+s}|\eta_t = 0), \qquad \text{for } s = 6 \text{ months}, 18 \text{ months}$$

where $E_{i,t}(y_{i,t+s}|\eta_t = 1)$ is firm i's expected turnover at horizon s given the oil price shock occurred at time t and $E_{i,t}(y_{i,t+s}|\eta_t = 0)$ is its expected turnover at horizon s given the oil price shock did not occur ceteris paribus.

In the same manner the questionnaire asked participants to evaluate the effect of the oil price shock on average purchase prices, total expenditure, average domestic sales prices and average foreign sales prices for the second half of 2012 (after 6 months) and for 2013 (after 18 months). The questionnaire further asked for firms' (pre-shock) expenditure on oil products in terms of total expenses ("oil share"), exports in terms of total turnover ("export share") and imports in terms of total expenses ("import share"). Appendix 6.4 gives a comprehensive list of variables used in this study.

Figure 2: Oil price shock scenario



The defined shock is similar to a permanent cost-push shock. We exclude (global or Swiss wide) oil demand shocks by stating that firms should consider their responses "under else constant economic circumstances". The shock is specified as a permanent shock by stating that "the oil price will remain 30% above your previous expectations".

4 Empirical results

We now discuss the results obtained from our survey based impulse response analysis on the effects of oil price shocks. We structure the results section according to the level of aggregation. Starting with the aggregate results we compare the outcome of our survey experiment with a structural VAR (SVARs). In a next step, heterogeneity within our data set is studied on the sectoral level. Thereafter, we study shock transmission channels at the industry level following Lee and Ni (2002). A further advantage of the survey experimental approach is illustrated on the firm level, where we dissect the generated survey based impulse responses by employing regression analysis. Thereby, we shed light on the relation between the oil intensity of firms and their responsiveness to oil price shocks.[17]

4.1 Aggregate results

The definition of impulse responses generated from survey experiments is equivalent to a general definition of impulse responses in the time series literature (see Section 2). To compare survey based impulse responses to time series impulse responses, we estimated a BVAR on oil prices, output (real GDP) and a producer price index (PPI). The VAR identification of oil price shocks follows Kilian (2008).[18]

Aggregate survey based impulse responses are derived by aggregating the representative sample of firm level data from our survey experiment using standard procedures (European Commission, 2007). First, individual impulse responses are aggregated to the industry level with firms' number of employees as weights.[19] Second, a Swiss economy-wide aggregate is built from industry groups by utilizing gross value added shares as provided by the Swiss Federal Statistical Office. The aggregation scheme can be found in Appendix 6.5. By weighting the firm level data first for industry groups and second for the whole economy we ensure generalizability of our sample. We investigated whether our results vary with the applied weighting schemes. The results do not depend on the weighting scheme, unweighted results are only marginally different from weighted results.[20]

As can be seen from Table 1 the one standard deviation (= 30%) oil price shock has significant effects on the Swiss economy according to both approaches. The survey based impulse response analysis yields a real turnover change of −0.4% within the first six months and by −0.6% within 18 months (see also Table 3). The BVAR based impulse responses to an oil supply shock at their posterior mean range from −0.4%

[17]The empirical analysis including aggregation and panel data analysis has been coded in R.

[18]In contrast to Kilian (2008) we use Bayesian methods to estimate the model. See Appendix 6.6 for further details. Note that our VAR based impulse responses depict average historical effects of oil price shocks whereas our survey based impulse responses determine the effects of a shock at the time of the survey in summer 2012, when the survey was conducted. This conceptual difference mutes comparability.

[19]The number of employees is a proxy for the value added of a company.

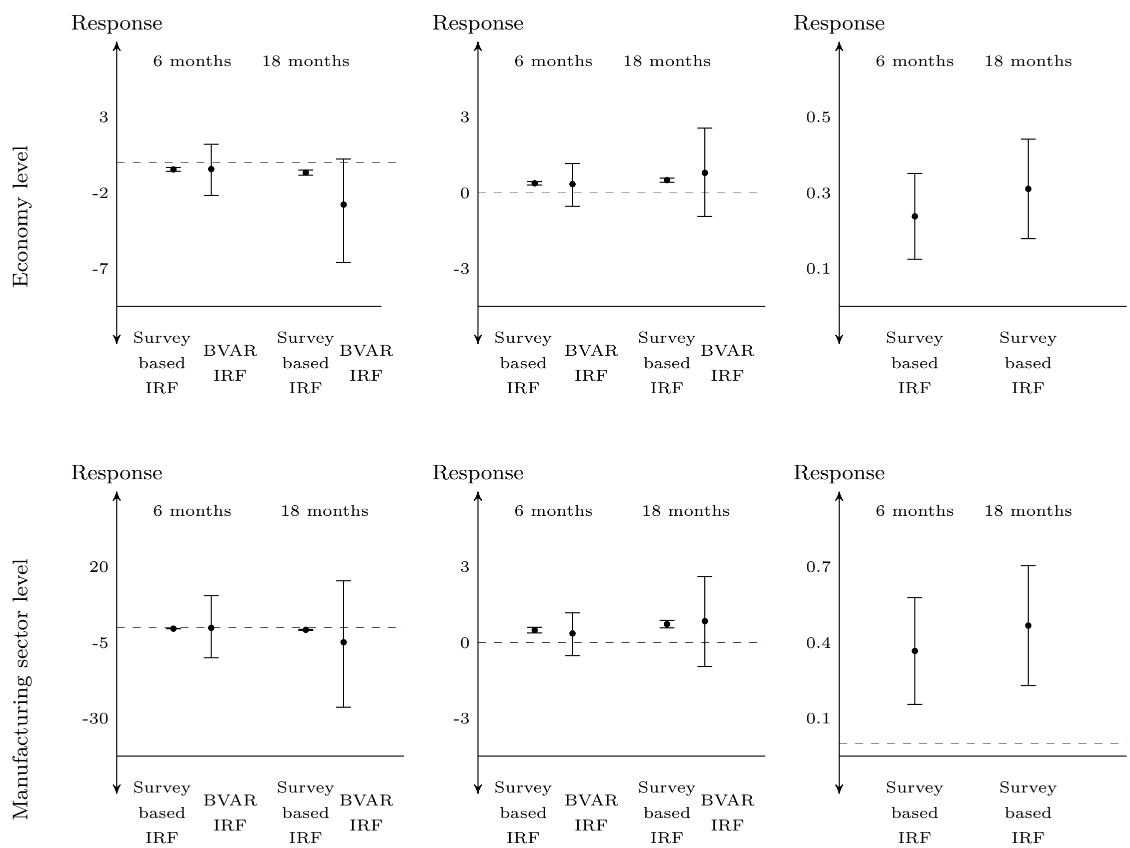
[20]Results are available on request.

within the first 6 months to −2.8% within 18 months (see Appendix 6.6 for full fledged impulse responses). However, there is a lot of uncertainty around the BVAR estimates, with most of the probability mass being in the negative region. BVAR error bands always include the values from the survey based impulse responses.

Domestic sales prices at the economy level increase stronger after 18 months (0.6%) than within the first 6 months (0.5%). These figures are strikingly in line with the responses obtained from the BVAR: a stronger price increase within 18 months of 0.9% than observed within 6 months (0.4%). Most of the posterior probability mass is in the positive region. We also investigated the effects of an oil price shock on foreign sales prices. Foreign sales prices react weaker than domestic sales prices. Within 6 months foreign sales prices at the economy level increase by roughly 0.3%. We do not observe a further increase within 18 months.

Table 1: Survey based and BVAR impulse response functions

	Output (real)	Sales Prices Domestic	Sales Prices Foreign



The figure depicts impulse response functions (IRFs) derived from a survey experiment and IRFs generated by a BVAR in response to a one standard deviation oil price shock. Responses are displayed at the 6 and 18 months forecast horizon and are centered in between the whiskers. The whiskers of the survey based IRFs are +/− 2 standard deviations. See Appendix 6.5 for calculation of these standard deviations. The whiskers of the BVAR impulse responses are the 5% and 95% percentiles of the respective posterior distribution of IRFs to an oil price shock.

The economy level survey based impulse responses rely on turnover values, which is not exactly the same as the GDP series used for the BVAR.[21] Thus, to provide further evidence for a comparison between VAR and survey based impulse responses, we aggregate the survey experimental outcomes to the manufacturing sector level and confront them with estimates from a BVAR using manufacturing real turnover and producer prices.[22]

The manufacturing sector level analysis confirms that the survey based impulse responses and the VAR based impulse responses are in the same ballpark. Real turnover changes by –0.5% within 6 and –0.8% within 18 months according to the survey based impulse response analysis. The BVAR yields posterior mean changes of 0.1% within 6 and –4.9% within 18 months. Note however that the BVAR manufacturing real turnover results are highly imprecisely estimated, complicating the comparison of BVAR results and survey based results. With respect to domestic sales prices, the values are again in line with each other: Mean survey based impulse responses depict a reaction of 0.8% to an oil price shock within six months and a response of 1.1% within 18 months. BVAR impulse responses lie at 0.4% within six months and 0.9% within 18 months. Survey based impulse responses for foreign sales price reactions to an oil price shock on the manufacturing level are stronger than on the economy wide level: Within six months foreign sales prices increase by 0.6%, within 18 months they rise by 0.7%.

We conclude that the impulse responses obtained from VAR analysis and the survey based impulse responses are broadly in line with each other.[23]

4.2 Heterogeneity within sectors

While aggregate results help to characterize the response of an economy to macroeconomic shocks, a lot of heterogeneity might be hidden below the surface. The results from our survey experiment shed light on the distribution of impulse responses on the firm level.

