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Foreign PMIs: A reliable indicator for exports?*

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Abstract

Foreign economic activity is a major determinant of export development. This paper presents an indicator for nowcasting and forecasting exports, that is based on survey data capturing foreign economic perspectives. We construct an indicator by weighting foreign PMIs of main trading partners with their respective export shares. For two very trade-exposed countries (Germany and Switzerland), the paper shows that the indicator based on foreign PMIs is strongly correlated with exports (both total exports and goods exports). In an out-of-sample forecast comparison, we employ MIDAS models to forecast the two different definitions of exports. We observe that our export indicator performs very well relative to univariate benchmarks and relative to other major leading indicators using hard and soft data.

JEL classification: F14, F17, C53

Keywords: Business tendency surveys, mixed frequencies, nowcasting, forecasting, MIDAS, exports

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1 Introduction

Assessing current and future economic conditions is crucial for decision-makers in both the private and public sector. Exports constitute a large, growing sector of GDP in many countries. They are also considered as a major driver of economic activity, especially for small open economies. Typically, official information on shipments is released with a time lag, particularly for service exports. In order to have a valid view on current export developments, one can use certain indicators as early information. There is an early available indicator available that is based on survey data, namely the Purchasing Manager's Index (PMI), which provides a timely indication of current and near-term industry conditions. In addition to its timeliness, further advantages of the PMIs are their broad availability and comparability across countries, and the fact that they are not subject to major revisions.

To investigate the usefulness of PMIs as a leading indicator for exports, we consider two European countries that are very exposed to economic developments abroad: Switzerland and Germany. Manufacturing is an important pillar of the economy in both countries. Moreover, manufacturing is highly export-intensive. Both countries have a relatively high share of total exports to GDP, of around 51 and 52%.¹ As a consequence, these economies are highly dependent on foreign activity and global trade. As such, the global trade collapse in 2008/2009 had a direct, huge impact on GDP. So early information on foreign activity is extremely valuable for getting a reliable view of the state of the Swiss and German economies. Foreign sentiment and industry conditions may provide especially important information on exports.

In this paper, we construct an indicator based on export-weighted foreign manufacturing PMIs of the main trading partners of Switzerland and Germany and show that it provides important information on the export development of these two countries. Moreover, we assess the in-sample and out-of-sample performance of export equations, using different survey-based indicators. We present evidence that our export indicator is superior to other available indicator measures. In an out-of-sample forecasting setup, we show that there are substantial benefits in terms of predictability for Swiss and German exports using our aggregate PMI-based export indicator.

Survey-based indicators such as the PMI are widely used by economic analysts for tracking the real economy as they provide early signals for economic performance (Fräle

¹The EU average of total exports to GDP is around 45%.

et al., 2010, 2011; Kaufmann and Scheufele, 2015). For the US, Koenig (2002) and Lahiri and Monokroussos (2013) provide evidence of the usefulness of the PMI as an indicator for growth in the manufacturing sector and the economy as a whole. Most recently, Chudik et al. (2014) have investigated the usefulness of PMIs for output forecasts in an international context using the GVAR methodology. They find that PMIs are extremely useful for nowcasting, but that their value diminishes for higher forecast horizons.

However, the performance of foreign PMI's for forecasting exports has not been investigated in the academic literature.² Generally, despite its prominent role, the prediction of exports has not received much attention in the literature. Among the existing literature, surveys already play an important role as leading indicators for exports. Baghestani (1994) documents that survey-based forecasts of US net exports from professional forecasters improve the predictions of net exports. Duarte and Cardoso (2006) find that survey data improve the forecasts for Portuguese exports. In a recent study, Lehmann (2015) analyzes the forecast performance of soft indicators for exports, looking at 20 European countries. His results suggest that survey-based indicators outperform the benchmark model and hard indicators (industrial production and exchange rates) for most countries.

Survey-based composite indicators for exports have recently been proposed for Germany by Jannsen and Richter (2012) and Elstner et al. (2013). The latter present an updated version of the ifo export climate indicator, which captures firms and consumer sentiments of the most important destination countries for Germany. The authors find that the export climate indicator is highly correlated with the year-on-year quarterly changes of exports. They also point out that it is a valuable indicator for forecasting German exports. Jannsen and Richter (2012) focus on exports of capital goods only. They provide an indicator for capacity utilization in Germany's export destination countries and show that it is a good indicator for forecasting Germany's exports of capital goods. One drawback of this indicator is, however, that it is only available on a quarterly basis. Our indicator is rapidly available on a monthly basis, follows the same definition for all countries, and is only marginally revised.

We show that the PMI-based export indicator is highly correlated with the current and future development of Swiss and German exports on a quarterly basis (both for total exports and for goods exports). Using MIDAS models, we provide evidence that the export indicator has valuable information for Swiss and German exports (total exports and goods

²A similar indicator is used by Credit Suisse (CS), which is called the CS export barometer.

exports). In particular, in nowcasting situations where some months of PMI information are already available, the forecasting accuracy relative to univariate models substantially improves. We also show the performance of the PMI-based export indicator relative to other leading indicators for exports, and find that in almost all situations it outperforms other benchmark models.

The remainder of the paper is organized as follows. In the next section, we discuss our data set and the construction of the export indicator. In section 3 we investigate the empirical performance of the export indicator, and section 4 concludes.

2 Data

2.1 Exports and their determinants

We use seasonally adjusted real goods and total (goods and services) quarterly exports from the national accounts for the period 1998Q1 to 2014Q4.³ The quarterly export data is provided by the Federal Statistical Offices for Germany and by the State Secretariat for Economic Affairs (SECO) for Switzerland, and is based on the European System of Accounts 2010. Although the common standard should make the data comparable to each other, Switzerland's goods trade is special in the sense that merchanting trade makes up for roughly 10% and can be extremely volatile. Hence, we exclude merchanting trade from the goods trade for Switzerland. For total trade, however, we do include merchanting.

