The Exchange Rate and Sales Prices: Evidence from Firm-level Data*

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Preliminary Draft

December 2011

Abstract

This paper analyses how firms respond to movements in the exchange rate and how price adjustments interact with different firm-level variables. While some firm-state variables such as capacity constraints lead firms to increase their sales prices, firms typically decrease prices in response to a higher degree of competition or to macroeconomic conditions such as an exchange rate appreciation. First, I find that adjustment patterns are asymmetric. Exchange rate movements affect only the probability of price decreases. As expected, firm-state variables are important determinants of price adjustments. Second, price decreases reveal a non-linear pattern across firms of different export exposure.The more exposed firms are to foreign markets, the more they adjust their prices downwards in reponse to an appreciation.

Keywords: EXCHANGE RATE; STICKY PRICES; FIRM-LEVEL DATA.
**JEL-classification**: E31, F14, F31.

1 Introduction

Prices and exchange rates have gained considerable attention in the literature. However, exchange rate pass-through has been found to be rather low (Goldberg and Knetter, 1997). But although there is substantial literature on the implication of exchange rate movements for prices and traded output on the macroeconomic level, there is only little evidence on the micro level beyond pure price setting behavior of exporting and importing firms (Gopinath and Rigobon, 2008; Gopinath et al, 2010). Recent work by Nucci and Pozzolo, 2010 and Berman et al., 2009 offers insights into the underlying mechanisms and channels at work that lead firms to respond to exchange rate swings in terms of employment, hours worked, prices or sales volumes. I contribute to the literature by analysing firm price setting behavior in response to exchange rate movements in Switzerland and its interdependency with firm-level characteristics. During the past ten years, Switzerland's currency has experienced a slight apppreciation after 2000, followed by a depreciation during the 2003-2007 boom. After the past financial crisis, it appreciated sharply (Graph 1). Interventions by the Swiss Central Bank starting in automn 2011 stopped the ongoing appreciation. The Swiss Franc has always served as a safe haven, but it had never before appreciated that fast and pronounced. The strong increase in relative prices should have reduced foreign demand for Swiss goods. But Swiss manufacturing exports grew by 9.4% in 2010 and exhibited positive growth rates until the third quarter 2011. Obviously, the rebound in foreign demand after the past recession should partly compensate for the rise in prices.[1] Also, the increasing diversification of Swiss trade with respect to the number of trading partners alleviates the impact of an appreciation vis-à-vis one particular currency. But could these factors fully offset the development in the exchange rate?

This paper seeks to disentangle the mechanisms beyond the overall impact of the exchange rate by analyzing price stickiness and price adjustments within a panel of Swiss firms in response to exchange rate movements at the level of the firm. First, the analysis confirms the importance of firm-state variables such as profits and costs, capacity utilization, competition and firm-level constraints (see Lein, 2010). Second, it reveals an asymmetric pattern in the price setting behavior of firms. Exchange rate swings affect only the probability of price decreases. However, the role of the exchange rate is only half as important as foreign demand. Third, the probability of changes in prices is non-linear in a sense that it depends on the degree of export exposure: an appreciation affects only the probability of price decreases for the more exposed firms.

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[1]See Lamla and Lassmann 2011.