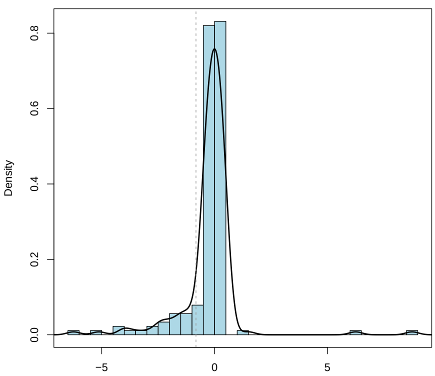
We observe a lot of heterogeneity within firms' impulse responses to an oil price shock. Figure 3 shows the empirical distributions of turnover changes in response to the oil price shock over all manufacturing sector firms and over all service sector firms. Distributions are presented in form of empirical probability mass functions (pmf) and in form of smoothed kernel densities calculated from the pmf. The overall weight of the real sales distributions for both the manufacturing and service sector lies in negative territory (upper row).

[21] A direct comparison between value-added GDP data and turnover data might be misleading (see, e.g., Kilian, 2008)

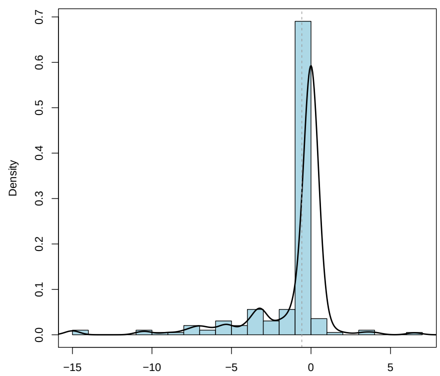
[22] The Swiss Federal Statistical Office only provides a manufacturing sector (but not an economy-wide) real turnover time series with sufficient length for VAR analysis.

[23] Survey based impulse responses are also in line with the evidence in Peersman and Van Robays (2012). The authors estimated a SVAR for Switzerland, amongst others, based on the time period 1986-2010, and identified the effects of oil price shocks on real GDP and consumer prices.

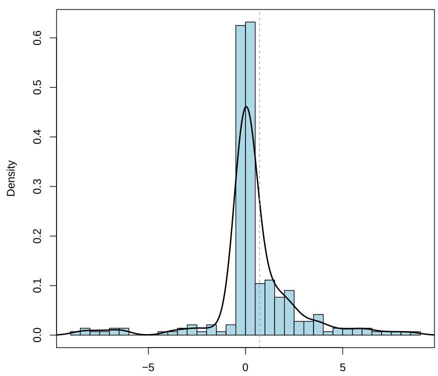
Figure 3: Changes in real sales, foreign & domestic prices within 18 months



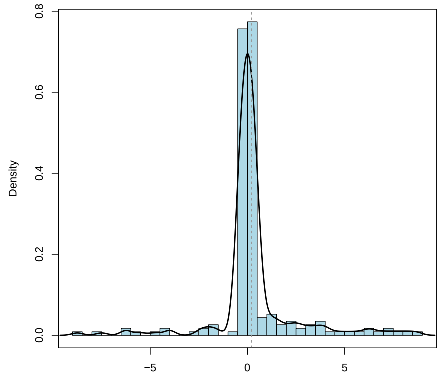
(a) Manufacturing real sales



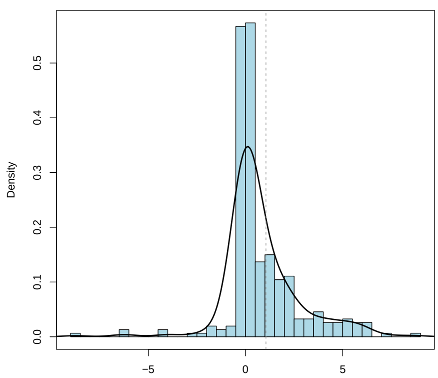
(b) Services real sales



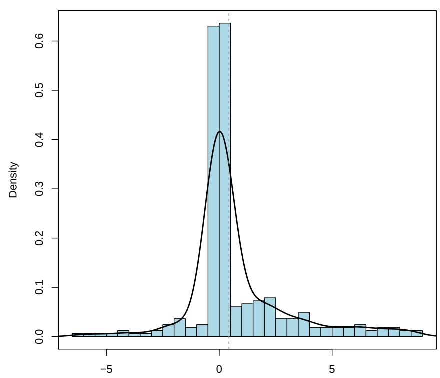
(c) Manufacturing foreign prices



(d) Services foreign prices



(e) Manufacturing domestic prices



(f) Services domestic prices

The histograms show 18 months impulse responses in real sales, foreign and domestic sales. The light blue bars show the relative frequency of firms' responses in percentage points. The solid black lines represent smoothed kernel densities. The dotted lines depict weighted means.

Both distributions have fat tails and are skewed to the left. The majority of firms only suffer from small reductions in output, yet a substantial fraction reports output losses of -5% and more in response to an unanticipated oil price shock of 30%. It is intriguing to see that large output reductions are more common for service sector firms than for manufacturing firms, while intuitively one might expect a picture the other way round. The detailed analysis of firm responses on the industry level in Section 4.3 will shed light on this issue – those service sector firms being mostly affected often belong to transportation & logistics.

Turning to foreign sales prices (middle row), most firms expect only slight changes in foreign prices compared to a no-shock scenario. Yet a distinction between manufacturing firms and service sector firms becomes apparent. The right-hand tail of manufacturing firms' responses is fatter than for service sector firms. Also, the manufacturing sector distribution of impulse responses is obviously skewed to the right, while the service sector distribution is much less skewed. Furthermore, what distinguishes the pictures for foreign sales prices and real sales, is that there are quite a number of counterintuitive observations: a substantial number of firms reports *decreases* in foreign sales prices in response to an oil price shock. Section 4.3 covers this issue, revealing that some industries are affected by a foreign demand channel, which is responsible for lowering sales prices in order to react to declining demand for their products as the oil price increases.

The figures for domestic sales prices responses are broadly similar to the pictures for foreign sales prices. However, domestic sales price responses are more skewed to the right, both for manufacturing firms and for service sector firms. It appears, that firms are more able to raise sales in response to an oil price shock on the domestic markets than on foreign markets. Section 4.4 investigates what firm characteristics (such as oil dependency, market power, firm size, etc.) are responsible for price setting capabilities.

4.3 Industry level results

We now turn to the industry level analysis of our survey experimental data. In theory, an oil supply shock affects output and prices through two main channels. The cost-push channel is described by firms' reactions to a firm specific cost increase in consequence of an oil price hike. The demand channel is characterized by reduced demand from firms' clients (consumers or other firms) as a reaction to an oil price increase. Following Lee and Ni (2002), we distinguish between the two channels in the following manner. After a negative oil supply shock the cost-push channel is important when firms respond positively in terms of sales prices and negatively in terms of real sales. In contrast, the demand channel dominates when sales prices and real sales both react negatively.

Table 2 shows the pattern of impulses responses of output, domestic sales prices, and foreign sales prices (see Table 3 for more detailed figures). Industries are ranked according to their oil share in total costs. Similar to the SVAR setup of Lee and

Table 2: Signs of impulse responses to an oil supply shock

Industry	Peak effect on sales prices	Peak effect on real turnover	Dominating channels
Maintenance of machinery goods	+/+	−	Dom. & foreign cost-push
Chemicals & pharmaceuticals	+/+	−	Dom. & foreign cost-push
Transport	+/−	−	Dom. cost-push & for. demand
Textiles	+/0	0	Insignificant
Metals (except machinery)	+/0	0	Insignificant
Construction	+/0	0	Insignificant
Machinery & automobiles	0/−	−	Foreign demand
Computers & electronics	+/0	−	Dom. cost-push
Food & tobacco	+/+	0	Insignificant
Wholesale & retail	+/+	−	Dom. and foreign cost-push
Hotel & hospitality	0/0	−	Insignificant
Housing & technical services	0/0	0	Insignificant
Research & development	+/+	−	Dom. and foreign cost-push
Telecom & IT services	+/+	−	Dom. and foreign cost-push
Financial services & insurances	0/0	0	Insignificant

Note:"'0" denotes impulse responses that are not significantly different from zero. "+" means that the peak effect of the impulse response is significantly different from zero and positive. "−" means that the peak effect is significantly different from zero and negative. The left-hand side of the fraction "./." refers to domestic sales prices and the right-hand side of the fraction to foreign sales prices. Peak effects are the largest reaction of impulses responses within 6 and 18 months.

Ni (2002), we find that oil intensive industries, such as maintenance of machinery goods, chemicals & pharmaceuticals, and transport all show an increase in domestic sales prices and a decline in output, indicating a dominance of the domestic cost-push channel.[24] The two industries maintenance of machinery goods and chemicals & pharmaceuticals are dominated by the cost-push channel also on foreign markets where the sales price increase of chemical & pharmaceutical firms is by far the strongest of all industries in international markets. Interestingly, the transportation and logistics industry, being highly dependent on oil-derivatives (e.g., fuel), is predominantly affected by a shift in international demand. This might be due to an elastic reaction of freight rates to an increase in energy prices, influencing the demand for international trade and logistics.

Four different patterns emerge among the remaining industries with a medium or lower oil share. Industries with no consistent (i.e. insignificant) outcomes, those with a prevalence of the domestic cost-push channel, of domestic as well as foreign cost-push channels, and of foreign demand. Industries with a negligible shift in costs or demand are textiles, metals, construction, food & tobacco, hotel & hospitality, housing & technical services, and banking & insurance.

[24]In a VAR setup Herrera (2008) finds negative output effects of an oil price increase in highly oil intensive industries for U.S. data from 1959-2000. Industry level effects for the US have also been studied by Lagalo (2011). Jiménez-Rodríguez (2011) provide similar evidence for the UK, Germany, Spain, France, and Italy. Fukunaga, Hirakata, and Sudo (2010) have been looking besides the US at industry level effects for the case of Japan.