In standard trade models, the main determinants of exports are usually foreign demand and competitiveness. Commonly used measures for demand are world GDP, export-weighted GDP, foreign IPs, and foreign soft indicators. Our measure for foreign demand will be based on foreign PMIs as described in the following subsection (2.2). The advantage of this soft indicator is its early availability for a wide range of countries. As a measure for competitiveness, we use the real effective exchange rate across 40 (38) main trading partners for Switzerland (Germany), which is defined in terms of consumer price indices.⁴ There has also been an extensive debate about exchange rate uncertainty. As we found no evidence that volatility of the exchange rate affects either Swiss or German

³The time period is restricted by the availability of PMIs. Up to 1997 only five countries in our sample provided PMIs. Between 1997 and 1999, nine additional countries started to provide a PMI. That is why we restrict our analysis to the period from 1998 onwards.

⁴Ca' Zorzi and Schnatz (2007) analyze different price competitiveness measures explaining exports of the Euro area. They find little evidence that there is one indicator outperforming the other. The advantage of consumer price-based, real exchange rates is that they are available very promptly.

exports significantly, we focus here on the two main drivers, namely foreign demand and competitiveness.

2.2 PMI-based export indicator

Our indicator reflecting foreign economic activity is based on monthly manufacturing headline PMI numbers of the most important destination countries for Swiss and German exports. We have picked the following 27 countries that cover 85% of Switzerland’s exports: Australia, Austria, Brazil, Canada, China, the Czech Republic, Denmark, France, Germany, Greece, Hong Kong, India, Italy, Ireland, Japan, Korea, the Netherlands, Poland, Russia, Saudi Arabia, Singapore, Spain, Sweden, Turkey, the United Arab Emirates, the United Kingdom, and the United States.⁵ For Germany, we replaced the German PMI by the PMI for Switzerland.⁶ Figure 1 shows the set of PMIs we use for short-run forecasting Swiss exports. Due to the heterogeneous economic activity of Switzerland’s main trading partners, it is hard in some periods to see a clear pattern among the 27 PMIs where foreign activity goes. An export indicator which nicely summarizes the heterogeneity may provide a clear signal. The export indicator is obtained by summing up the weighted PMI of country i

$$EI_t = \sum_{i=1}^{27} w_{it} PMI_{it} \quad (1)$$

where the weights w_{it} are the country i ’s share of the exporting country’s goods exports relative to the sample such that $\sum_{i=1}^{27} w_{it} = 1$.⁷ The weights are a moving average over nine months (past four months, current and coming four months) in order to smooth outliers. For Switzerland, a graphical illustration of the weights over the period from 1998 to 2014 is provided in figure 3. The largest weight of 23% during the last year is attributed to Germany; the second (with a share of around 14%) is the US. The moving average of export shares means we would lose weights for the current four months. We address this by extending the exports for the coming four months with its last observation.

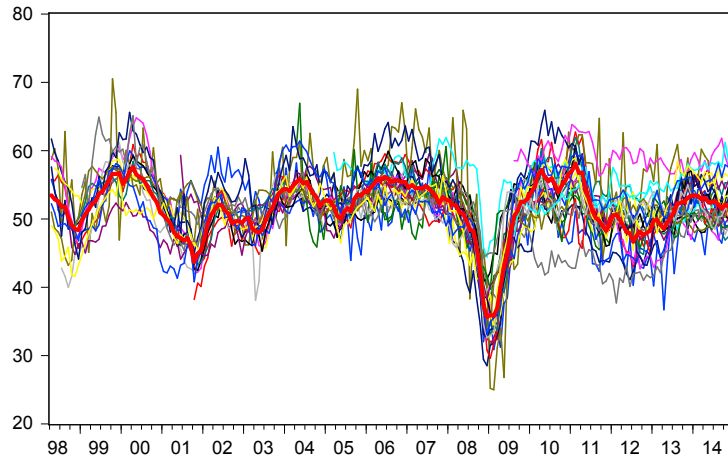
Aggregating country-specific indices raises concerns about the comparability of the series across countries. As the PMI number is constructed by similar methods across countries, it is a standardized measure which allows for international comparison. Thus

⁵For Saudi Arabia and the United Arab Emirates, we use the PMI of the non-oil private sector.

⁶For Germany, the selected set of countries covers roughly 80% of German exports.

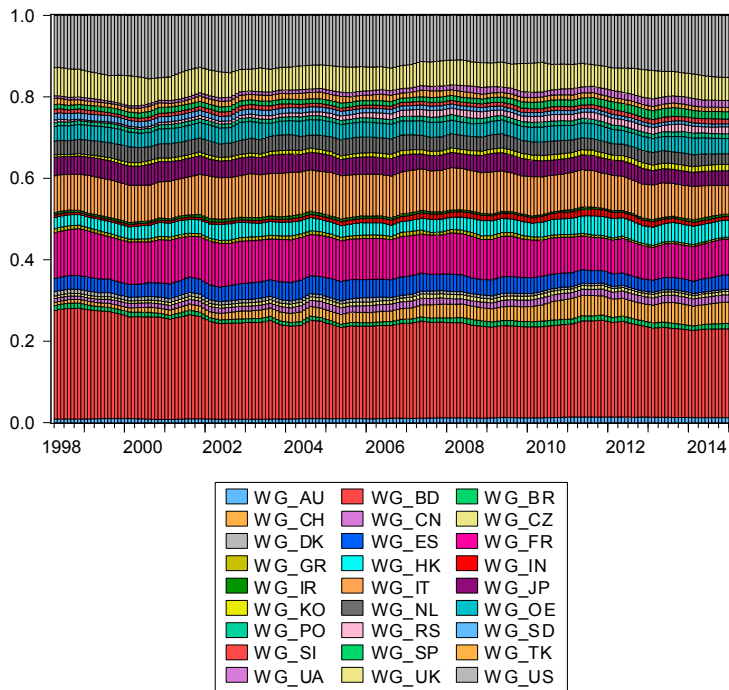
⁷We use the share of goods exports only as we do not have bilateral information on total exports. Figures for the export of services are not available across all the countries.

