

The Success of Switzerland's Chemicals and Pharmaceuticals Industries

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The strong international presence of Switzerland's chemicals industries — characterized by a major export market and substantial investment in its companies abroad — has helped to make the Swiss chemicals and pharmaceuticals industries among the world's most successful.

Switzerland, at first glance, appears to possess none of the assets necessary for successful export industries: It has virtually no natural resources; personnel costs are among the highest in the world; and, the Swiss franc has for years been stronger than many other currencies.

What, then, is the story behind the industrial success of this small European country? Let's first consider a brief historical overview (1).

The Swiss chemicals sector became an economic force in 1859, when Alexandre Clavel, Louis Durand, and Etienne Marnas came from France to the northern Swiss city of Basel to produce synthetic dyes. Their company became known as *Chemische Industrie in Basel* (CIBA).

At the same time, Johann Rudolf Geigy-Merian, a Basel-based chemist and druggist, was extracting and synthesizing dyes. Thus, the roots of Ciba-Geigy (formed a century later, in 1970) were established. In the 1880s, two employees of CIBA, chemist Alfred Kern and businessman Edouard Sandoz, formed the Kern and Sandoz Co. In the 1990s, Ciba-Geigy and Sandoz merged to create Novartis, now Switzerland's largest chemicals firm.

Also, as early as 1885, synthetic medicines were being produced in Switzerland. One specialist in pharmaceuticals, Fritz Hoffmann-La Roche, founded his company in 1896.

Monetary conversions from Swiss franc (CHF) to U.S. dollars are based on the exchange rate in effect when this article was written, 1 CHF = US\$1.12.

Switzerland's Basel region became the center of the 19th-century chemicals and pharmaceuticals industries as a result of several propitious circumstances. Switzerland at that time had no restrictive patent legislation — quite unlike the situation that existed, for example, in neighboring France. In order to produce dyestuffs without hindrance, using new technologies, many French chemists and entrepreneurs immigrated to Switzerland, bringing their capital and their know-how with them. Many of these “patent refugees” chose to set up their new enterprises in Basel, just across the border from France and Germany.

Another factor was Basel's location on the Rhine River, which provided the water for the dyestuffs manufacturing process, and — in keeping with the prevailing practice — an outfall for wastewater. Other contributing factors included the plentiful supply of capital in Basel, with its rich trading and banking tradition; the open cultural climate of Basel, an old university town; and a good communication network.

Because Switzerland's formative chemicals industry could not rely on a large domestic market or an abundance of raw materials, its companies focused on high-value-added specialty chemicals produced in small volumes (*i.e.*, a few metric tons). Today, 90% of the Swiss chemicals industry's product portfolio is specialty chemicals, and is dominated by such major product groups (and manufacturers) as pharmaceuticals and diagnostics (Roche, Novartis, Merck Serono),

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fine chemicals (Clariant, Lonza, Siegfried, Sika, Dettikon Exclusive Synthesis [DSM]), vitamins (Roche, Lonza, DSM), flavors and fragrances (Firmenich, Givaudan), and crop protection agents (Syngenta).

Recent success stories in Switzerland's important pharmaceuticals industry include:

- *the diagnosis and treatment of AIDS.* Roche registered Inivrase as the world's first HIV proteinase inhibitor drug in 1995, and in 2003 collaborated with the U.S. company Trimeris on the drug Fuzeon, which hinders the virus from entering human cells.

- *the marketing and application of L-carnitine.* During the 1980s, Lonza played a decisive role in building the market for L-carnitine, a nutritional supplement with benefits for the heart and the immune system.

- *cancer and asthma treatment.* Novartis contributed significantly to the treatment of early-stage breast cancer through its aromatase blocker letrozol (Femara), and helped launch the injectable drug omalizumab (Xolair) as a treatment for allergic asthma.

Today, the Swiss chemical industry is well differentiated, with more than 30,000 products.