Table 3: Industry level responses

Industry	Turnover (real)		Sales prices domestic		Sales prices foreign		Oil share
	6 months	18 months	6 months	18 months	6 months	18 months	
Maintenance of machinery	-1.13 *(0.37)*	-1.67 *(0.41)*	0.10 *(0.10)*	0.60 *(0.30)*	0.16 *(0.16)*	0.55 *(0.29)*	8.42 *(2.72)*
Chemicals & pharmaceuticals	-0.59 *(0.28)*	-1.13 *(0.40)*	1.83 *(0.29)*	2.24 *(0.31)*	1.85 *(0.39)*	2.20 *(0.39)*	7.71 *(1.18)*
Transport	-0.55 *(0.46)*	-0.68 *(0.46)*	0.77 *(0.23)*	0.80 *(0.23)*	0.23 *(0.33)*	0.31 *(0.31)*	3.54 *(0.76)*
Textiles	0.38 *(0.40)*	-0.23 *(0.33)*	0.60 *(0.15)*	0.76 *(0.18)*	-0.08 *(0.22)*	0.13 *(0.18)*	3.33 *(0.54)*
Metals (except machinery)	-0.50 *(0.47)*	-0.73 *(0.59)*	0.77 *(0.33)*	1.03 *(0.43)*	0.55 *(0.30)*	0.41 *(0.27)*	2.11 *(0.47)*
Construction	-0.93 *(0.15)*	-0.95 *(0.17)*	0.96 *(0.17)*	0.89 *(0.22)*	0.14 *(0.18)*	0.08 *(0.21)*	2.08 *(0.42)*
Machinery & automobiles	-0.63 *(0.23)*	-0.63 *(0.23)*	0.10 *(0.17)*	0.22 *(0.29)*	-0.54 *(0.47)*	-0.73 *(0.63)*	1.68 *(0.37)*
Computers & electronics	-0.06 *(0.19)*	-0.09 *(0.24)*	0.58 *(0.12)*	0.74 *(0.14)*	0.11 *(0.09)*	0.13 *(0.10)*	2.56 *(0.33)*
Food & tobacco	-0.29 *(0.13)*	-0.54 *(0.14)*	-0.12 *(0.14)*	0.13 *(0.20)*	-0.43 *(0.25)*	-0.16 *(0.29)*	2.28 *(0.32)*
Wholesale & retail	-0.53 *(0.21)*	-0.82 *(0.52)*	0.42 *(0.13)*	0.54 *(0.17)*	0.10 *(0.19)*	0.16 *(0.26)*	1.54 *(0.32)*
Hotels & hospitality	-0.36 *(0.33)*	-0.40 *(0.34)*	0.06 *(0.10)*	0.06 *(0.12)*	0.06 *(0.15)*	0.05 *(0.16)*	1.58 *(0.24)*
Housing & techn. services	-0.76 *(0.49)*	-0.88 *(0.50)*	0.18 *(0.15)*	0.40 *(0.19)*	0.20 *(0.15)*	0.27 *(0.16)*	1.73 *(0.20)*
Research & development	-0.64 *(0.21)*	-0.75 *(0.26)*	0.61 *(0.16)*	0.75 *(0.17)*	0.33 *(0.11)*	0.42 *(0.14)*	1.56 *(0.19)*
Telecom & IT services	0.05 *(0.22)*	-0.97 *(0.48)*	0.00 *(0.10)*	0.33 *(0.18)*	0.00 *(0.07)*	0.47 *(0.24)*	1.14 *(0.16)*
Fin. services & insurances	-0.03 *(0.04)*	-0.03 *(0.06)*	0.03 *(0.03)*	0.03 *(0.04)*	0.08 *(0.09)*	0.08 *(0.09)*	0.43 *(0.11)*
Manufacturing sector	-0.45 *(0.12)*	-0.82 *(0.16)*	0.80 *(0.09)*	1.05 *(0.11)*	0.55 *(0.12)*	0.73 *(0.13)*	4.06 *(0.35)*
Service sector	-0.44 *(0.09)*	-0.58 *(0.11)*	0.33 *(0.06)*	0.42 *(0.07)*	0.14 *(0.06)*	0.20 *(0.07)*	1.33 *(0.10)*
Economy total	-0.41 *(0.07)*	-0.61 *(0.09)*	0.48 *(0.05)*	0.62 *(0.06)*	0.25 *(0.06)*	0.34 *(0.06)*	2.16 *(0.14)*

The table depicts impulse responses of firms to an oil price shock in percent aggregated at industry, sector and economy level. Values in parenthesis are standard deviations (see Appendix 6.5). Aggregation has been conducted as described in the text.

Interestingly, food & tobacco show an inelastic effect on output but are in the position to set prices domestically and internationally. While being able to set prices domestically, industries like textiles, metals, construction, and computers & electronic equipments are not able to set prices on international markets. Banks & insurances, having the lowest oil share in the entire sample, show no reaction in terms of output and prices. Industries where the domestic cost-push channel is predominantly active are manufactures of computers and electronic equipments. Domestic as well as foreign cost-push channels are important for wholesale & retail, research & development, and telecommunications & IT. In contrast, the foreign demand channel dominates for manufactures of machinery and automotive suppliers. This importance of the foreign demand channel is due to the fact that Swiss automotive suppliers almost exclusively export their products to car producers in Germany, France, Italy, and the USA.

Industries with relatively high oil shares show comparatively strong output decreases in reaction to an oil price shock. This notwithstanding, Table 3 reveals that there is no monotonic relationship between oil intensity and output reactions at the industry level. Lee and Ni (2002) also report no unambiguous link between oil dependency and the responsiveness of output. A reason might be that industry level results mix effects of oil intensity with industry specific effects. Fortunately, the survey experimental approach allows us to zoom in further: in next subsection we show that by shifting the analysis to the firm level it is indeed possible to isolate oil intensity effects from industry specific effects and to establish a clear link between oil intensity and output responsiveness.

4.4 Firm level results

While common micro data inform about the heterogeneity of (unconditional) changes in output and prices, they lack insights about the variation in output and price changes in response to (i.e. conditional on) macroeconomic shocks. Survey experiments generate microeconomic data and, hence, combine the advantages of heterogeneity in micro data sets with structural identification of shock origins usually found in macro time series analysis. To demonstrate the usefulness of structural microeconomic data generated by survey experiments we now turn to the dissection of driving forces behind impulse responses generated by survey experiments. Four questions and hypothesis are in the focus of our analysis: While we find no clear relation between oil-price triggered output reactions and oil intensity of industries (similar to the finding of Lee and Ni, 2002), we utilize our firm-level micro data set to investigate this relationship further and decompose oil intensity and industry membership. Firms size and market power might play a role in explaining the magnitude of firm level responses to an oil price shock. Larger firms might possess a higher ability to absorb oil price shocks. Firms with more market power might be able to pass on cost increases to their customers more easily than firms with less market power. Furthermore, sluggishness in responses might be expected, given that contracts are not fully flexible and rollover of contracts do not occur instantaneously.

Using the survey experimental data we can set up the following regression model:

$$\psi_{i,t+s} = \beta \mathbf{x}_i + \gamma \mathbf{z}_i + \theta \mathbf{d}_s + \xi_{i,s} \qquad \forall i = 1, \ldots, I. \tag{16}$$

$\psi_{i,t+s}$ is either the real sales impulse response, domestic sales impulse response or foreign sales impulse response of firm i at horizon s to the 30% oil price shock (see the variables presented in Appendix 6.4). $\mathbf{x}_i$ is a row vector of firm-specific explanatory variables and $\mathbf{z}_i$ is a row vector of J industry dummy variables where the j-$th = 1st, \ldots, J$-th dummy variable takes value 1 if firm i is in industry j and zero otherwise. $\mathbf{d}_s$ represents a time dummy which takes value 1 for $s = 18$ months and zero otherwise. $\mathbf{x}_i$ includes three variables: firm i's size as measured by its number of employees, firm i's (non-shock scenario) oil input share defined as the expenses for oil products (e.g., fuel, gasoline, diesel, oils, grease, plastics, chemical products) as a share of total costs and firm i's market power as measured by its profit margin, i.e. (total sales – total costs)/total sales, on average over 2010–2012. β is a row vector of coefficients attached to $\mathbf{x}_i$, γ is a vector of industry specific intercepts or industry specific fixed effects that control for unobserved heterogeneity between industries, and θ captures the difference between impulse responses at the 18 month horizon and the 6 month horizon. $\xi_{i,s}$ is the error term. θ is a row vector of coefficients attached to $\mathbf{D}_s$. The regression coefficients are estimated by OLS.

As can be seen in Table 4, an increase in oil intensity by one percentage point intensifies the reduction of real sales in response to an oil price shock by 0.06 percentage points. For some industries such as textiles, chemicals & pharmaceuticals, transportation and retail, real sales are significantly reduced by between 0.9 and 1.3 percentage points (independently of oil share). However for other industries such as financial services & insurances or machine manufacturers we do not find significant effects on real sales which cannot be attributed to oil dependency. We find no significant time effects: real sales responses are statistically not different within 6 months and within 18 months after an oil price shock. Firm size and market power do not matter in terms of real sales responses when controlling for industry effects.

We thus find that firms' responsiveness of output to an oil price shock clearly depends on the oil intensity of a firm, after controlling for covariates that also might influence firms' responsiveness. Our findings are in contrast to the ambiguous correlation between the oil share and industry level responses reported in Lee and Ni (2002) and also found in the industry level analysis in section 4.3. Moreover, we find no significantly stronger impulse responses after 18 month, reflected by the insignificant time dummy variable. The homogeneity of responses across time differs from the visual inspections of impulse responses for manufacturing firms in Lee and Ni (2002), where responses at a longer horizon are stronger than responses at a shorter horizon.