Figure 1: Export indicator and individual PMIs



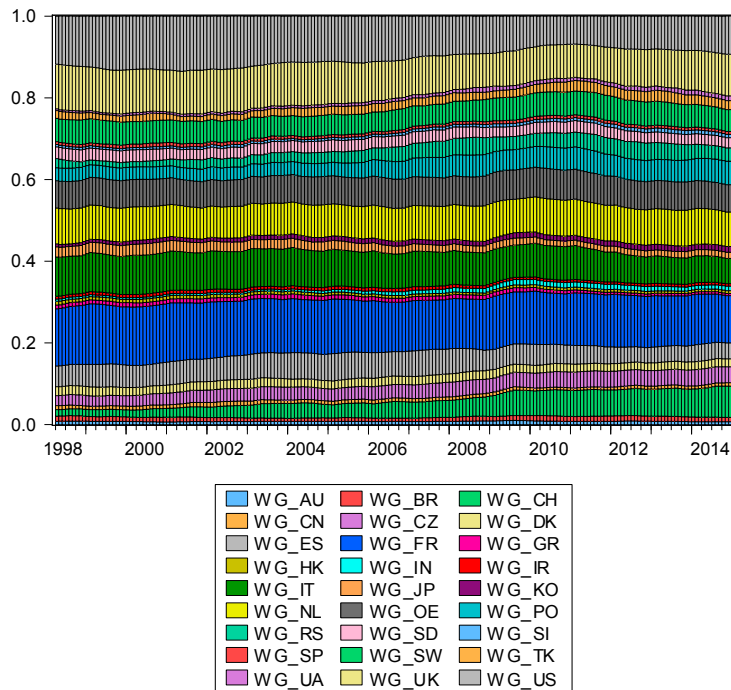
the heterogeneity across countries is less of a concern in this case.

Figure 2: Foreign PMI weights based on export shares, for Switzerland



For the construction of the PMI indicator, we have to address the issue of data avail-

Figure 3: Foreign PMI weights based on export shares, for Germany



ability. As illustrated in figure 1, not all PMIs have the same length. For many countries the sample is quite short. Moreover, not all PMIs are released on the same date; there are basically two waves of PMI releases. There are two potential solutions to this problem. A simple approach would be to set the weight equal to zero for the time when no PMIs are available, i.e. $w_{it} = 0$ if there is no PMI available for country i at time t . This would imply that we give a higher weight to the remaining countries. A more sophisticated solution would be to extend the individual series of PMIs by Stock and Watson's EM algorithm in combination with a factor model (e.g. Stock and Watson, 2002). A big advantage of this second approach is that we thereby obtain a balanced sample of PMIs. As there are countries in the sample which are permanently above others, a balanced sample helps us to obtain a time-consistent, export-weighted PMI indicator. The main idea behind this second approach is that international movements in PMIs are driven by common factors. As such we can make use of the information contained in the set of available PMIs to extend the PMIs which are not available, together with the AR structure of individual PMI series. We proceed as follows. (1) We estimate an $AR(p)$ model for each country's

PMI in order to take into account its autocorrelated structure. (2) The factors are estimated on the remaining errors but only for those countries with complete data. (3) These factors are used to impute data for the missing observations by means of OLS. (4) The full imputed data set is then used to estimate new factors. (5) The last two steps (steps (3) and (4)) are iterated until the factors converge. (6) Finally, we use the factors and the AR structure to compute a balanced data set of all missing PMIs.

2.3 Alternative monthly indicators reflecting foreign demand

For both Switzerland and Germany we compare the performance of the export indicator based on foreign PMIs with a number of other publicly available early indicators.⁸ The Institute for Economic Research (ifo) provides several soft indicators. We employ the following: the ifo business climate index (*IFOCLIMATE*), the ifo export climate index (*IFOEXPORTBARO*) and the ifo expectations with regard to export business in the next three months (*IFOEXPORTEXP*). The ifo climate index is a well-known leading indicator for the German economy and reflects the assessment of the current situation and expectations of about 7000 firms from the manufacturing sector, construction industry, wholesale trade and retail trade. The export climate index consists of firm and consumer sentiment and an indicator for price competitiveness against 37 German trading partners.⁹ The ifo export expectations focus on the export sector and form part of the Ifo Business Survey (Grimme and Wohlrabe, 2014). Moreover, we use new orders to manufacturing from abroad provided by Deutsche Bundesbank (*ORDERDEF*). For Switzerland we also use the backlog of orders (*BACKLOGSW*) which is provided by the KOF manufacturing survey. We have also looked at other Swiss indicators such as production, expected orders and expected production of the KOF manufacturing survey and PMI Switzerland. Neither of these has beaten our export indicator based on foreign PMIs. Among all these Swiss indicators we picked the backlog of orders which performed best.

Beside these soft indicators, our evaluation includes an alternative measure of foreign activity built on hard indicators. The indicator we have in mind here is industrial production of the main export destinations of Switzerland and Germany. Based on individual monthly IP growth rates, we construct an export-weighted foreign IP growth indicator

⁸Because Germany and Switzerland have a similar export structure, we also take the German counterparts into account for forecasting Swiss exports. Indicators for Germany should also be valuable indicators for Switzerland.

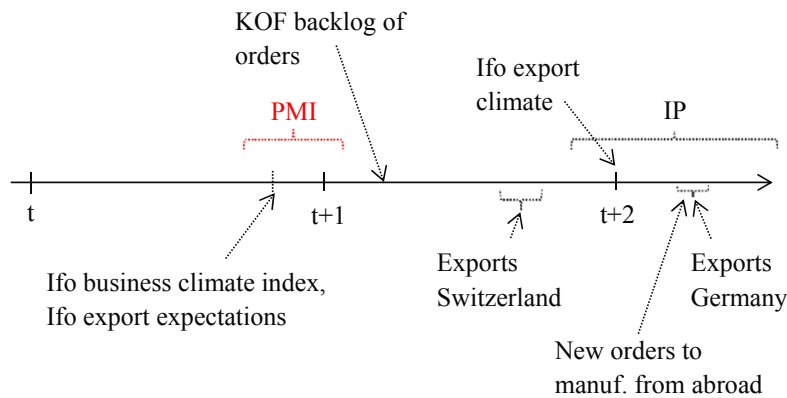
⁹For an analysis of the ifo export climate index, see Elstner et al. (2013).

similar to the export-weighted PMIs. In our set of 27 countries, various IPs become available several months later. We extend these IPs analogue to the PMIs, using Stock and Watson's EM algorithm. As information on industrial production is available much later than PMIs, it can be best seen as a coincident indicator. However, comparing its out-of-sample performance with our export indicator serves as an interesting benchmark relative to the PMI-based indicator. Is it worth waiting for the IPs or does the PMI indicator already capture most relevant information on foreign activity?

