International Competition and Invention Quality: Evidence from Swiss Firms

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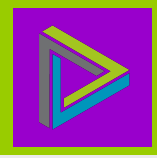
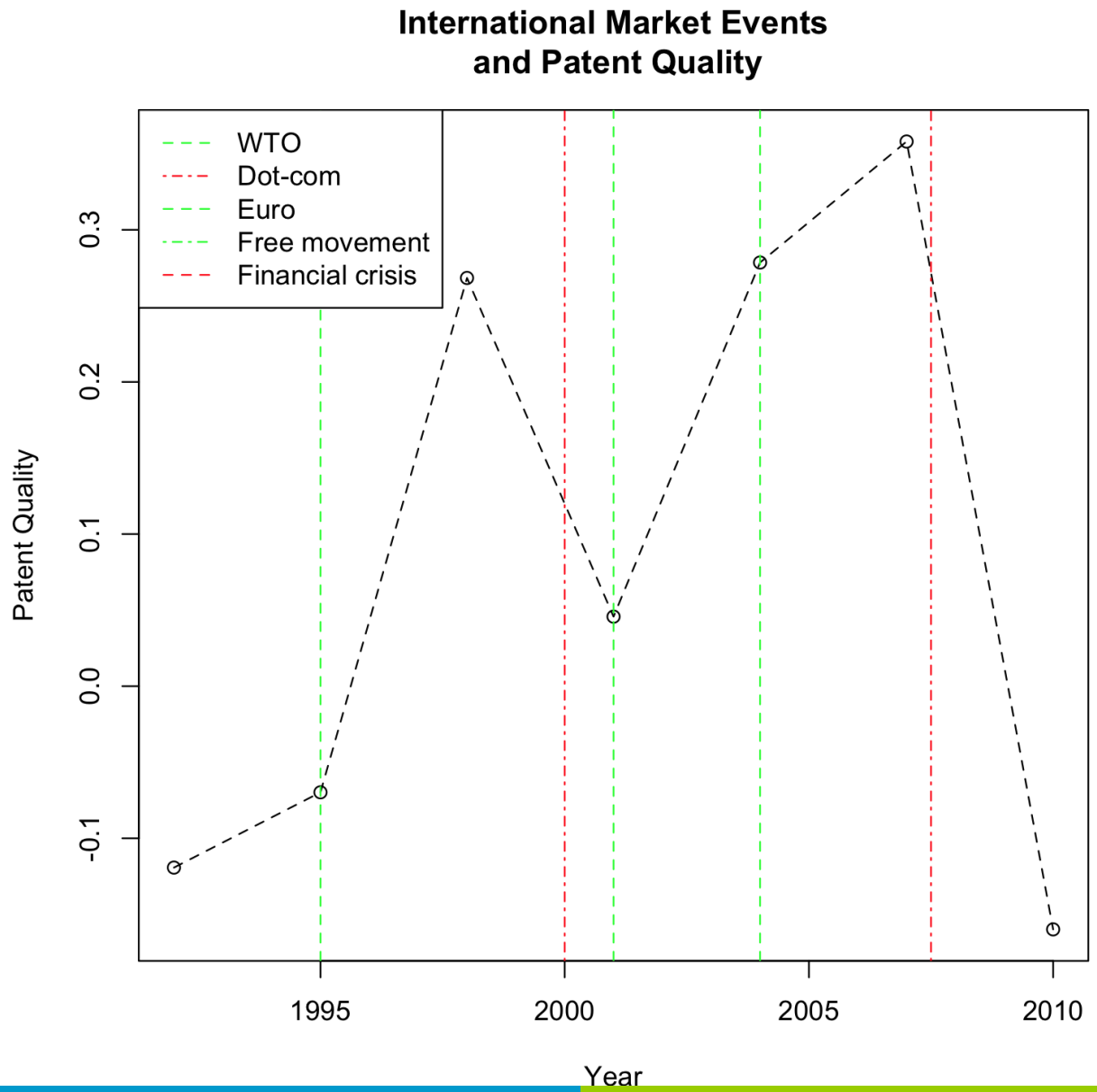
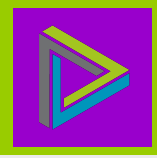


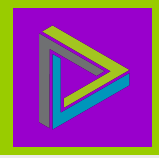
Outline


International Market Events
and Patent Quality
WTO
Dot-com
Euro
Free movement
Financial crisis
Patent Quality
-0.1
0.0
0.1
0.2
0.3
1995
2000
2005
2010
Year



Stylized finding from the literature

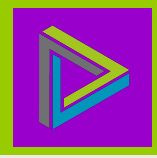
1. the first is that invention quality is a normal good and tends to be associated with more demand ("pull" theory);
2. there is a general observation that internationally oriented firms tend to produce more patents;
3. patents tend to be associated with firms with better sales performance;
4. competition fosters innovation.