Turning to prices, we find a significant influence of the oil input share on domestic sales price responses. A one percentage point increase in the oil input share increases the response of domestic sales prices to an oil price shock by 0.08 percentage points. In contrast, we do not find a statistically significant effect for foreign sales prices. Further, domestic sales prices react sluggishly to oil price shocks. The average domestic sales price increase from 6 months to 18 months after the shock is 0.21

Table 4: Response of real sales, domestic and foreign sales prices to oil price shock

	Real sales	Domestic sales prices	Foreign sales prices	Purchase prices	Costs
	(1)	(2)	(3)	(4)	(5)
Oil input share	−0.061***	0.077***	0.014	0.156***	0.069***
	(0.018)	(0.012)	(0.013)	(0.015)	(0.013)
No. of employees	0.00003	−0.00001	−0.00002	0.00000	−0.00001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Market power	−0.0002	0.0001	0.0001	0.001	0.001
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Time dummy	−0.249	0.213**	0.090	0.322**	0.221*
	(0.171)	(0.103)	(0.128)	(0.136)	(0.117)
Food & tobacco	−0.027	0.923***	0.529*	0.951***	1.512***
	(0.421)	(0.241)	(0.309)	(0.317)	(0.289)
Textiles	−1.096***	0.202	0.101	1.471***	0.832***
	(0.389)	(0.236)	(0.285)	(0.307)	(0.274)
Chemicals &	−0.928**	0.712***	1.002***	2.016***	0.997***
pharmaceuticals	(0.379)	(0.240)	(0.274)	(0.308)	(0.271)
Metals	−0.299	0.222	0.039	0.865***	0.727***
(except machinery)	(0.294)	(0.193)	(0.225)	(0.258)	(0.224)
Computers &	−0.516*	0.263	0.001	0.943***	0.483**
electronics	(0.311)	(0.200)	(0.241)	(0.273)	(0.235)
Machinery &	−0.092	−0.223	−0.099	0.730***	0.342*
automobiles	(0.259)	(0.176)	(0.195)	(0.233)	(0.200)
Maintenance of	−0.293	−0.176	0.299	1.075**	0.400
machinery goods	(0.484)	(0.322)	(0.372)	(0.443)	(0.373)
Construction	−0.211	0.476**	0.383	0.941***	0.758***
	(0.355)	(0.185)	(0.273)	(0.244)	(0.213)
Whole sale &	−1.117***	0.810***	0.537**	0.976***	0.783***
retail	(0.295)	(0.151)	(0.224)	(0.197)	(0.170)
Transport	−1.302***	0.969***	0.929***	1.822***	1.052***
	(0.364)	(0.202)	(0.259)	(0.264)	(0.226)
Hotel &	−0.131	−0.353	−1.345***	1.647***	0.037
hospitality	(0.587)	(0.308)	(0.446)	(0.395)	(0.330)
Telecom &	0.237	−0.134	−0.299	0.687*	0.849***
IT services	(0.474)	(0.278)	(0.379)	(0.372)	(0.319)
Financial services &	−0.077	−0.117	0.215	0.101	0.201
insurances	(0.289)	(0.188)	(0.218)	(0.254)	(0.217)
Housing &	−0.949***	0.036	0.150	−0.179	−0.260
techn. services	(0.319)	(0.190)	(0.236)	(0.257)	(0.219)
Research &	−0.407	−0.342	−0.121	0.242	0.139
development	(0.482)	(0.288)	(0.344)	(0.375)	(0.322)
Observations	829	1,186	944	1,208	1,216
Adjusted R^2	0.133	0.196	0.058	0.407	0.216

p-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1

percentage points, indicating a certain degree of stickiness in domestic sales prices. We further find differences in price setting capabilities across industries. Firms belonging to industries such as chemicals & pharmaceuticals, construction, retail, and transportation seem to be able to set prices domestically independently of their oil share.[25] Moreover, we do not find any significant firm size or market power effects when controlling for industry effects.

Responses of purchase prices and costs induced by an oil price shock are also driven by firms' degree of oil dependency. A one percentage point increase in the oil share increases the purchase price response to a 30% oil price jump by 0.16% and the response of costs by 0.07%. Again firm size as expressed by the number of employees and market power do not have significant effects. A time effect is prevalent: the purchase price effect 18 month after the oil price shock is on average (controlled for all other influencing factors) 0.32 pecentage points higher than the effect 6 months after the oil price shock. The costs response increases by 0.22 percentage points.

5 Conclusion

In this paper, we used a survey experiment to identify the effects of oil price shocks at the aggregate and firm level. We applied macroeconomic treatment scenarios to a representative sample of over 1000 Swiss firms. The prevalent diversity of industries and company types of our panelists led to a rich dataset. The variations in firm responses allow to draw conclusions on the effects of aggregate shocks on the economy.

We showed that the results generated by our survey experimental procedure are conceptually equivalent to impulse responses calculated in VARs. In contrast to VARs, the impulse responses obtained from survey experiments allow to identify aggregate shocks without the need to impose parametric restrictions. Moreover, we showed that the identification assumptions in VARs imply restrictions on the firm level impulse responses that might cause a bias at the aggregate level. Potentially, this bias could be tested using survey based impulse response data.

On the aggregate level, we identified the impact of oil price shocks on Swiss economic activity and producer prices. We find that aggregate figures obtained from the survey experiment and from the Bayesian VAR are in line with each other. We further decomposed the survey based impulse responses to an oil supply shock into a cost-push channel and a demand channel. It turns out that the impulse responses are quite diverse across industries. At the firm level, we show that a correlation between oil intensity and the responsiveness of output, that is not visible at the industry level, is identifiable when using our *structural* firm level data.

We analyzed possible determinants of firm level impulse responses by regressing

[25] By studying the frequency of price changes, Bils and Klenow (2004) and Nakamura and Steinsson (2008) also report heterogeneity in price setting capabilities.

them on a set of covariates such as oil intensity, market power, firm size, industry membership and time effects. Our findings suggest that market power and firm size do only play a minor role in explaining responses to an oil pric shock, while oil dependency matters.

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6 Appendix: For online publication

6.1 Validity of the survey experiment

This section discusses general challenges that need to be overcome in order to obtain reliable data from surveys. The discussion of survey errors in this appendix covers the aspects of possible survey errors described in the handbooks of Dillman, Smyth, and Christian (2014) and Weisberg (2005): sampling error, measurement error due to interviewers or respondents, coverage error, non-response and post-survey error. The respective subsections will discuss these aspects of error and what we have done to avoid them in practice. Interviewer bias will not be discussed in detail though as our survey is conducted as an online and paper based survey mixed-mode survey only and hence is not prone to interviewer bias. The only personal contact with participants is through telephone based reminders that do not interview participants. Also, post-survey error is not discussed in greater detail as the survey is conducted by the KOF Swiss Economic Institute which has multiple decades of experience in the conduction of surveys and in maintaining databases that store survey data. Thus possible post-survey errors that are related to not storing answers correctly or difficulties with reading survey data in are not discussed at length. In turn we put additional emphasis on issues that relate to economic surveys in particular such as bias induced by inaccurate respondents, coverage and non-response. Further, Druckman, Green, Kuklinski, and Lupia (2006), Kinder (2007), Gaines, Kuklinski, and Quirk (2006), Barabas and Jerit (2010), and Guterbock and Nock (2010) carefully examine possible pitfalls of survey experiments.

Measurement error due to respondents

Measurement errors due to respondents can be the consequence of several aspects such as firms' understanding of the questions, relevance of the questions to participants, willingness to answer the questions correctly and carefully or shortcomings of the questionnaire. We checked the validity and relevance of our scenario questions carefully in an interviewer pre-test among randomly selected companies.[26] We also made sure that the questionnaire reached out to the right persons, namely top level executives or heads of accounting/controlling by attaching the scenario questions to the bi-annual KOF Investment survey. The KOF Panel is well established among companies and is continously maintained to keep high quality relations to Swiss firms in the service sector, the construction sector and the manufacturing sector. Surveys based on the KOF panel have a long history of contributing to valid pre-

[26] Groves (1989, p. 422) writes that the recall of past events depends on the length of the recall period, the salience of the event to be recalled, the task difficulty of the event, the respondents attention or motivation. More recent events are recalled better than earlier events. Specifically, Gaines, Kuklinski, and Quirk (2006) argue that agents are indeed able to evaluate the causal effects of a counterfactual event provided that they experienced similar events in the past, and that they consider such events to be relevant for them.

dictions of various economic figures and thus using the KOF sample encourages our trust in firms willingness to participate carefully and correctly.

We do not claim that every single firm executive builds unbiased and informative expectation. Rather, for survey based impulse response to be valid responses must be unbiased in the aggregate, i.e. on average over all firms. This weak form of unbiasedness can be tested by checking whether firms realizations are in line with their expectations in the baseline scenario. In order to do so, we use information from two waves of the KOF investment survey which collects firms' expectations and realizations of key financial figures. The 2012 spring wave which is linked to our scenario survey contains projections and the 2013 spring wave contains the corresponding realizations for the same period. Thus, we can directly compare firms' projections with their realizations. Because no substantial macroeconomic shock hit the Swiss economy during this period, we can assume that deviations are rather based on idiosyncratic shocks or measurement errors due to the respondent. When testing for differences we ensure data quality by excluding observations with obvious typos and multiplication/divison by 1000 mistakes (i.e. projection 1000 Swiss Francs, realized numbers 1 million Swiss Francs). In order to test if projected numbers are on average in line with realized figures we conduct a Student t-test on projection errors by calculating the firm-specific relative projection error

$$e_{GI_i} = \frac{GI_i - GI_i^e}{GI_i^e},$$

where GI_i is gross investment reported by firm i and GI_i^e depicts projected gross investments. Table 5 shows the results of a t-test testing the null hypothesis that the true mean is equal to 0. With a p-value of 0.29 it cannot be rejected that the mean of 0.027 is equal to zero. Hence, it cannot be rejected that firm projection errors are i.i.d. and the average projection error is zero.