Worldwide presence

A very small portion of these products is consumed domestically, giving great economic importance to Switzerland's sizable international chemicals and pharmaceuticals market. Sales data for the worldwide chemicals and pharmaceuticals industries in 2012 indicate that North America and Europe (excluding Switzerland) account for 43% and 32%, respectively, of Swiss exports, followed by 23% for the rest of the world; around 2% of the products manufactured in Switzerland are consumed at home.

In fact, a strong presence in the international markets characterizes not only Switzerland's large multinational corporations (e.g., Novartis, Roche, Lonza), but also its small and medium-sized enterprises (SMEs). In all, Switzerland's companies account for 5% of the world's exports of chemical and pharmaceutical products — making it the eighth largest export nation for these products. Considering that Switzerland ranks 147th in the world in area, 95th in population, and 33rd in gross domestic product (GDP), this underscores the remarkable performance of the country's chemicals production sector.

The presence of Swiss chemical companies and their

Table 1. Top ten Swiss chemical and pharmaceutical companies in 2012.

Company	Revenue	Employees
Novartis	\$59.5 billion	130,000
Roche	\$51.0 billion	82,000
Syngenta	\$15.1 billion	27,000
Clariant	\$8.7 billion	21,000
Sika	\$5.4 billion	15,000
Givaudan	\$4.7 billion	9,000
Omya	\$4.7 billion	6,000
Lonza	\$4.4 billion	11,000
Galencia	\$3.7 billion	7,000
Firmenich	\$2.9 billion	6,000

Source: (2).

direct investments in more than 80 countries since the beginning of the 21st century have further strengthened Switzerland's competitiveness in the world chemistry market. In 2002, investments by Swiss companies in their overseas chemicals and pharmaceuticals operations rose to \$69.5 billion, representing approximately 46% of all direct investments by Swiss industry. Today, the Swiss chemicals sector has sales organizations in nearly every country, although manufacturing is concentrated at a few sites to optimize economics. Swiss companies have an extensive international network of research centers. For example, Novartis and Roche operate numerous large research centers

outside Switzerland, namely in the United States, Singapore, Japan, the United Kingdom, and Germany.

In 2012, Switzerland's chemicals and pharmaceuticals industries employed around 65,000 people, approximately 15% of whom are highly skilled research personnel. This workforce represents 14% of the total chemical industry employment worldwide, according to a study that examined the employment distribution of Switzerland's top-ten chemical companies (Table 1) by geographic region (Table 2).

The importance of Switzerland's exports

Table 3 summarizes the trends in exports and imports for the Swiss chemicals industry from 2002 to 2012. The value of Switzerland's chemical exports was double the value of its imports in 2012. Even more impressive is the per capita surplus of 3,600 euros (\$4,800), which is one of the highest

Table 2. Employees of the top ten Swiss chemical companies are stationed throughout the world.

	2004	2006	2008	2010	2012
Switzerland	36,300	39,100	41,200	44,800	45,100
Europe*	86,800	93,200	110,700	119,300	102,000
North America	59,600	67,200	67,100	70,700	69,700
South America	20,800	21,300	27,500	27,500	25,200
Asia	37,300	44,000	55,300	68,200	69,300
Oceania	2,100	2,400	2,600	2,100	1,000
Africa	3,500	4,600	7,600	5,700	8,200
Total	246,400	271,800	312,000	338,300	320,500

* Excluding Switzerland

Table 3. Chemicals and related finished products account for a substantial portion of Switzerland's exports.				
	Exports, U.S.\$ billions		Imports, U.S.\$ billions	
	Chemicals	Total	Chemicals	Total
2002	50.3	160.2	30.7	152.3
2004	55.6	171.3	33.2	161.4
2006	70.6	207.6	40.1	198.5
2008	80.6	242.1	42.9	221.4
2010	85.1	228.1	42.4	205.6
2012	88.6	225.2	44.1	197.8

in the world (e.g., approximately seven times higher than in Germany, and an estimated 15 times higher than in France, the United Kingdom, or Japan). Chemical exports account for 30–40% of Switzerland's total exports, and approximately 20% of imports (Table 3).

Figure 1 breaks down specialty chemical exports by category. Pharmaceutical products have accounted for an increasingly larger share: From 1980 to 2012, exports of pharmaceuticals, vitamins, and diagnostic products have risen more than 1,600%. In contrast, during the same period, exports of some other specialty chemicals have experienced a more-moderate increase of between 130% and 400%.