Figure 1: Development of the Swiss Franc
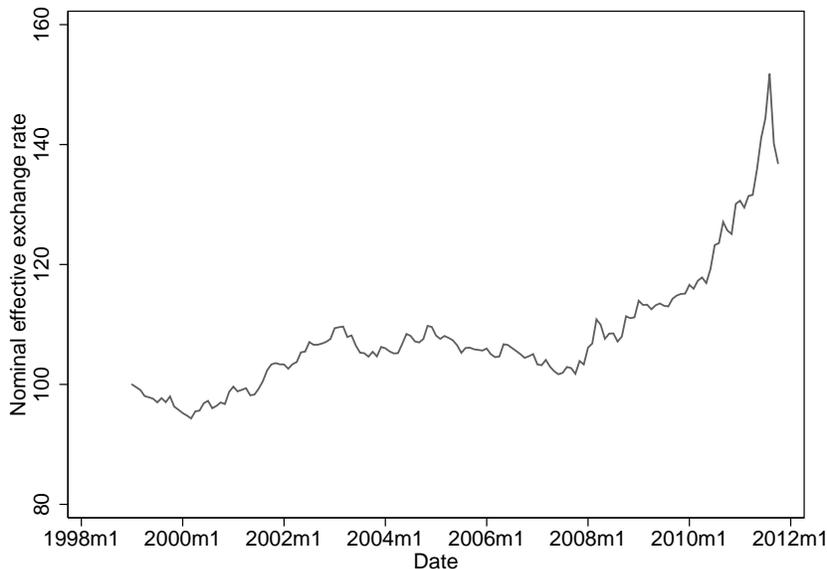
2 Descriptive Statistics

The panel used in this paper covers 79,247 quarterly observations from 2,622 firms in the Swiss manufacturing sector from 1999 to 2011 and is conducted by the KOF Swiss Economic Institute in order to construct business tendency indicators. The average number of observations by firm is 45.7. Table 1 indicates the survey questions and available response categories.[2] The survey includes questions about sales prices, expectations with respect to sales prices, costs and exports, about changes in the competitive situation of the firm, capacity utilisation, the scope of production and different sorts of constraints. The macroeconomic variables are the nominal exchange rate and real industrial production as a proxy for real activity.

Summary statistics pf the KOF survey variables are shown in Table 2. I analyze the following firm-level characteristics. The *Export share* is a categorical variable that takes 1 if firms have an export share in total turnover of 0-4%, 2 if the share is 5-33%, 3 if it is 34-66% and 4 if > 66%. The median share is between 5 and 33%. The median of the *sales price*, *expected costs* for intermediate goods and raw materials, the *competitive situation* in the domestic, EU and extra-EU market, and

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[2]The same panel was analyzed by Lein, 2010, Köberl and Lein, 2009 and Mikosch, 2011. Note that part of the content of this table is adopted from Lein, 2010. See also Lein, 2010 for a detailed description of the survey, sample correlations and Markov transition matrices of the price and cost variables.

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Table 1: KOF Questionnaire Design

Variable	Question	Response
Price	The selling price you charged during the past 3 month has	increased; remained unchanged; decreased
$E_t(Price_{t+1})$	You expect the selling price in the next 3 months to	increase; remain unchanged; decrease
$E_t(Cost_{t+1})$	You expect the costs for intermediate products and raw materials in the next 3 months to	increase; remain unchanged; decrease
$E_t(Exports_{t+1})$	You expect the exports in the next 3 months to	increase; remain unchanged; decrease
Domestic competition	During the past 3 months your national competitive situation has	improved; remained unchanged; deteriorated
EU competition	During the past 3 months your competitive situation in the EU has	improved; remained unchanged; deteriorated
Non-EU competition	During the past 3 months your competitive situation outside of the EU has	improved; remained unchanged; deteriorated
Technical capacity	Technical capacities in your firm are	more than sufficient; sufficient; insufficient
Capacity utilisation	At what capacity has your firm been running in the past 3 months as a percentage of full capacity	50%;55%;60%;...;110%
Scope	Production is secured for	number of months

technical capacity is zero, i.e., these variables do not change most of the time. The median *capacity utilization* is 85% and the median *scope of production* is 2 months. While prices, profits and the competitive situation within the EU more frequently increase than decrease, costs, the competitive situation within the domestic market and within extra-EU markets as well as technical capacity more frequently decrease than increase.