This finding confirms the ability of our respondents' to consistently predict the outcomes of their companies' financial figures. Consistent expectations in the baseline case also validate the scenario case because the scenario can be considered as a simplification of the baseline (see Section 2.3).

Table 5: Student t-test on firms' projection errors

Mean projection error	t-values	p-values	obs.
0.0265	1.052	0.293	657

Coverage error

Coverage error occurs when there is a bias due to the omission of noncovered units (Weisberg, 2005, p. 206). In our context this might be the case if we underrepresent certain industry types while overrepresenting others. In order to correct for such misalignments, we give extra weight to hard-to-obtain respondents. The answers are weighted twofold (see Appendix 6.5). First, individual responses within an industry group (based on NACE classification scheme) are weighted based on firms' number of employees. This weighting scheme yields the distribution of answers for each industry category. Second, the industry categories are aggregated to an industry average by utilizing gross value added shares as provided by Swiss Statistical Office. The number of employees is a proxy for the value added of a company. Industrial firms with a larger value added are more likely to also employ more workers. By weighting the answers first for the industry categories and second for industry total we ensure representativity of our sample. This aggregation scheme is in line with international standards for aggregation business sentiment surveys (European Commission, 2007).

Accounting for non-response bias

Potentially our results could be biased by self-selection into the sample. If our questionnaire was highly relevant to a particular group of firms, these firms may systematically select themselves into the sample, while firms to which the questionnaire is less relevant choose to drop out. In that sense, if our questionnaire was only relevant to firms with a large oil share, our result might over-estimate the effects of an oil price shock for the entire economy because highly oil dependent firms were over-represented by selecting themselves into the sample.

To ensure our estimation results are not biased by the fact that firms with an high oil share were more likely to respond than others, we apply the "surrogate" approach of Wallace and Mellor (1988). We compare the firms that responded on time, i.e. by July 9, 2012, with those that did not answer the survey until that date. Regarding the late responders we enforced participation by pressuring them with phone calls. Hence, the late responders can be interpreted as a sample from the non-response population. Following Wallace and Mellor (1988), we create two sub-samples by selecting the first 50 observations from the early responders and the last 50 observations from late responders. Given that subsample participants submitted in random order, both subsamples should be random draws from the total population and thus should not differ in their means and distribution. Based on this idea we test for differences in means for the oil share variable. Note that this could be done in principle for differences in any of our variables, yet we focus on the oil share because of its focal role. We also perform a Kolmogorov-Smirnov test to check whether distributions of both subsamples are equal. The following paragraphs present the results for an unweighted sample as well as for a weighted sample, which weighs firms according to their contribution to the entire economy.

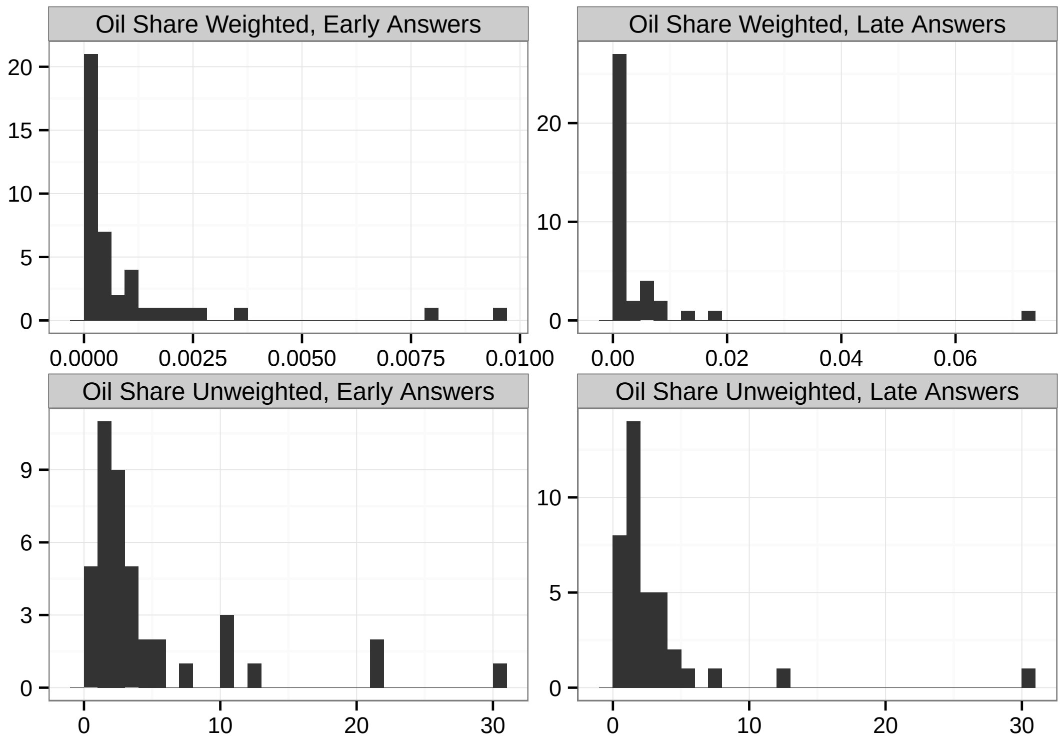
Table 6 shows the results of a simple t-test testing for equality of means in both groups: late respondents and early respondents. The differences in mean oil shares are not significant at the 10 percent level. This results holds also when we multiply firms' oil shares by their weights used in the aggregation procedure.

Table 6: Mean oil shares of early and late respondents

Test	Mean oil share of early respondents	Mean oil share of late respondents	p-value
Unweighted t-test	4.4107	2.6941	0.1880
Weighted t-test	0.0010	0.0043	0.1050

The sample mean helps to get a first idea of the oil share variable but does obviously not fully represent differences in sampling distributions. Thus, we also look at the sampling distributions of both samples. Figure 4 shows histograms for both groups and both samples.

Figure 4: Distributions by samples



The Kolmogorov-Smirnov (KS) tests fails to reject the hypothesis of equal distributions for both the weighted and the unweighted sample. Table 7 summarizes the results of the KS test.

Table 7: Kolomogorov-Smirnov test results for equality of distributions

Test	Test statistic D	p-value
Unweighted KS-test	0.1980	0.4147
Weighted KS-test	0.2544	0.1512

6.2 Enterprise panel

The enterprise panel at KOF Swiss Economic Institute is based on a sample of 7000 firms taken from the Business Register (BR) of the Federal Statistical Office. The sample, which covers manufacturing, construction and the commercial area of the service sector, is stratified according to sectors and sector-specific variables and is adjusted regularly. The corresponding address database, which in addition to numerous structural features of the firms, contains all information that is required to ensure that panel surveys run smoothly (specific contact points, checking of replies, recalls, and incomplete surveys etc.), was developed continuously and updated regularly throughout the project.

Based on the KOF enterprise panel, regular collections of data on the structural changes, innovative activities and on investment plans of Swiss companies are conducted. The enterprise panel draws from a population of 60270 companies. These companies are part of the entire collection of firms within Switzerland. Out of all firms within Switzerland only those with a business register number (assigned in year 2001) and with at least 5 employees have been selected. Companies belonging to agricultural activities or public administration have been included. In contrast to the sample used for structural investigations of the Swiss economy the utilized investment sample also contains firms being active in education, health, waste disposal, entertainment, cultural and sports activities.

The sample of 7000 firms has been drawn out of the population of 60270 companies by utilizing stratified random sampling. While simple random sampling would assign the same probabilities to be drawn to each observation (or firm), stratified random sampling allows adjustments to the sampling weights. Stratification is important in order to achieve representation on sector and industry level, as well as in terms of size classes. Size classes are measured by number of employees as a proxy. Larger companies are assigned higher sampling weights compared to smaller companies, firms being active in less represented industries also become assigned higher weights. The population of 60270 has been divided within industry groups into three size classes, small, medium, and large, based on the number of employees. Within each industry the cut-offs between small, medium and large differ. The cut-offs have been determined based on the distribution of firms sizes within an industry. Take for instance the financial industry and carpenters. In Switzerland the smallest banks have more employees compared to the smallest carpenter. Also, the largest banks have more employees than the largest carpenter. Therefore each industry requires individual cut-offs, based on the distribution of employees within an industry. These cut-off values are determined according to Dalenius and Gurney (1951).

Once cut-offs of size classes within industries have been determined, the sampling weights within each industry size class are assigned. The sampling weight, i.e. the drawing probability, of large firms within each industry has been set to 100%. All large firms shall be included (this increases the number of employees the survey is based on). The sampling weights of medium categories are a mixture between 100% drawing probability and random sampling. The medium sized firms which have been drawn with 100% drawing probability belong to the chemical industry, metal production, machinery, electrical engineering, electronics and instruments, watches, cars, energy, retail, transportation, banking and insurance, and communication. Industries with a priori assumed higher tendency to innovate have been assigned a higher drawing probability in the medium size category. Drawing probabilities for small size classes and remaining medium size classes are based on the number of firms within each industry size class multiplied by a weighting factor and divided by the sum of all other number of firms again multiplied by the same weighting factor. Thereby, the relative weight of each industry size class (small and medium), belonging to those classes not being assigned a 100% drawing probability, can be determined. This drawing probability is furthermore multiplied by the number of remaining firms to be drawn. The number of remaining firms to be drawn is the difference between the target sample size (i.e. 3000 for manufacturing, 600 for construction, 3400 for services) and the number of firms with 100% drawing probability (i.e. for manufacturing 3000–929=2071). Larger weighting factors have been assigned to the remaining medium size firms compared to the weighting factors for small firms. These are determined endogenously based on the number of full time worker equivalents. Within each industry size class the sampling weights are the same. The attribution of sampling weights for each industry size class is based on Cochrane (1977).