The advantage of several soft indicators is their early availability. However, the monthly goods trade is also available quite early, at least for Switzerland (only around two to three weeks after the PMIs). Monthly data on the goods trade obviously already contain some information on the quarterly trade figures. Hence we also analyze how foreign demand indicators perform, compared to the monthly goods trade. Our monthly goods trade series are seasonally adjusted.

The publication dates of the indicators described is illustrated in Figure 4. The month to which the indicator refers is denoted by t . The first PMIs are available at the end of the current month and the last ones early at the beginning of the following month. The ifo business climate index and ifo export expectations are also available early. The majority of the IPs is available roughly one month later.

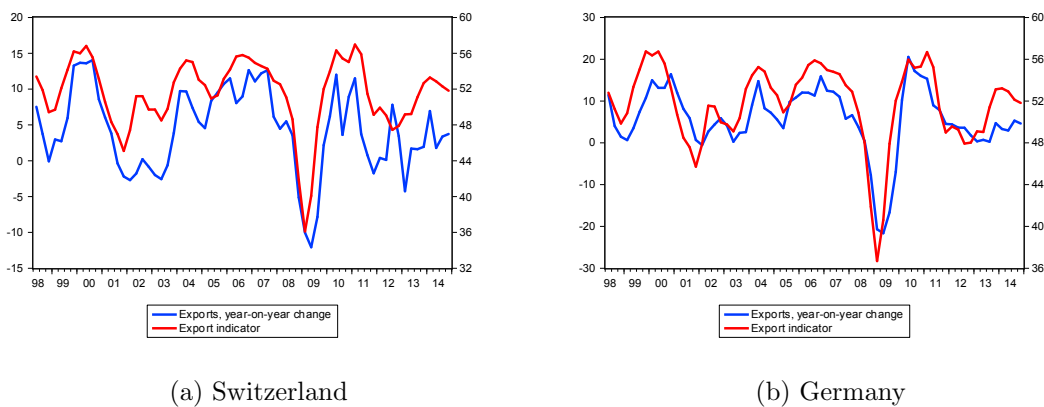
Figure 4: Publication dates of indicators



3 In-sample explanatory power

How well does our PMI-based indicator fit Swiss and German exports? To analyze this issue, we look at quarterly data of goods and total (goods and services) exports as reported by the national accounts for the period 1998Q1 to 2014Q4. The quarterly export indicator (EI) is then obtained by simply averaging the monthly data. Panel a) in Figure 5 shows our export indicator and the year-on-year change in real Swiss exports on a quarterly basis, panel b) depicts the two series for Germany. The figure reveals a quite close correlation between the two measures.

Figure 5: Export-weighted PMIs and year-on-year change in Swiss and German exports



Next, we proceed more formally by estimating a dynamic relationship using year-on-year (yoy) quarterly export changes $\Delta_4 x_t$ with the following equation:

$$\Delta_4 x_t = c + \alpha \Delta_4 x_{t-1} + \beta_0 EI_t + \beta_1 EI_{t-1} + \beta_2 \Delta_4 reer_t + u_t. \quad (2)$$

The results are provided in table 1 and confirm the strong visual connection. The current export indicator and an additional lag explain at least 3/4 of the variation in yoy change. For Switzerland we obtain an adjusted R^2 of 0.77 for goods and 0.72 for total exports. For Germany, the adjusted R^2 is around 0.8. Including the real effective exchange rate increases the adjusted R^2 slightly further. Including the endogenous lag term implies that the lagged EI becomes insignificant.

Despite the fact that these specifications display high explanatory power, it is worth noting that these results based on yoy growth rates are quite fragile. In three of the eight regressions there is evidence of a structural break in the relationship, which happens around 2010. Moreover, for Germany there is still evidence of autocorrelation in the

Table 1: Export growth rates (versus previous year) and export indicator

	Switzerland				Germany			
	Total exports		Goods exports		Total exports		Goods exports	
c	-40.86*** (5.82)	-47.32*** (6.99)	-71.20*** (5.07)	-47.58*** (6.99)	-54.48*** (5.56)	-52.00*** (5.38)	-48.17*** (5.05)	-46.58*** (4.84)
EI_t	0.84*** (0.11)	0.66*** (0.14)	0.56*** (0.17)	0.67*** (0.16)	1.08*** (0.11)	1.06*** (0.11)	0.98*** (0.10)	0.95*** (0.09)
EI_{t-1}		0.33* (0.20)	0.90*** (0.17)	0.31				
$\Delta_4 x_{t-1}$	0.41*** (0.08)	0.25** (0.10)		0.37*** (0.10)	0.53*** (0.05)	0.51*** (0.05)	0.53*** (0.05)	0.51*** (0.05)
$\Delta_4 reer_t$		-0.39*** (0.08)		-0.19** (0.08)		-0.15** (0.06)		-0.15*** (0.05)
adjusted R^2	0.77	0.85	0.77	0.84	0.88	0.89	0.88	0.89
<i>Tests of autocorrelation and heteroscedasticity (p-values):</i>								
$Q(4)$ test	0.21	0.35	0.30	0.57	0.02	0.02	0.02	0.05
White test	0.87	0.75	0.50	0.68	0.32	0.57	0.28	0.46
<i>Endogenous structural break tests:</i>								
Max. LR (p-value)	0.01	0.48	0.37	0.54	0.45	0.00	0.31	0.01
Break date	2010q3				2010q1			2010q1

Notes: Standard errors are reported in parentheses. Significance levels are denoted by *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.1$.

residuals despite the dynamic relationship (which remains present even when more lags are used). This may not be very surprising, as the yoy filter introduces a moving average structure into the residuals that is hard to capture by only lagged endogenous variables. We therefore consider quarter-on-quarter growth rates as our major dependent variable in the following analysis.