Table 3 indicates the price duration by export share. While this table confirms that larger firms (in terms of employees) export more (see Bernard et al. 20xx), the median price duration is 3 quarters across all firms. This is slightly lower than the median price duration of 10 to 15 months found for US firms (Gopinath and Rigobon, 2008). The average price duration is higher (more than 5 quarters) but similar across firms with a differing degree of export exposure as well.

Graph 2 illustrates the frequency of firms' price increases and decreases and the evolution of the exchange rate over the sample period. The (positive) correlation between an appreciation of the exchange rate index and the frequency of price decreases seems to be stronger than the (negative) correlation between the exchange rate index and the frequency of price increases at first glance. I continue by analyzing this relationship empirically in the following Chapter.

Table 2: Summary Statistics

| Variable	Obs.	Mean	Std.	Median	Obs=1	Freq.	Obs=0	Freq.	Obs=-1	Freq.
Export share	78726	2.15	1.24	2						
Price	52906	-0.08	0.50	0	8865	16.8	39385	74.4	4656	8.8
$E_t(Cost_{t+1})$	52906	0.22	0.55	0	3340	6.3	34526	65.3	15040	28.4
Profit	52906	-0.13	0.61	0	13628	25.8	32385	61.2	68936	13.0
Domestic competition	52906	0.01	0.45	0	5061	9.6	42343	80.0	5502	10.4
EU competition	47221	-0.06	0.90	0	20708	43.9	8742	18.5	17771	37.6
Non-EU competition	48818	0.07	0.89	0	17615	36.1	10055	20.6	21148	43.3
Technical capacity	52906	0.09	0.41	0	2440	4.6	43496	82.2	6970	13.2
Capacity utilisation	45925	81.8	13.7	85						
Scope	44854	3.45	5.21	2						

The table presents summary statistics from 1999 to 2011. The variables are defined as follows; Exchange rates: Nominal exchange rate index export-weighted 24 countries; GDP: weighted annualized quarter-to-quarter GDP growth Euro area, US and Japan; Export share: 1=0-4%, 2=5-33%, 3=34-66%, 4=67-100%; Price, $E_t(Price_{t+1})$, $E_t(Cost_{t+1})$, domestic competition, EU competition, non-EU competition, technical capacity and $E_t(Exports_{t+1})$: 1=increase, 0=unchanged, -1=decrease; capacity utilisation: in %; scope: in months.

Table 3: Export share and price duration

	Obs.	Mean no. employees	Mean frequency	Median frequency	Mean Duration	Median Duration
Total	79247	128	0.15	0.10	5.49	3
Export share=1	36462	61	0.14	0.10	5.60	3
Export share=2	13158	125	0.15	0.10	5.39	3
Export share=3	9936	145	0.15	0.10	5.73	3
Export share=4	19170	250	0.15	0.10	5.25	3

The table presents the firm-product weighted mean and weighted median frequency of price changes and price duration in quarters across firms (1999-2011); Exp.share: 1=0-4%, 2=5-33%, 3=34-66%, 4=67-100%