The sample size of individual industries has been adjusted according to

$$\tilde{n}_i = (N - C) * \frac{n_i s_i}{\sum n_i s_i} \tag{17}$$

with $\tilde{n}_i$ being the adjusted sample size of different industries in a sector, separated by size, and N the target sample size of a sector. C represents the correction of the target sample size, calculated as the sum of all estimated samples that are not adjusted. n_i represents the size of an industry that has to be adjusted and s_i its standard deviation (Cochrane, 1977, p. 104). The sampling weights w_i are then calculated as

$$w_i = \frac{\tilde{n}_i}{n_i} \tag{18}$$

The utilized sample contains 7000 firms. Out of these 7000 a total of 3000 firms belongs to manufacturing, 3000 belong to services, 600 to construction and 400 to health services, waste disposal, education, cultural activities and sports. Within each of these categories the distribution of weights is optimal (see Cochrane, 1977).

6.3 Questionnaire

KOF **Investment Survey**

KOF Konjunkturforschungsstelle
ETH Zürich, WEC D 15, 8092 Zürich
www.kof.ethz.ch

Tel. 044 632 85 33
Fax 044 632 13 52
ivu@kof.ethz.ch

Please note

- Do not use a red pencil.
- Please tick relevant boxes or enter figures.
- Data applies to all production facilities in Switzerland.
- See explanatory information on the back side.
- Please return the questionnaire by: **29 June 2012**

KOF is subordinated to the Federal Statistics Act (FStatA).
All information will be treated strictly confidentially.

Spring Questionnaire

1. Total Investment Activity

a) Our gross fixed capital formation excluding VAT (construction, machinery, equipment and other investments) amounted to/is expected to amount to

2010 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2011 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2012 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

b) In comparison to 2012, our gross fixed capital formation in 2013 are expected to

– –	-	=	+	++	NA
☐	☐	☐	☐	☐	☐

– – decrease strongly; – decrease slightly; = remain unchanged; + increase slightly; ++ increase strongly; NA no answer

2. Investment Activity by Kind

	Equipment and other Investments		Construction Investments	
2010	☐☐☐ %	+	☐☐☐ %	= 100%
2011	☐☐☐ %	+	☐☐☐ %	= 100%
2012	☐☐☐ %	+	☐☐☐ %	= 100%

3. Employees

Our number of employees in Switzerland (converted into full-time equivalent positions) at year end amounted to

2011 ☐☐☐'☐☐☐

4. Turnover

a) Our domestic and foreign sales (excluding VAT) originating from Switzerland amounted to/will amount to according to our expectations

Banks and insurances please refer to explanations on the back

2010 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2011 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2012 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

1st half of 2012

☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2nd half of 2012

☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

b) We consider the realization of our sales forecast for **2012** to be

very certain	rather certain	rather uncertain	very uncertain	NA
☐	☐	☐	☐	☐

c) Compared to 2012, we expect our sales to change in **2013** as follows (approximately)

⩽-10%	7.5%	-5%	-2.5%	0%	2.5%	5%	7.5%	10%	≥20%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5. Expenditures

Our domestic total costs (including personnel expenditures, intermediate input, other expenses; excluding investments) amounted to/will amount to (according to our expectations)

2010 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2011 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2012 ☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

1st half of 2012

☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

2nd half of 2012

☐☐'☐☐☐'☐☐☐'☐☐☐.- CHF

This questionnaire has been completed by:

Name: ....

Function: ....

Telephone: ....

In future we would like to answer the questionnaire via the internet. Our e-mail-address:

....

Many thanks for your participation

Explanations

General remarks

The Investment Survey is an instrument for the early recording of planned investment trends.

Definition «Investment»

The investments addressed by this questionnaire mean inflows minus outflows of fixed capital assets. These should be recorded before depreciation on the basis of their purchase price (gross investment). It is irrelevant whether the equipment which is being used for the first time is new or second-hand, and whether it has been bought, hired or created in-house.

Fixed capital formation thus encompasses:

Construction

- New construction, conversion work and renovation of commercial premises.

Machinery and equipment

- Machinery, mechanical plants, conveying equipment and warehouse equipment, office machines incl. IT (hardware and software), furniture and equipment, vehicles used for business purposes, and (only) such services which are designed to preserve, to improve or to renovate plants.

This means that fixed capital formation does not include:

- Financial investment (e.g. equity holdings, securities)
- Investment in residential property
- Real estate costs
- Buildings and plants which are intended for hire by the lessor, where the lessor acts merely as a (third-party) financier
- Inventory investment (inventory increases)
- Intangible assets (e.g. expenditure on marketing concepts, for human capital, for research & development, for patents and licences)

Definition «Turnover»

The turnover addressed by this questionnaire conforms with the definition of the Swiss Federal Statistical Office:

«Turnover comprises the totals invoiced by the observation unit during the reference period, and this corresponds to market sales of goods or services supplied to third parties. Turnover includes all duties and taxes on the goods or services invoiced by the unit with the exception of the VAT invoiced by the unit vis-a-vis its customer and other similar deductible taxes directly linked to turnover. Turnover also includes all other charges (transport, packaging, etc.) passed on to the customer, even if these charges are listed separately in the invoice.

Reduction in prices, rebates and discounts as well as the value of returned packing must be deducted. Price reductions, rebates and bonuses conceded later to clients, for example at the end of the year, are not taken into account.»

Banks:
Earnings from interest revenue and trading, services and commission business.

Insurances:
Gross premiums minus gross payments for insurance claims plus net earnings from capital investments; gross fees for consulting services.

Definition «Expenditures»

Expenditures are defined as expenses for material, goods and services, wages and labor costs, social security contributions, other personnel and operating expenditures.

No expenditures are therefore:
Investments, financial expenses, depreciation, other write-downs, additional costs, nonoperating and extraordinary expenses, taxes.

Remarks

KOF Special Survey «Oil Price and Exchange Rate»

KOF Konjunkturforschungsstelle
ETH Zürich, WEC D 15, 8092 Zürich
www.kof.ethz.ch

Tel. 044 632 85 33
Fax 044 632 13 52
ivu@kof.ethz.ch

An approximate estimation based on experience is sufficient. Precise figures are not required.

6. Exchange Rate

a) The Swiss National Bank (SNB) announced to defend the lower limit of 1.20 CHF/EUR. The current exchange rate of Euro to Swiss Franc is 1.20 CHF/EUR. Which average exchange rate do you expect?

2nd half of 2012

≤1.00	1.10	1.15	1.20	1.25	1.30	≥1.40	NA
☐	☐	☐	☐	☐	☐	☐	■

2013

≤1.00	1.10	1.15	1.20	1.25	1.30	≥1.40	NA
☐	☐	☐	☐	☐	☐	☐	■

b) How large are your current exports as a percentage of total turnover?

Exports to Euro Area

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

Exports to Rest of the World

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

c) How large are your current imports as a percentage of total turnover?

Imports from Euro Area

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

Imports from Rest of the World

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

7. Scenario «Exchange Rate»

Suppose the SNB reduces the lower limit of the exchange rate to 1.10 CHF/EUR under else constant economic circumstances. Suppose this leads to an exchange rate of 1.10 CHF/EUR, which corresponds to a revaluation of the Swiss franc. How your financial figures change under these circumstances as compared to your previous expectations for these figures?

a) Total Turnover

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

b) Total Expenditures (incl. staff, inputs, other expenses; excl. investments)

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

8. Oil Price

How large are your expenses for oil (e.g. fuel, gasoline, diesel, oils, grease, plastics, chemical products) as a percentage of total expenditures?

0%	1%	2%	3%	4%	5%	7.5%	10%	12.5%	15%	20%	≥30%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

9. Scenario «Oil Price»

Suppose the oil price increases by 30% within the next month under else constant economic circumstances and will remain 30% above your previous expectations regarding the oil price development. How do your financial figures change compared to your previous expectations regarding these figures?

a) Purchase Prices (average of all purchases of goods and services)

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

b) Total Expenditures (incl. staff, inputs, other expenses; excl. investments)

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

c) Domestic Sales Prices

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

d) Foreign Sales Prices

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

e) Total Turnover

2nd half of 2012

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

2013

≤-7.5%	-5%	-3%	-2%	-1%	0%	1%	2%	3%	5%	≥7.5%	NA
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	■

6.4 Data

The dataset generated by our survey (experiment) and by external data sources contains the following variables:

Table 8: Data

Variable	Description	Scale
Oil Share	Share of expenses for oil (e.g. fuel, gasoline, diesel, oils, grease, plastics, chemical products) as a percentage of total expenditures	0% to >= +30%
Export Share Euro Area	The share of exports to Euro area countries relative to total turnovers	0% to +100%
Export Share World (excluding Euro Area)	The share of exports to countries outside the Euro area	0% to +100%
Import Share Euro Area	The share of imports from Euro area countries relative to total turnovers	0% to +100%
Import Share World (excluding Euro Area)	The share of imports from countries outside the Euro area	0% to +100%
Employees	Number of employees (full time equivalents) in Switzerland at the end of 2011	Absolute values
Turnover Nominal	Turnover nominal excl. VAT generated by the Swiss parts of the company (including sales to foreign countries) in Swiss Francs. Reported balance sheet values for 2010 and 2011, projected values for 2012	Absolute values
Total Costs	Total costs including wages, intermediate goods, other expenses, excluding investments, in Swiss Francs. Reported balance sheet values for 2010 and 2011, projected values for 2012	Absolute values
Purchase Price Response	Purchase price response to a 30% (1 St. Dev.) oil price shock: Average effect on all purchases of goods and services	<= –7.5% to >= +7.5%
Total Costs Response	Total costs response to a 30% (1 St. Dev.) oil price shock: Total costs response including wages, intermediate goods, other expenses, excluding investments	<= –7.5% to >= +7.5%
Domestic Sales Price Response	Domestic sales price response to a 30% (1 St. Dev.) oil price shock: Sales price response for sales in Switzerland	<= –7.5% to >= +7.5%
Foreign Sales Price Response	Foreign sales price response to a 30% (1 St. Dev.) oil price shock: Sales price response for sales outside Switzerland	<= –7.5% to >= +7.5%
Nominal Turnover Response	Nominal turnover response to a 30% (1 St.Dev.) oil price shock	<= –7.5% to >= +7.5%
Real Turnover Response	Nominal turnover divided by the weighted mean of domestic and foreign sales price responses. Weights are derived from Euro area and world export share variables.	
Value Added	Gross value added figures for 2011 for all Swiss industries based on international NACE classification scheme. Source: Swiss Statistical Office, www.bfs.admin.ch	Absolute values

Responses based on judgement in June/July 2012 for expected effects by end of 2012 (6 months ahead) and by the end of 2013 (18 months) ahead. All responses have been transformed to continuous scale.