Simple Model of Consumers

$$\underset{U}{\text{argmax}} \qquad U[\mathbf{x}_j] = x_{1j}^{\alpha_j} \cdot x_{2j}^{(1-\alpha_j)}, 0 \leq \alpha \leq 1$$

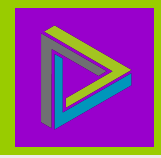
$$\text{subject to} \qquad \sum_{i=1}^{I=2} p_{ij} x_{ij} \leq m_j, \; j = 1, \ldots, m$$



Preferences as a function of R&D

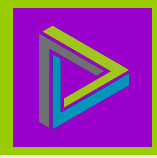
Equation 2 is our putative firms innovation function for quality shifts that preference α:

$$\alpha_{1j}[r_{ijt}] = \frac{1}{1 + e^{-k_\alpha \sum_{t=0}^{T} r_{ijt}}} \tag{1}$$



Sales as a function of R&D

$$\frac{\partial s_{ij}}{\partial r_{ijt}} = \frac{k e^{k_\alpha \sum_{t=0}^{T} r_{ijt}} m_j}{(1 + e^{k_\alpha \sum_{t=0}^{T} r_{ijt}})^2} \tag{2}$$

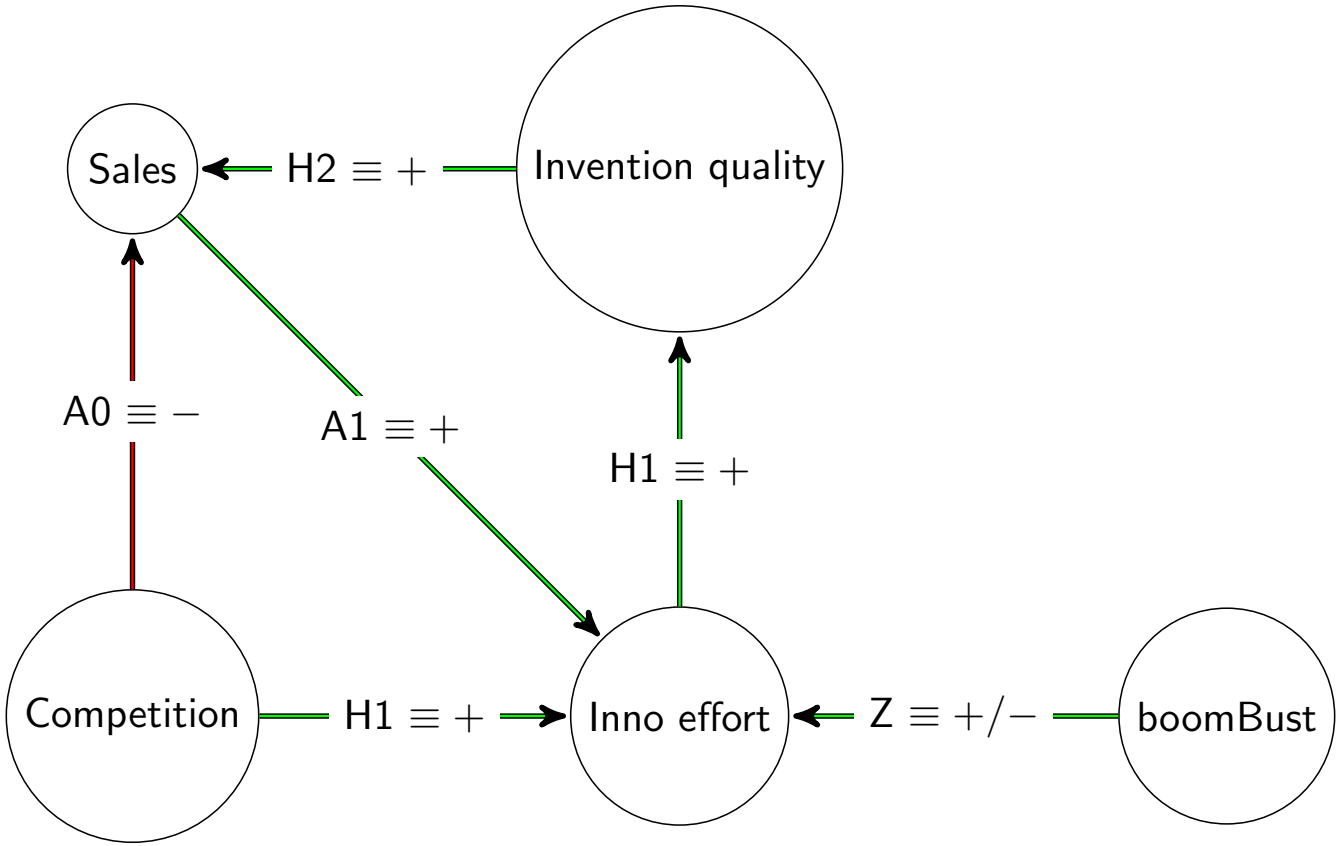


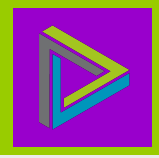
Hypotheses

H1: *If firms compete in larger markets, then they produce higher quality inventions.*

H2: *If firms produce higher quality inventions for larger markets, then they generate more sales.*

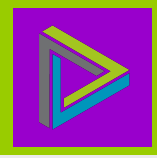
Hypothesized Causal Graph





KOF / CIS Innovation Survey

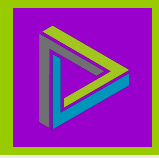
1. 1990-2013 every 2-3 years : 9 cross-sections
2. Bayesian imputation to handle selection effects
3. Patent data from PATSTAT



Measuring Invention Quality

Table: Factor Loadings of Quality Attributes

	PC1	PC2	PC3	PC4	PC5
ln[FWCitations]	0.439	-0.485	0.097	-0.748	0.052
ln[Generality]	0.397	-0.622	-0.315	0.597	0.025
ln[FamilyCount]	0.511	0.424	0.017	0.079	0.743
ln[NPLcount]	0.438	0.120	0.750	0.248	-0.413
ln[NumClaims]	0.444	0.429	-0.573	-0.129	-0.523
λ	0.451	0.180	0.157	0.123	0.088



Measuring Competition