Figure 2: Price adjustments and the exchange rate
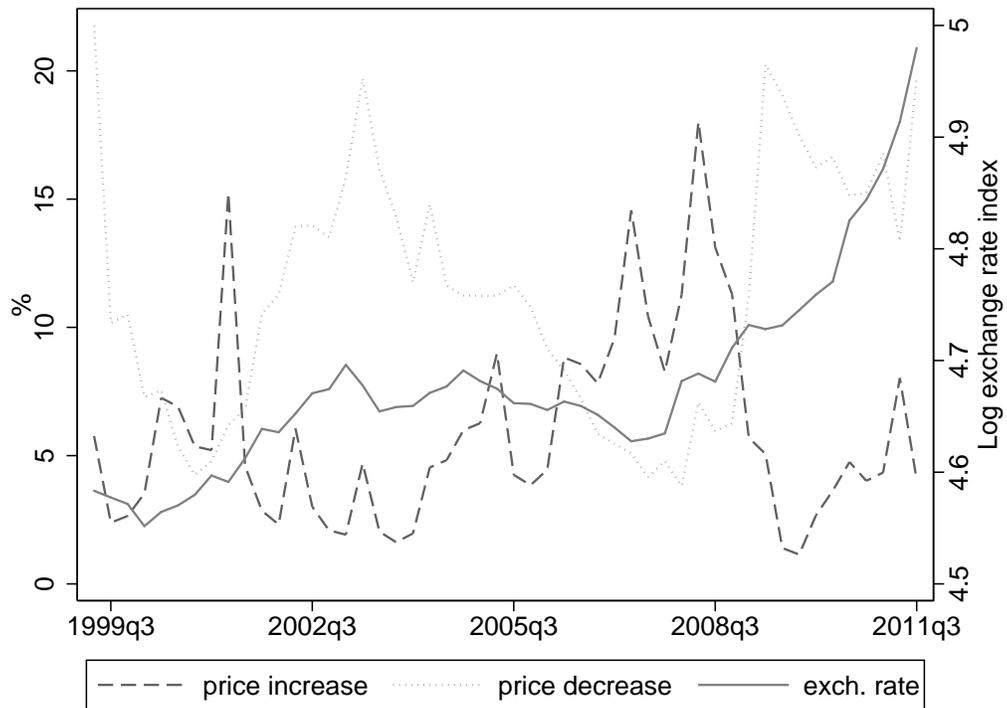
3 Prices versus Prices

Empirical literature normally studies the role of the exchange rate by estimating the pass-through of exchange rates into import prices using an equation of the following form (see Goldberg and Knetter, 1997):

$$\Delta p_t = \alpha + \gamma \Delta e_t + \delta \Delta c_t + \phi \Delta d_t + \epsilon_t \tag{1}$$

with complete pass-through if $\gamma = 1$, measuring the change in local currency import prices resulting from a 1% change in the exchange rate between exporting and importing country, and incomplete pass-through if $\gamma < 1$. Incomplete pass-through occurs because of varying mark-ups and increasing marginal costs.

I estimate the effect of the exchange rate on sales prices by accounting for changes by including the exchange rates, demand shifters and domestic prices as in Equation 1. In order to disentangle the channels that lead firms to adjust their prices, I additionally account for variables that determine price setting at the firm-level as described in Chapter 2. Specifically, I estimate the probability of a price change by the following panel fixed effects logit model conditional on an observed price change:

$$P(y_{it} = 1 | x_{it}) = \frac{exp(x_{it}b)}{1 + exp(x_{it}b)} \tag{2}$$

with $i = 1, ..., n$ firms and $t = 1, ..., T$ quarterly time observations for the $i - th$ firm. Vector x_{it} includes the set of lagged explanatory variables on the macro and micro level as well as quarterly time dummies. Y_{it} measures either price increases ($Price_t = 1$) or prices decreases ($Price_t = -1$). The respective variable is equal to one if the firm indicated a price change in either direction during the last quarter. The marginal effects from the baseline regressions are presented in Table 4. The dependent variable is a price increase in Columns (1)-(3) and a price decrease in Columns (4)-(6). Columns (1) and (3) include only the variables from Equation 1, while Columns (2) and (4) include the extended set of explanatory variables. Columns (3) and (6) are augmented by the following firm-level constraints: demand, employment, capacity and other constraints. While neither the exchange rate nor foreign activity are significant drivers of a firm's probability to increase its prices, domestic inflation does play a role. The micro-level variables are important and significant determinants. An increase in the cost variable has the strongest effect. The lower marginal effect for the inflation variable also suggests that it picks up some part of the development of domestic prices. Higher profits, technical capacity, scope and an improvement in the competitive situation in the domestic market have a positive and significant effect as shown in Column (2). These results remain robust in Column (3). However, the marginal effect of the capacity utilization and

scope variables is close to zero. Firm-level constraints add to the model in the following way: demand constraints reduce the probability of a price increase, while employment and capacity constraints increase it as theory would predict. Changes in the competitive situation outside the domestic market do not play a significant role.