6.5 Aggregation scheme

We aggregate firms' responses by calculating a weighted mean,

$$\bar{y} = \sum_{i=1}^{N} w_i y_i.$$

where y_i is the response of firm $i = 1, \ldots N$ and w_i is the specific weight attached to firm i. The corresponding weighted standard deviation writes

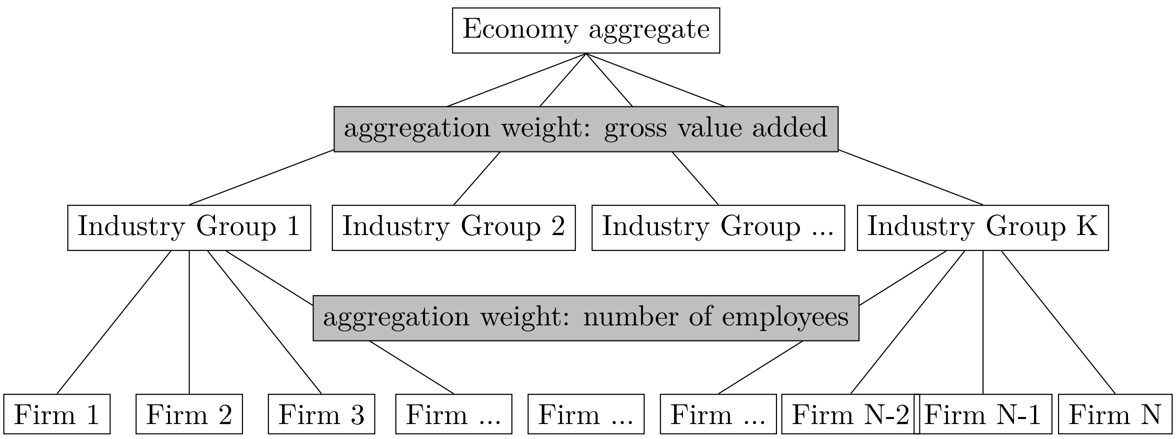
$$\sigma_{y_i} = \sqrt{\sum_{i=1}^{N} (y_i - \bar{y})^2 w_i}$$

The weights w_i are derived from an aggregation scheme such that any coverage error does not induce a bias in the results and representativeness is ensured. Specifically,

$$w_i = w_i^{Emp} * w_i^{VA},$$

where w_i^{Emp} is the number of employees of firm i divided by the cumulated number of employees of all firms within firm i's industry group and where w_i^{VA} is the gross value added of firm i's industry group divided by the cumulated gross value added of all industry groups together. The value added data have been taken from the 2011 Value Added Statistics of the Swiss Statistical Office. Figure 5 depicts the aggregation scheme. The accumulated gross value added of all industry groups together has been adjusted by omitting those industry groups, for which we did not observe a sufficient number of firms/firm employees. The aim was to have at least 30 observations within each group (with the exception of motor vehicles and furniture and repair & installation works).

Figure 5: Aggregation scheme



6.6 VAR companion model

To identify the effects of oil price shocks on the Swiss economy we follow the strategy suggested by Kilian (2009), who used this approach to identify the effects of oil price shocks on the U.S. economy. At a first step we identify oil supply, oil demand, and precautionary oil demand shocks at an international level using a VAR. To find the effects of these international oil price shocks on the Swiss economy we use a distributed lag model of Swiss aggregated variables and the identified oil price shocks. We employ Bayesian methods to estimate the VAR and the distributed lag model. The Bayesian approach has the advantage that both models can be estimated in one step, which simplifies the assessment of uncertainty around our estimates.

World wide model

Consider the following VAR

$$y_t = c + \sum_{i=1}^{24} B_i y_{t-i} + u_t \tag{19}$$

with $y_t = [\Delta oilprod_t,\ react_t,\ oilprice_t]$, where $\Delta oilprod_t$ is world crude oil production, $react_t$ is the world real economic activity index provided by Kilian (2009)[27] , and $oilprice_t$ is the crude oil price (Brent). All variables are on a monthly basis ranging from April 1990 to April 2013. The reduced form error u_t is normally distributed with zero mean and variance covariance matrix Σ. The reduced form error term can also be written as $u_t = A\epsilon_t$, where $\mathbf{A}$ ist a lower triangular matrix obtained from a Cholesky decomposition of Σ. As in Kilian (2009) the vector of structural shocks ϵ_t consists of an oil supply shock, an aggregate demand shock, and an oil-specific demand shock.

Model for Switzerland

To calculate the effects of the oil price shocks identified in the VAR on Swiss GDP and inflation, consider the following regressions

$$x_t = \alpha_j + \sum_{i=1}^{12} \beta_{ij} \xi_{jt-i} + e_{jt,x} \tag{20}$$

with

$$e_{jt,x} = \sum_{i=1}^{3} \phi_{ij,x} e_{jt-i,x} + \nu_{jt,x}, \tag{21}$$

where x_t is turnovers, $\nu_{jt,x}$ is a normally distributed disturbance with mean zero and standard deviation $\sigma_{j,x}$, and ξ_t is the vector of structural shocks at quarterly frequency.[28] Because Swiss GDP is available only at a quarterly frequency the

[27] We use the updated version of the series which can be downloaded from Kilian's webpage.

[28] Equations (21) and (24) deviates from the setup in Kilian (2009). Kilian (2009) does not model the serial correlation in the error terms.

oil shocks are aggregated from monthly to quarterly frequency using the following equation

$$\xi_t = \frac{1}{3}\sum_{m=1}^{3}\epsilon_{mt}, \quad (22)$$

where m denotes months at each quarter t. The regressions for the effects of the oil price shocks on Swiss PPI inflation can be expressed as

$$\pi_t = \delta_j + \sum_{i=1}^{12}\theta_{ji}\xi_{jt-i} + e_{jt,\pi}, \quad (23)$$

with

$$e_{jt,\pi} = \sum_{i=1}^{3}\phi_{ij,\pi}e_{jt-i,\pi} + \nu_{jt,\pi}, \quad (24)$$

where π_t denotes Swiss PPI inflation and $\nu_{jt,\pi}$ is a normally distributed disturbance with mean zero and standard deviation $\sigma_{j,\pi}$. As discussed in Section 4 we repeat the analysis using Swiss manufacturing real turnover instead of Swiss GDP.

Estimation

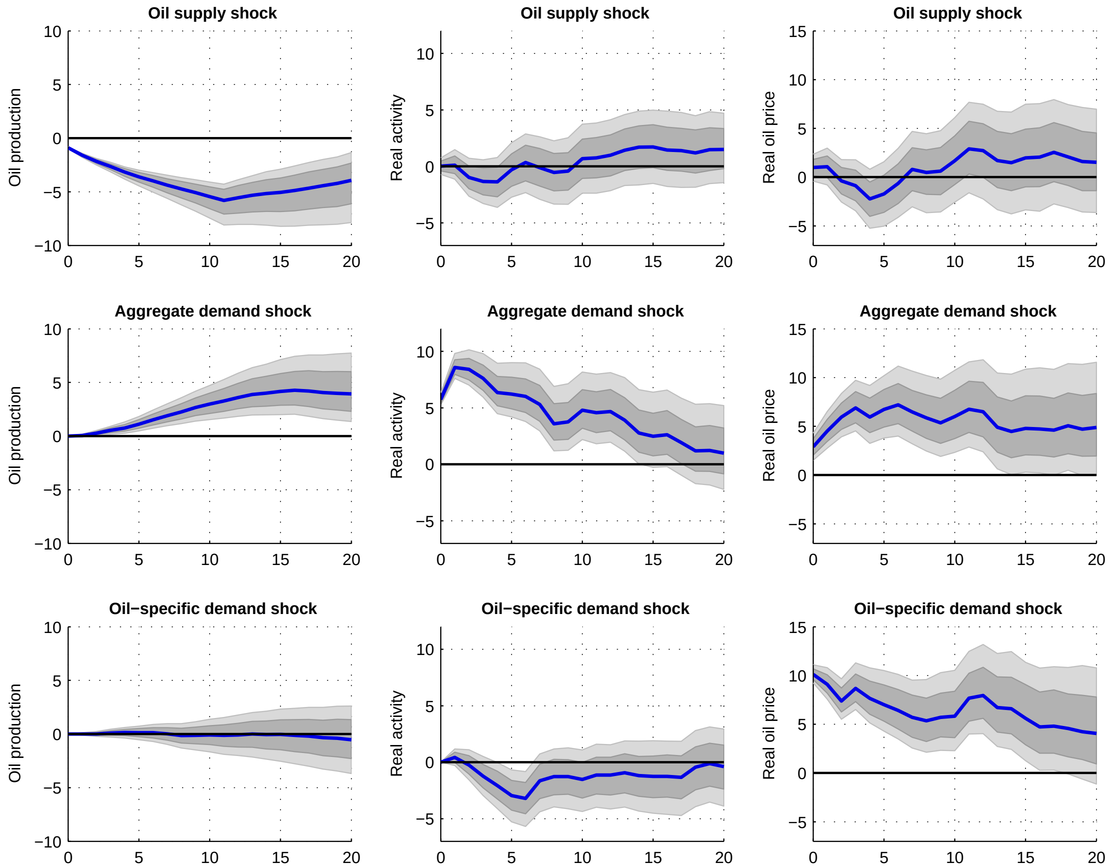
The model is estimated using Bayesian methods, more precisely the Gibbs sampling procedure. The Gibbs sampler consists of the following blocks. In a first step, conditional on the variance covariance matrix Σ draw the VAR coefficients $B_1, \ldots, B_{24}, c$ from a multivariate normal distribution. Conditional on the VAR coefficients obtain draws for Σ from an inverted Wishart distribution (see, e.g. Karlsson and Kadiyala, 1997). In the next step, draw the $\beta_{1j}, \ldots, \beta_{12j}, \alpha_j$ (or $\theta_{1j}, \ldots, \theta_{12j}, \delta_j$) conditional on the VAR parameters and the particular parameters of the serially correlated error equations from a multivariate normal distribution. Conditional on the coefficients of the distributed lag model and the variance of the disturbance equations draw the coefficients $\phi_{1j,x}, \ldots, \phi_{3j,x}$ (or $\phi_{1j,\pi}, \ldots, \phi_{3j,\pi}$) from a multivariate normal distribution. Finally, conditional on the coefficients of the distributed lag model and the serially correlated error equations draw the variance $\sigma_{j,x}$ ($\sigma_{j,\pi}$) from an inverted gamma distribution (see, e.g., Chib, 1993 for the last three blocks). After the estimation of the last block, we start the next iteration step again at the first block by conditioning on the last iteration step. These iterations have the Markov property: as the number of steps increases, the conditional posterior distributions of the parameters and the factor converge to their marginal posterior distributions at an exponential rate (see Geman and Geman, 1984).