Next we look at the quarter-on-quarter development of exports. First, we investigate the causal direction in a Granger sense. When our export indicator is meant to have some explanatory power it should cause exports (null hypothesis: exports are not caused by the export indicator). Since exports from a small country like Switzerland should not influence foreign PMIs, we expect causality to run in one direction running from the export indicator to exports and not vice versa. Table 2 shows the results for Granger causality tests for quarterly exports (total and goods). We use the Akaike criterion to select the number of lags. Even using this criterion, we find some evidence of additional autocorrelation which we cannot get rid of (even by including additional lags). Generally, these tests confirm for both Switzerland and Germany that causality is from the indicator to exports, which implies that the export indicator is Granger-causing exports. This further indicates that our PMI-based measure might be a good indicator for future export developments.

The Granger causality test also has implications for finding a good forecasting equation

Table 2: Granger causality tests

$$EI_t = a + \sum_{j=1}^p b_j EI_{t-j} + \sum_{j=1}^p c_j \Delta x_{t-j}^i, \Delta x_t^i = a' + \sum_{j=1}^p b'_j EI_{t-j} + \sum_{j=1}^p c'_j \Delta x_{t-j}^i$$

	Switzerland		Germany	
	Total exports	Goods exports	Total exports	Goods exports
$EI_t \rightarrow GC\Delta x_t^i$	0.036	0.014	0.000	0.000
$\Delta x_t^i \rightarrow GCEI_t$	0.512	0.472	0.805	0.797
T	64	64	66	66
p (lag length)	4	4	2	2
$Q(p+1)$ test	0.09	0.06	0.08	0.08
White test	0.27	0.91	0.32	0.27

Notes: The Granger causality test is based on a bivariate VAR using an F -Test (p -values are displayed in the table). Lag selection is done by Akaike.

for exports. One-way causality means we can ignore any feedbacks and specify an autoregressive distributed lag model for exports with the indicator as an exogenous variable (see Granger and Newbold, 1977, Chapter 8.2, for a discussion of this).

The correlation between the export indicator and quarterly growth rates of exports is also quite high. For the quarter-on-quarter change of exports Δx_t we estimate the following equation:

$$\Delta x_t = c + \alpha \Delta x_{t-1} + \beta_0 EI_t + \beta_1 EI_{t-1} + \beta_2 \Delta reer_t + u_t. \quad (3)$$

Again we estimate two specifications. The first sets $\beta_2 = 0$ and ignores the exchange rate effect. The results of the two equations for our export measures are shown in table 3. Without the real exchange rate, we obtain for Switzerland an adjusted R^2 of 0.48 and 0.40 for goods and total exports respectively. Adding the exchange rate and the lagged term increases the adjusted R^2 to 0.51 and 0.59, for goods and total exports respectively. For Germany the adjusted R^2 is around 0.6 for both goods and total exports if we restrict $\beta_2 = 0$. The R^2 increases to 0.68 when we include the real effective exchange rate and the lagged endogenous term. For Germany, the results for goods and total exports are much more similar. This can be explained by the fact that the share of services in Swiss exports is much larger (about one third) than it is for Germany (around 15%).

Table 3: Export growth rates (versus previous quarter) and export indicator

	Switzerland				Germany			
	Total exports		Goods exports		Total exports		Goods exports	
c	-67.66*** (17.29)	-68.67*** (15.22)	-76.97*** (15.41)	-82.02*** (14.31)	-86.40*** (12.49)	-79.12*** (11.65)	-78.76*** (11.52)	-71.56*** (10.58)
EI_t	3.43*** (0.55)	3.09*** (0.49)	3.19*** (0.43)	3.05*** (0.40)	3.77*** (0.43)	3.60*** (0.40)	3.34*** (0.40)	3.18*** (0.36)
EI_{t-1}	-1.99*** (0.49)	-1.63*** (0.44)	-1.59*** (0.40)	-1.34*** (0.37)	-1.98*** (0.43)	-1.96*** (0.40)	-1.71*** (0.40)	-1.69*** (0.36)
Δx_{t-1}	-0.30** (0.12)	-0.28** (0.11)	-0.21* (0.12)	-0.24** (0.11)				
$\Delta reer_t$		-0.53*** (0.12)		-0.35*** (0.10)		-0.31*** (0.09)		-0.31*** (0.08)
adjusted R^2	0.40	0.51	0.48	0.59	0.62	0.68	0.60	0.68
<i>Tests of autocorrelation and heteroscedasticity (p-values):</i>								
$Q(4)$ test	0.33	0.38	0.47	0.87	0.57	0.80	0.47	0.56
White test	0.68	0.40	0.50	0.65	0.66	0.72	0.50	0.61
<i>Endogenous structural break tests:</i>								
Max. LR (p-value)	0.24	0.96	0.04	0.42	0.67	0.19	0.51	0.32
Break date			2011q4					

Notes: Standard errors are reported in parentheses. Significance levels are denoted by *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.1$.

4 Out-of-sample evaluation

It is well known that in-sample results do not always translate into a reliable forecasting ability (Stock and Watson, 2003; Rossi and Sekhposyan, 2011). Therefore we conduct a forecasting experiment in pseudo real-time to compare the predictive ability of the export indicator with an univariate benchmark and with other promising leading indicators (section 2.3).

4.1 Indicator models using MIDAS

A framework that directly employs the information content of monthly indicator information was proposed by Ghysels et al. (2004) and Andreou et al. (2011) and has been recently applied by Clements and Galvão (2009) and Marcellino and Schumacher (2010) to macroeconomic forecasting. We follow their MIXed DATA Sampling methodology here (henceforth MIDAS). The main advantage is that the specification allows for flexible responses with only a small number of parameters to be estimated. We follow the procedure as outlined by Drechsel and Scheufele (2012), which is based on an Almon lag polynomial that can be estimated by least squares. We augment their baseline specification to allow for a second predictor.