Columns (4)-(6) suggest that macro-level variables matter for the downward adjustment of sales prices. An appreciation of the exchange rate by one index point increases the probability of a price decrease by at least 1%. Foreign demand growth is an even more important determinant. Inflation is only significant in Columns (4) and (5). Again, the firm-level variables provide large added value to the model. Increased profits, capacity utilization and production scope, an ameliorated situation in the domestic market and an expected increase in costs reduce the probability of a price decrease in Column (5) and remain robust in Column (6). Again the marginal effect of capacity utilization and scope is close to zero. The rest-of-world competition variable does not have the expected sign. However, it does not remain significant with the inclusion of the constraint variables. Demand, employment and other constraints also play a role.

I repeat the regressions according to the firm's export exposure in order to account for possible non-linear patterns in the response function. The results are shown in Table 5. As expected, the marginal effect of the exchange rate variable becomes larger with higher export exposure. Surprisingly, the demand variable becomes insignificant, except for a positive and significant role of demand for the probability of a price increase within the sample of highly exposed firms. The marginal effect of the inflation variable is positive and significant for the probability of a price increase in Columns (1), (3) and (5). The firm-state variables do again explain an important part of the price setting behaviour, and their importance varies across firms with different export shares. In particular, the domestic competition variable matters only for domestic firms. Competition outside the domestic market is not significant any more. Changes in profits and costs as well as demand and employment constraints are most important determinants for the probability of price adjustments for the domestically oriented firms, while capacity utilization is constant over the different samples and scope is insignificant.

4 Conclusion

In this paper I analyzed the role of the exchange rate for the price setting patterns of a sample of Swiss firms in the manufacturing sector. First, I found that this pattern is asymmetric: Exchange rate swings affect only the probability of price de-

Table 4: Baseline Regressions

	Price inc.	Price inc.	Price inc.	Price dec.	Price dec.	Price dec.
Exchange rate growth	0.398	0.129	0.201	1.443***	0.914***	1.276***
	(0.259)	(0.153)	(0.220)	(0.200)	(0.223)	(0.269)
GDP growth	0.160	-0.297	-0.796	-2.881***	-1.772***	-2.906***
	(0.714)	(0.420)	(0.610)	(0.508)	(0.508)	(0.648)
Inflation (CH)	0.106***	0.030***	0.042***	-0.067***	-0.027***	-0.014
	(0.010)	(0.008)	(0.010)	(0.008)	(0.009)	(0.010)
Profit		0.023***	0.030***		-0.079***	-0.086***
		(0.006)	(0.008)		(0.010)	(0.010)
$E_t(Cost_{t+1})$		0.113***	0.159***		-0.069***	-0.078***
		(0.018)	(0.020)		(0.009)	(0.009)
Capacity utilisation (%)		0.002***	0.002***		-0.003***	-0.003***
		(0.000)	(0.000)		(0.000)	(0.000)
Scope		0.001*	0.001		-0.002**	-0.002*
		(0.001)	(0.001)		(0.001)	(0.001)
Domestic competition		0.029***	0.034***		-0.044***	-0.050***
		(0.008)	(0.010)		(0.009)	(0.011)
EU competition		-0.001	-0.001		-0.000	0.007
		(0.006)	(0.009)		(0.008)	(0.010)
ROW competition		-0.003	-0.007		0.015**	0.016
		(0.005)	(0.008)		(0.008)	(0.010)
Demand constraints			-0.086***			0.150***
			(0.016)			(0.014)
Employment constraints			0.032**			-0.107***
			(0.014)			(0.020)
Capacity constraints			0.053***			-0.035
			(0.017)			(0.023)
Other constraints			-0.014			0.067***
			(0.013)			(0.014)
Obs.	42497	19262	17209	48061	20722	18229

Fixed-effects panel logit regressions with quarterly time dummies (1999-2011).