The priors specified for the model's parameters are all extremely diffuse. The prior for the VAR parameters follow a Normal-Wishart distribution and the one for the ADL parameters follow a Normal-Gamma distribution.

The results were computed using 500.000 draws from the Gibbs sampler. The first 400.000 draws were discarded as burn-in. From the remaining 100.000 draws we have saved each 100th draw resulting into a sample of 1.000 draws. Convergence of the Gibbs sampler was checked by inspecting recursive mean plot of the parameters and by starting from different initial values and by comparing the results.

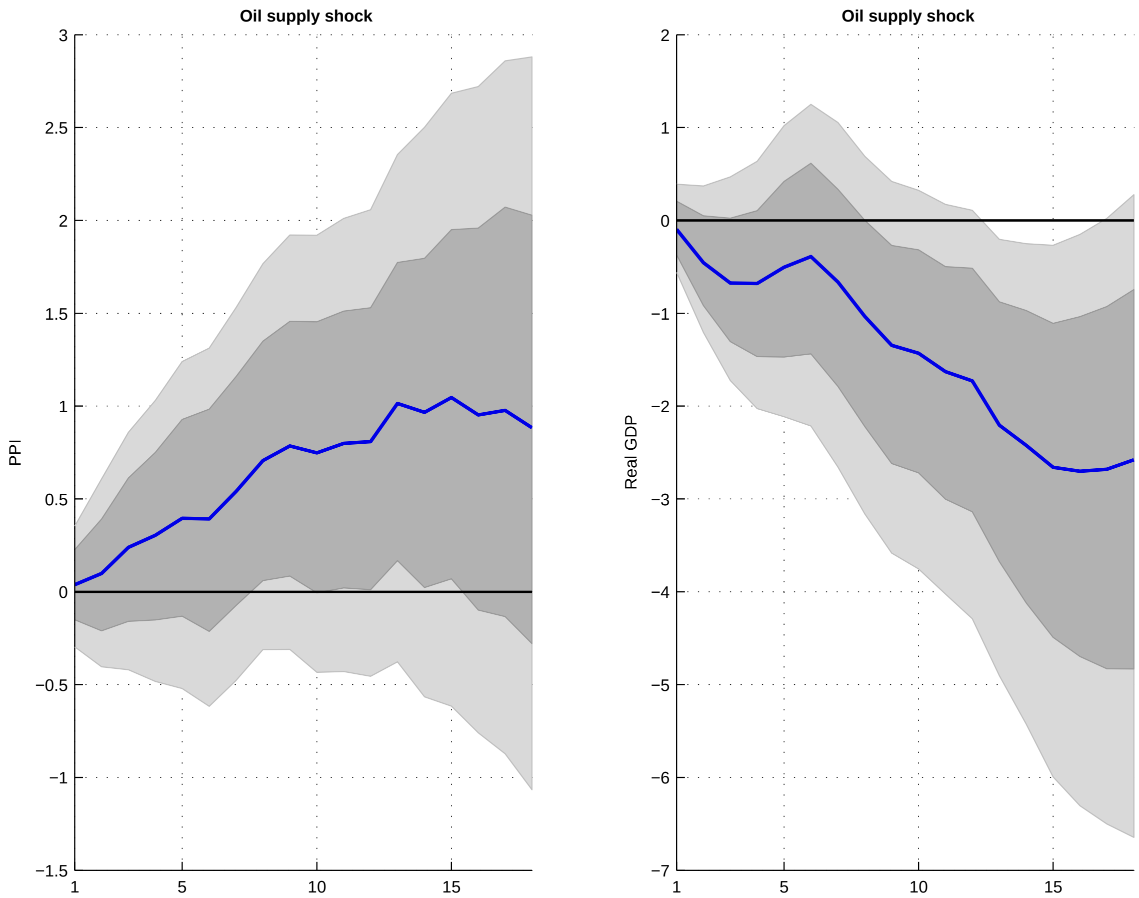
Figure 6 shows impulse responses in the world wide model. Figure 7 displays the effects of oil price shocks on Swiss GDP and PPI while Figure 8 presents the results for Swiss manufacturing real turnover and PPI inflation.

Figure 6: Impulse responses for world wide model



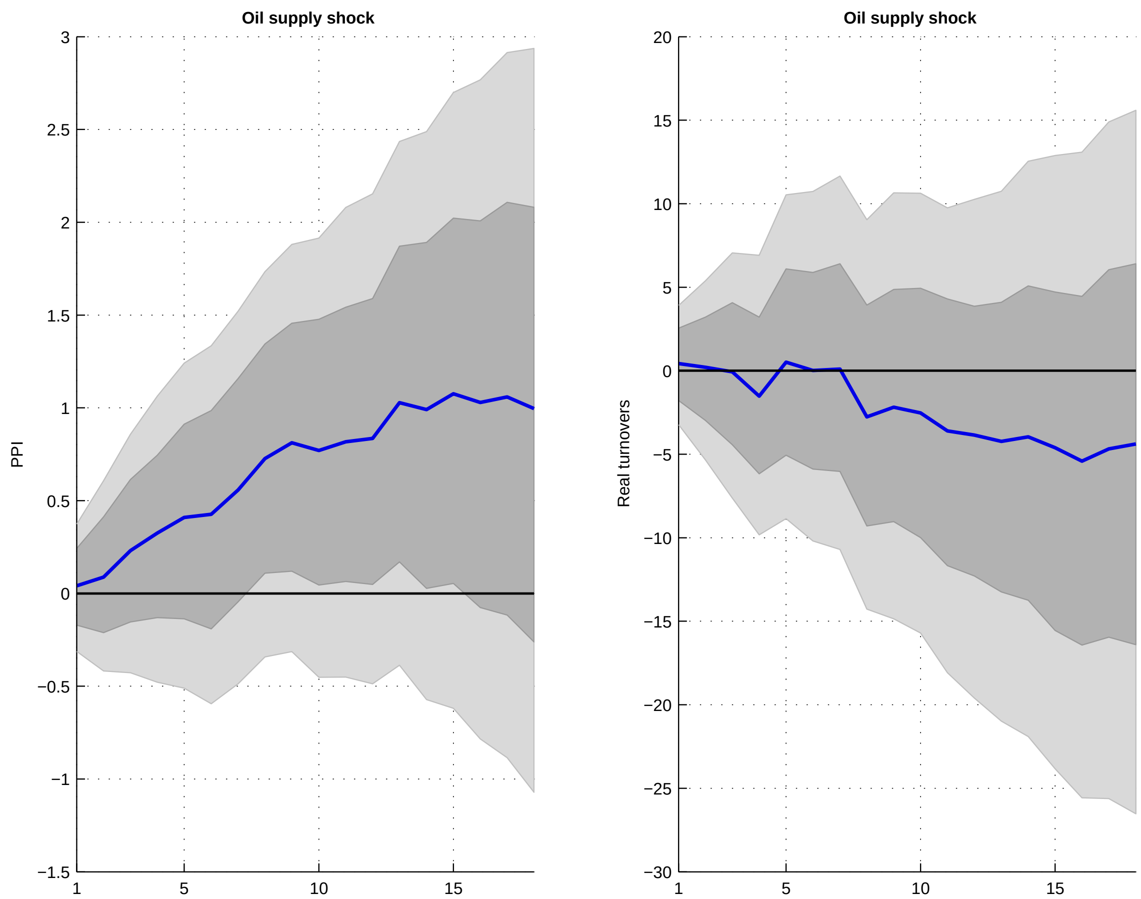
Impulse responses for a one-standard deviation shock in the world wide model. The dark gray area indicates the 16th and 84th percentiles of the impulse responses and the light gray area indicates the 5th and 95th percentiles.

Figure 7: Effects on Swiss GDP and inflation



Responses of Swiss GDP and PPI level to each structural shock. The dark gray area indicates the 16th and 84th percentiles of the impulse responses and the light gray area indicates the 5th and 95th percentiles.

Figure 8: Effects on Swiss manufacturing real turnovers and inflation



Responses of Swiss manufacturing real turnovers and PPI level to each structural shock. The dark gray area indicates the 16th and 84th percentiles of the impulse responses and the light gray area indicates the 5th and 95th percentiles.