Compared to ARDL models, the MIDAS methodology exploits the availability of

monthly information by directly relating the quarterly export series to the monthly indicator information. This is an important advantage. As shown by Ghysels et al. (2004), aggregating the data to the least frequently observed series (which is necessary for estimating ARDL models) is less efficient than a MIDAS regression. Note that the MIDAS approach follows a direct modelling technique (see Marcellino et al., 2006, for a comparison).

Our baseline MIDAS model may take into account two different explanatory variables (x and z) and allows for autoregressive dynamics (Clements and Galvão, 2009). This model is given by

$$y_t = \lambda y_{t-1} + \beta_0 + B(L^{1/3}; \theta) \left(1 - \lambda L^1\right) x_t^m + C(L^{1/3}; \gamma) \left(1 - \lambda L^1\right) z_t^m + \epsilon_t. \quad (4)$$

where $B(L^{1/3}; \theta) = \sum_{k=0}^{K-1} b(k; \theta) L^{(k+s)/3}$, $C(L^{1/3}; \gamma) = \sum_{j=0}^{J-1} c(j; \gamma) L^{(j+s)/3}$ and $L^{(k+s)/3} x_t^m = x_{t-(k+s)/3}^m$. t is the time index of interest (in our case, quarters). The higher sampling frequency is equal to three (three months per quarter). As such s is a continuous index ($s = 0, 1, 2, 3$) which reflects the availability of the monthly indicator. More concretely, if all three months of a quarter are available, we have $s = 0$ and if no month is available s is equal to 3. The maximum number of lags we allow for is set by K . In our case x reflects the indicator used (our export indicator or any other leading indicator), while z is the additional indicator, namely the real effective exchange rate.

We parameterize $b(k; \theta)$ and $c(j; \gamma)$ as an Almon-Distributed Lag model which is estimated with a restricted least squares approach and can be represented as:

$$b(k; \theta) = \theta_0 + \theta_1 k + \theta_2 k^2 + \dots + \theta_{q_k} k^{q_k}, \quad (5)$$

where q_k is the polynomial degree ($q_k < K$), which can be substantially lower than K . Even with very small q_k many flexible forms can be approximated. $c(j; \gamma)$ is specified in a similar way to $b(k; \theta)$. However, we allow for a different polynomial degree q_j and a different lag length J . In practice one has to make a choice for q_k , q_j , J and K . We use information criteria, namely the SIC, to choose among different combinations of the four parameters and whether to include the lagged endogenous variable $\lambda \neq 0$.

In the MIDAS specification (eq. 4) the target variable y_t is directly related to information available at period $t - s/3$. s therefore reflects the exact state of monthly information.

This implies that $b(k; \theta)$ can generally vary for different information assumptions for the current quarter and for different forecasting rounds. Under the assumption that one month of the actual quarter is already available ($s = 2$), $K = 12$ (one year of information), $\lambda = 0$ and one predictor variable in the MIDAS regression model equals

$$y_t = \beta_0 + b(0; \theta)x_{t-2/3}^m + b(1; \theta)x_{t-1}^m + b(2; \theta)x_{t-1-1/3}^m + \dots + b(11; \theta)x_{t-4-1/3}^m + \epsilon_t. \quad (6)$$

One major advantage of the MIDAS approach is that it easily allows us to simulate a realistic flow of indicator information in such a way that different information sets can be compared. In our setting it would be interesting to see how the forecasting performance changes from a situation where the indicator series is complete to one in which some months are missing. To investigate the different states of information, we consider four different situations: where the indicator is available for all months of the forecasted quarter, where two months are available, where only one month is available, and where the indicator is available for the last month of the previous quarter.

4.2 Forecast evaluation

In our out-of-sample forecast experiment, we compare the performance of the export indicator with several benchmark models: an autoregressive model as well as other indicator models using hard and soft data. The first estimation sample consists of 1998q1-2004q4. Then forecasts up to 2014q4 are computed using a rolling estimation window. Four different forecasting situations are compared: a nowcast situation where all indicator values for the complete quarter are given, and three situations with incomplete information.

Given the obtained forecasts of our models, we compute root mean squared forecast errors relative to the autoregressive benchmark model. This allows us to compare the average forecast performance of our export indicator with the performance of the other indicators. Next we ask whether the predictive ability of the export indicator is significantly superior, relative to the autoregressive model. We follow the arguments of Giacomini and White (2006) for the rolling estimation scheme and apply the Diebold-Mariano test for equal predictive ability (Diebold and Mariano, 1995).

Moreover, an additional measure is used: the fraction of periods that the export indicator forecast beats the AR model. The advantage of this statistic is that it is easy to interpret and is robust to outliers. However, it does not take into account the amount of

improvement. Finally, we conduct forecast encompassing tests to see whether a forecast combination of an alternative model with the export indicator forecast is able to improve upon the single model forecast (Harvey et al., 1998).

Table 4: Switzerland: Forecast errors (RMSE), MIDAS models

	Total exports				Goods exports			
	<i>Available indicator information</i>							
	all 3M	2M	1M	prev. Q	all 3M	2M	1M	prev. Q
AR-Model	12.85				10.65			
Without real exchange rate								
Soft indicators:								
EI ^a	0.83	0.88	0.98	0.93	0.75	0.84	0.82	0.89
IFOEXPORTEXP ^a	0.94	1.04	1.10	1.19	0.82	0.91	0.90	1.23
IFOEXPORTCL ^c	0.93	1.00	0.95	1.10	0.96	1.00	0.93	0.96
IFOCLIMATE ^a	0.99	1.02	0.99	1.00	0.90	0.92	0.93	0.93
BACKLOGSW ^a	1.00	0.97	0.99	0.99	1.01	1.06	1.06	1.07
ORDERDEF ^c	1.22	1.22	1.15	1.19	0.98	0.96	1.07	1.27
Hard indicators								
IPIND ^c	1.02	1.00	1.09	1.12	0.78	1.05	1.17	1.17
EXPORTSM ^b	0.80	0.90	1.04	1.05	0.43	0.59	0.87	1.18
Including real exchange rate								
Soft indicators:								
EI ^a	0.85	0.75	0.92	1.28	0.75	0.85	1.03	1.14
IFOEXPORTEXP ^a	0.90	0.93	1.10	1.18	0.81	1.05	1.14	1.25
IFOEXPORTCL ^c	0.94	0.87	1.00	1.22	0.96	0.94	1.00	1.02
IFOCLIMATE ^a	0.94	0.89	1.13	1.18	0.90	0.96	0.98	1.20
BACKLOGSW ^a	1.21	0.95	1.06	1.22	0.96	0.98	1.07	1.47
ORDERDEF ^c	1.15	1.05	1.07	1.35	1.10	1.06	1.23	1.39
Hard indicators:								
IPIND ^c	1.05	1.20	1.13	1.23	0.97	1.14	1.22	1.37
EXPORTSM ^b	0.86	0.95	1.18	1.25	0.56	0.71	0.92	1.54