	Int. Oligopolistic	Int. Non-Price	Market 2	Market 3
priceCompetition	-0.47	0.45	-0.66	-0.37
nonPriceCompetion	0.18	0.73	0.56	-0.34
degreeCompetition	-0.66	0.25	0.27	0.65
exportShare	0.56	0.45	-0.41	0.57
$\lambda =$	1.10	1.07	0.93	0.88

Table: Principal Component Loadings of Market Attributes

Table: Competition and Innovation Output (FE)

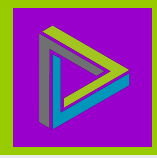
	$\text{Patents}_{i,t}$ (Ia)	$\text{lnQuality}_{i,t}$ (IIa)	$\text{Patents}_{i,t}$ (Ib)	$\text{lnQuality}_{i,t}$ (IIb)
priceCompet_{t-1}	-0.055^{***}	0.02		
$\text{nonPriceCompet}_{t-1}$	0.070^{***}	0.05		
$\text{degreeCompetition}_{t-1}$	0.017^{***}	0.02		
exportShare_{t-1}	0.301^{***}	0.43^{***}		
$\text{intOligopolisticMarket}_{t-1}$			0.059^{***}	0.08^{**}
$\text{intNonPriceMarket}_{t-1}$			0.040^{***}	0.11^{***}
$\ln[\text{firmSize}_{t-1}]$	0.170^{***}	0.11^{***}	0.226^{***}	0.11^{***}
$\ln[\text{knowledgeStock}_{t-1}]$	0.922^{***}	0.26^{***}	0.815^{***}	0.26^{***}
$\ln[\text{knowledgeStock}^2_{t-1}]$	-0.031^{***}	-0.01	-0.02^{***}	-0.01
$\text{shrEmplHiEduc}_{t-1}$	-0.402^{***}	0.61^{***}	-0.408^{***}	0.64^{***}
pastDemand_{t-1}	0.038^{***}	0.07^{**}	0.044^{***}	0.07^{**}
$\text{techPotential}_{t-1}$	0.064^{***}	0.07^{**}	0.060^{***}	0.08^{**}
$\text{wagePercentileWithinIndustry}_{t-1}$	-19.9	-1.90^{***}	11.41	-1.87^{***}
$\text{wagePercentileWithinCH}_{t-1}$	0.476^{***}	2.27^{***}	0.646^{***}	2.23^{***}
Firm fixed effects	*yes*	*yes*	*yes*	*yes*
Time fixed effects	*yes*	*yes*	*yes*	*yes*
R^2		0.14		0.14
F		674***		38.3***
Log-Likelihood	-6619	674***	-6613	38.3***
N	1796	1796	1796	1796

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Patents equation modeled as Poisson count.