Table 5: Baseline Regressions

	Export share							
	0-4%		5-33%		34-66%		67-100%	
	Price inc.	Price dec.	Price inc.	Price dec.	Price inc.	Price dec.	Price inc.	Price dec.
Exchange rate growth	0.377	0.083	-0.473	0.649	-0.485	1.903**	0.487*	2.253***
	(0.403)	(0.373)	(0.587)	(0.556)	(0.575)	(0.850)	(0.294)	(0.671)
GDP growth	-0.681	-5.250***	-3.745**	-2.469*	-2.115	0.212	1.453*	0.027
	(1.099)	(0.946)	(1.711)	(1.339)	(1.671)	(1.822)	(0.862)	(0.786)
Inflation (CH)	0.051***	-0.011	0.070***	-0.012	0.048*	-0.042	0.008	-0.001
	(0.018)	(0.015)	(0.027)	(0.021)	(0.029)	(0.029)	(0.010)	(0.012)
Profit	0.040***	-0.119***	0.030	-0.044**	0.019	-0.082***	0.016*	-0.030**
	(0.015)	(0.013)	(0.019)	(0.022)	(0.017)	(0.025)	(0.010)	(0.012)
$E_t(Cost_{t+1})$	0.203***	-0.080***	0.208***	-0.060***	0.138**	-0.115***	0.068**	-0.037***
	(0.030)	(0.011)	(0.043)	(0.023)	(0.058)	(0.033)	(0.027)	(0.013)
Capacity utilisation (%)	0.002***	-0.002***	0.002***	-0.003***	0.002***	0.001	0.002***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Scope	0.001	-0.004**	-0.001	-0.000	0.002	0.002	0.001	-0.000
	(0.001)	(0.001)	(0.004)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
Domestic competition	0.037**	-0.052***	0.046*	-0.041*	0.035	0.014	0.012	-0.027
	(0.017)	(0.014)	(0.025)	(0.023)	(0.026)	(0.034)	(0.012)	(0.017)
EU competition	-0.011	0.011	-0.002	-0.004	-0.028	0.009	0.017	-0.002
	(0.016)	(0.015)	(0.021)	(0.018)	(0.024)	(0.032)	(0.012)	(0.013)
ROW competition	0.000	0.012	-0.022	0.028*	-0.005	-0.023	-0.001	0.008
	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.025)	(0.009)	(0.012)
Demand constraints	-0.125***	0.186***	-0.092***	0.115***	-0.064*	0.145***	-0.028	0.040**
	(0.027)	(0.017)	(0.033)	(0.042)	(0.039)	(0.038)	(0.017)	(0.019)
Employment constraints	0.043*	-0.161***	0.050	-0.115**	0.052	-0.126*	0.003	0.002
	(0.025)	(0.030)	(0.035)	(0.053)	(0.037)	(0.065)	(0.014)	(0.019)
Capacity constraints	0.121***	-0.078*	0.040	0.024	0.019	-0.088	0.015	-0.011
	(0.038)	(0.042)	(0.040)	(0.041)	(0.033)	(0.055)	(0.015)	(0.021)
Other constraints	-0.007	0.069***	-0.003	0.010	-0.049	0.138***	-0.005	0.037*
	(0.023)	(0.020)	(0.034)	(0.026)	(0.036)	(0.048)	(0.014)	(0.020)
Obs.	7766	9238	3149	2578	2408	2197	3814	4147

Fixed-effects panel logit regressions with quarterly time dummies (1999-2011).

creases. Second, the analysis confirms the importance of firm-state variables beyond the overall impact of the exchange rate such as profits and costs, capacity utilization, competition and firm-level constraints. Third, the probability of changes in prices is non-linear in a sense that it depends on the degree of export exposure: an appreciation affects only the probability of price decreases for the more exposed firms.

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