Notes: Different states of information are compared. All numbers show the RMSE relative to the benchmark model. Forecasts are generated rolling for the period 2005q1-2014q4 by a direct method (following the MIDAS methodology eq. 4). Each equation is re-optimized in every forecast step.

^a: early availability; ^b: medium run availability; ^c: late availability.

4.3 Results

4.3.1 The Swiss case

Table 4 displays the results of the MIDAS forecast methodology for Switzerland. The upper panel shows the results without exchange rate, while the lower panel includes the real exchange rate. It compares the forecast performance in different states of information for

each indicator. Forecast accuracy is mostly at its highest in the case where the indicator is available for the entire quarter; after this it deteriorates. The PMI-based export indicator performs best among the leading indicators in basically all situations. Even when no PMI information is available for the quarter of interest, PMI information from the previous quarter can help to predict the development of exports in Switzerland. In many cases it significantly outperforms the AR benchmark model (see Table 5). This table also shows that the export indicator beats the AR model in the clear majority of cases.

Table 5: Switzerland: Performance of the EI

	Total exports				Goods exports			
	<i>Available indicator information</i>				all 3M	2M	1M	prev. Q
	all 3M	2M	1M	prev. Q				
RMSE AR	12.85				10.46			
EI relative to AR	0.83	0.88	0.98	0.93	0.75	0.84	0.82	0.89
p-value	0.04	0.07	0.30	0.19	0.07	0.27	0.05	0.10
average rank (EI)	1.43	1.45	1.48	1.43	1.35	1.40	1.38	1.53
% of best (EI)	57.5	55	52.5	57.5	65	60	62.5	47.5

Notes: Different states of information are compared. All numbers show the RMSE relative to the benchmark model (AR(1) model as in Table 4). Forecasts are generated from 2005q1-2014q4 by a direct method (following the MIDAS methodology in eq. 4). Each equation is re-optimized in every forecast step.

For goods exports, the PMI-based indicator also does very well. However, when at least two months of the monthly trade data are given, one can improve the pure PMI-based indicator by using this information. Interestingly, monthly exports of goods do not help that much for total exports. The weighted IP indicator is only helpful for goods exports if all three months are available (which is much later compared to the PMI releases).

Taking into account the date of publication, we would need to compare the EI, IFOEXPORTEXP, IFOCLIMATE and BACKLOGSW with at least one month less information for IFOEXPORTCL and ORDERDEF (see the timeline in Figure 4). The majority of the IPs is available 1.5 months after the PMIs, but there are still a few that are published three or even four months later. If we take the timing into account, the PMI indicator performs far better than all soft indicators and the IP in all situations.

As our in-sample analysis indicates, the exchange rate is relevant for the development of Swiss exports. Hence, it is also used for the out-of-sample experiment. We therefore augmented the single indicator MIDAS model with the real effective rate as an additional variable. The results are provided in the lower panel of Table 4. We find that the aug-

mented model hardly improves the baseline estimates (without exchange rates). Only in cases where two months of information are given is there some improvement by taking into account the exchange rate.

Table 6: Germany: Forecast errors (RMSE), MIDAS models

	Total exports				Goods exports			
	<i>Available indicator information</i>							
	all 3M	2M	1M	prev. Q	all 3M	2M	1M	prev. Q
AR-Model	10.87				9.63			
Without real exchange rate								
Soft indicators:								
EI ^a	0.64	0.69	0.76	0.77	0.62	0.74	0.79	0.81
IfoEXPORTEXP ^a	0.67	0.88	0.98	0.86	0.69	0.92	1.02	1.21
IfoEXPORTCL ^c	0.57	0.67	0.65	0.77	0.61	0.69	0.63	0.82
IfoCLIMATE ^a	0.74	0.78	0.87	0.87	0.74	0.78	0.85	0.89
ORDERDEF ^c	0.62	0.69	0.74	0.98	0.67	0.76	0.78	1.00
Hard indicators:								
IPIND ^c	0.61	0.63	0.86	0.93	0.64	0.65	0.88	0.99
EXPORTSM ^c	0.45	0.44	0.67	0.89	0.51	0.51	0.65	0.89
Including real exchange rate								
Soft indicators:								
EI ^a	0.80	0.78	0.80	0.82	0.82	0.70	0.83	0.84
IfoEXPORTEXP ^a	0.84	0.89	0.87	0.95	0.88	0.95	0.90	1.03
IfoEXPORTCL ^c	0.95	0.86	0.74	0.93	0.98	0.76	0.74	0.99
IfoCLIMATE ^a	0.87	0.78	0.95	0.92	0.85	0.82	0.99	1.00
ORDERDEF ^c	0.76	0.81	0.72	0.96	0.77	0.87	0.87	1.01
Hard indicators:								
IPIND ^c	0.84	0.57	0.91	0.93	0.87	0.67	0.91	1.00
EXPORTSM ^c	0.47	0.52	0.79	1.18	0.55	0.56	0.79	1.20

Notes: Different states of information are compared. All numbers show the RMSE relative to the benchmark model. Forecasts are generated from 2005q1-2014q4 by a direct method (following the MIDAS methodology eq. 4). Each equation is re-optimized in every forecast step. ^a: early availability; ^b: medium run availability; ^c: late availability.