Table: Innovation Sales Performance and Competition

	$\ln[\text{innoSales}]_{i,t}$		
	(V)	(VI)	(VII)
$\ln\text{FirmSize}_{t-1}$	0.06^{*}	0.06^{*}	0.06
$\ln\text{PatentStock}_{t-1}$	0.46^{***}	0.45^{***}	0.48^{***}
wagePercentileWithinIndustry	2.83^{***}	2.83^{***}	2.86^{***}
wagePercentileWithinCH	-3.09^{***}	-3.09^{***}	-3.14^{***}
shrEmplHiEduc	2.32^{***}	2.32^{***}	2.41^{***}
pastDemand_{t-1}	0.20^{***}	0.20^{***}	0.20^{***}
$\text{techPotential}_{t-1}$	0.49^{***}	0.49^{***}	0.49^{***}
$\text{inventionQuality}_{t-1}$	0.07^{**}	0.01	0.07^{**}
priceCompet_{t-1}	0.04	0.04	
$\text{nonPriceCompet}_{t-1}$	0.32^{***}	0.32^{***}	
$\text{degreeCompetition}_{t-1}$	-0.15^{***}	-0.15^{***}	
exportShare_{t-1}	2.35^{***}	2.40^{***}	
$\ln[\text{inventionQuality}_{t-1}]$*$\text{exportShare}_{t-1}$		0.25^{***}	
$\text{intOligopolisticMarket}_{t-1}$			0.17^{***}
$\text{intNonPriceMarket}_{t-1}$			0.83^{***}
$\text{intOligopolisticMarket}_{t-1}$*$\ln[\text{inventionQuality}_{t-1}]$			0.04
$\ln[\text{inventionQuality}_{t-1}]$*$\text{intNonPriceMarket}_{t-1}$			0.05^{*}
R^2	0.18	0.18	0.18
Firm fixed effects	*yes*	*yes*	*yes*
Time fixed effects	*yes*	*yes*	*yes*
Imputation	*yes*	*yes*	*yes*
F			
N	7852	7852	7852

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$



Instrument

$$Z = [\text{exportShare}_{t=0} \cdot \{\text{boom} = 1 \wedge \text{bust} = -1\}] \qquad (3)$$

Table: IV for Patent Quality through Boom and Bust

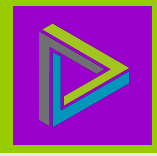
	ln[InnoSales]				
	WTO	'08 Crisis	Boom	Bust	Boom-Bust
(Intercept)	3.45^{***}	2.03	2.64^{***}	2.75^{***}	3.07^{***}
IV[patentQuality]	0.34	1.70^{***}	0.70^{**}	1.05^{***}	0.79^{**}
lnFirmSize	0.33^{*}	0.59^{**}	0.16	0.05	0.16
$\text{lnPatentStock}_{t-1}$	0.10	0.15	0.20^{***}	0.18^{***}	0.16^{***}
emplShrHigher	2.90^{***}	1.78^{*}	2.99^{***}	2.46^{***}	2.68^{***}
demandPast	-0.00	0.00	0.22^{**}	0.28^{***}	0.20^{**}
techPotential	0.45^{***}	0.38^{***}	0.53^{***}	0.45^{***}	0.49^{***}
intOligopolisticMarket	0.40^{***}	0.03	0.30^{***}	0.30^{**}	0.31^{***}
intNonPriceMarket	0.10	-0.02	0.65^{***}	0.35^{**}	0.54^{***}
wagePercentileWithinCH	4.62^{*}	-5.84^{**}	-1.74	-5.90^{***}	-1.73
wagePercentileWithinIndustry	-3.89	4.08	1.42	5.14^{***}	1.33
R^2	0.08	0.01	0.13	0.05	0.07
F (p-value)	0.08	0.01	0.13	0.05	0.07
Num. obs.	1209	1259	1989	1675	1989

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Random G2SLS with errors clustered on individual; time-effects not shown.

Industry effects absorbed in the wage percentile variable.

Scenario*exports instruments for patent quality, cf. text.



Conclusions

1. We find that firms competing in larger markets produce higher quality inventions as evidenced by the increase in patent quality conditional on the export share of the companies in our sample.
2. we also saw that firms in a price-competitive environment tend to produce lower quality inventions;
3. higher quality inventions translate directly into sales, if and only if the firm has a large market, which in our study means internationally active.