4.3.2 The German case

For Germany, the PMI indicator reduces the average error measure substantially, compared to the AR-Model. The improvement goes up to 38% and in some cases it is statistically significant (see Table 7). Additionally, the PMI-based forecasts are closer to the realizations in the majority of cases.

When compared to other export-related indicators, the performance of the PMI-based indicator is less dominant than for Switzerland. In particular, the ifo export barometer

Table 7: Germany: Performance of the EI

	Total exports				Goods exports			
	<i>Available indicator information</i>							
	all 3M	2M	1M	prev. Q	all 3M	2M	1M	prev. Q
RMSE AR	12.85				10.65			
EI relative to AR	0.64	0.69	0.76	0.77	0.62	0.74	0.79	0.81
p-value	0.08	0.17	0.27	0.18	0.17	0.36	0.33	0.21
average rank (EI)	1.38	1.45	1.38	1.43	1.48	1.50	1.45	1.43
% of best (EI)	62.50	55	62.5	57.5	52.5	50	55	57.5

Notes: Different states of information are compared. All numbers show the RMSE relative to the benchmark model (AR(1) model as in table 4). Forecasts are generated rolling from 2005q1-2014q4 by a direct method (following the MIDAS methodology in eq. 4). Each equation is re-optimized in every forecast step.

does very well. This is not surprising, as this measure follows a similar concept as the PMI-based indicator but with more detailed survey information, including producer and consumer surveys and competitiveness measures. However, one has to take into account the fact that the ifo barometer is released with a considerable time-lag. Incoming orders from abroad perform similarly compared to the export indicator, but with the restriction that it is released about five weeks after the PMIs. Similar arguments apply for the IP-based indicator that performs much better when compared to Switzerland, and does well when IP figures are given. Even more promising are monthly export data that are very helpful after the first monthly data are released. The inclusion of exchange rates as an additional predictor seems to be of little help in the German case.

4.4 Encompassing tests

Typically, forecasters do not use one indicator in isolation, but base their predictions on many indicators and models. We therefore provide some additional evidence as to how the proposed export indicator might be useful in practice, namely in terms of forecast combination. Hence we ask: given any indicator, do we improve the forecast performance by combining it with forecasts based on the PMI indicator? Table 8 shows that in nearly all cases a combined forecast would improve the single indicator forecast. This implies that the alternative indicators do not encompass the PMI-based export indicator. For Germany (as well as for Swiss goods exports), the cases when sufficient monthly trade data is available form the exceptions. But overall, the export indicator is able to improve the forecast based on single indicators.

Table 8: Encompassing test

	Total exports				Goods exports			
	<i>Available indicator information</i>				all 3M	2M	1M	prev. Q
	all 3M	2M	1M	prev. Q				
Switzerland								
IfoEXPORTEXP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IfoEXPORTBARO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IfoCLIMATE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BACKLOGSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
ORDERDEF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPIND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXPORTSM	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00
Germany								
IfoEXPORTEXP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IfoEXPORTBARO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IfoCLIMATE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORDERDEF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPIND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EXPORTSM	0.53	0.37	0.27	0.05	0.54	0.35	0.23	0.08

Notes: Different states of information are compared. All numbers show the RMSE relative to the benchmark model (AR(1) model as in table 4). Forecasts are generated from 2005q1-2014q4 by a direct method (following the MIDAS methodology in eq. 4). Each equation is re-optimized in every forecast step.

5 Conclusion

In this study, we built an export indicator based on a weighted sum of various foreign PMIs. Accounting for the importance of a country's economic situation, we use export shares as weights to aggregate the different PMIs. For export-extensive countries (Switzerland and Germany), we show the potential of this export indicator in predicting export developments.

We document the in-sample and out-of-sample properties of the PMI-based indicator. First, by testing for Granger-causality and by estimating leading indicator models we find a strong connection with export measures. Secondly, using MIDAS models and by considering different states of data availability, we show that the PMI-based indicator can significantly outperform univariate benchmark models and does relatively well compared to other indicator models using soft or hard data. In particular, once the data availability is taken into account, the PMI-based export indicator is very competitive and helpful when the monthly goods trade figures are not yet available. Our proposed methodology can be easily implemented for other countries as well.

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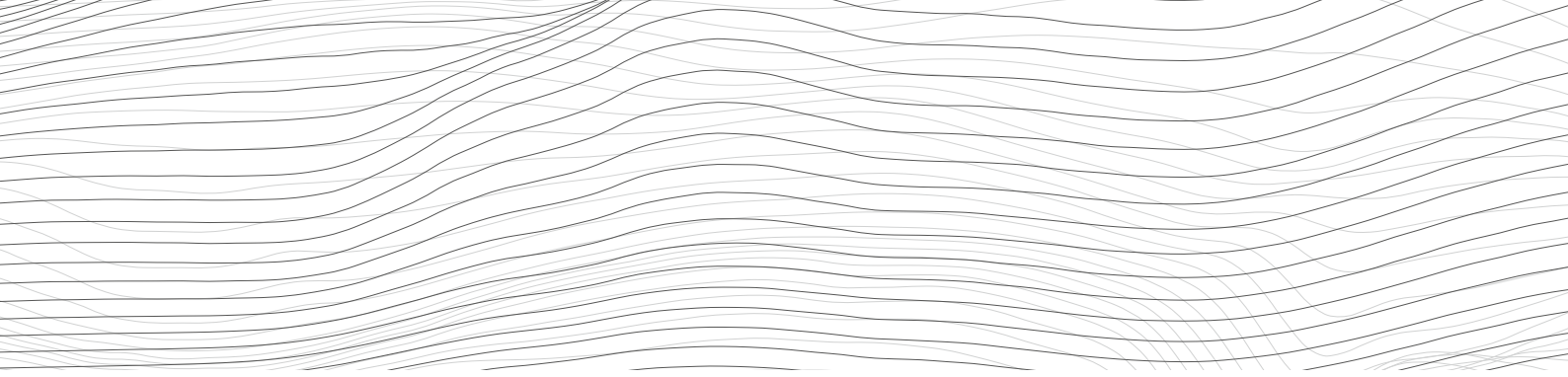
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