Another indicator of recent change is the restructuring of the industry, with once-diversified companies now focusing more on their core competencies. A recent example is the acquisition of Ciba (no longer Ciba-Geigy) by BASF in 2009.

At the same time, a new generation of companies has emerged with biotechnology as their core business. Roche, for example, is now one of the largest biotech companies in the world, and Actelion is an innovator in this field. Overall, the number of small and medium-sized biotech companies in Switzerland is estimated to have tripled from 70 to 210 in the five years from 1998 to 2003. In 2011, these young start-up companies employed approximately 11,000 people and generated sales of \$4.82 billion, representing an economic factor of growing importance.

The significance of research and development

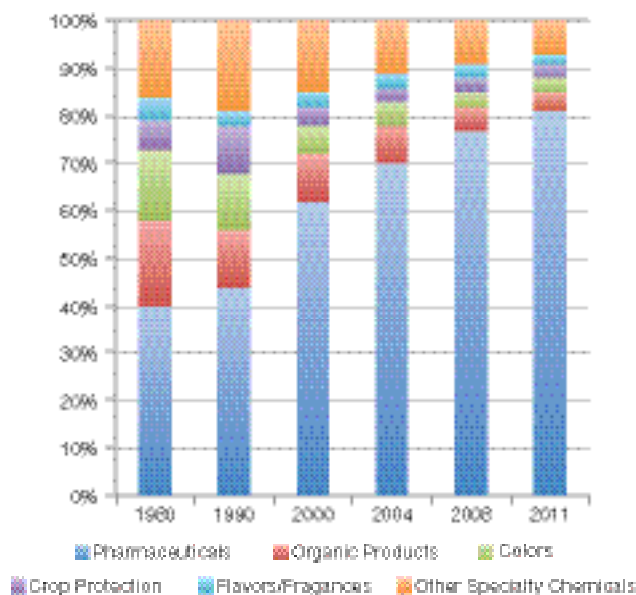
In the dynamic worldwide chemicals market, with its demand for high product quality, corporate strategies of improving efficiency and reducing costs could not alone have guaranteed the success of Switzerland's chemical industries. These successes have also involved strong elements of innovation, scientific and technological know-how, a creative atmosphere, and significant expenditures in

research and development. An international comparison in 2004 showed that Switzerland's index of research intensity (i.e., R&D expenses vs. sales) is approximately 7% — more than double that of Japan, the U.S., and the EU-15.

These R&D expenses are realized both domestically and internationally. Over the past decade, Swiss companies' R&D investments in their research centers abroad have been roughly twice the amount spent on R&D on their home soil — ranging from \$8.9 billion (abroad) and \$5.3 billion (domestic) in 2004, to \$15 billion (abroad) and \$7.6 billion (domestic) in 2012.

The dominant position played by Switzerland's pharmaceutical products necessitates such R&D investment. Today, 10 to 12 years can elapse before new drugs reach clinical trials; out of 10,000 substances going to preclinical tests, only five are tested on humans, and only one of these is eventually marketed. Significant R&D costs are not exclusive to the pharmaceuticals industry. For instance, the development of a new active ingredient for crop protection costs 30% more today than it did 10 years ago.

The prevailing regulatory environment (including issues surrounding patents and prices) is an important factor. The lack of skilled professionals, and a quota system that permits only individuals from European Union (EU) nations to profit from an agreement on the free movement of people to and from Switzerland, are additional hurdles for Swiss industry. The necessary, significant investment in research can only be made if companies can rely on future returns; research expenditures are funded by the profits made



▲ Figure 1. The share of pharmaceutical products among Switzerland's specialty chemical exports doubled between 1980 and 2011.

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from the sales of today's products. In addition, without repatriation of the industry's profits, Switzerland would be inconceivable as a research location.

Innovation and the Swiss workforce

From this general overview, the importance of the chemicals industry in the Swiss economy should be obvious. It accounts for 4% of the country's GDP, ranking second only to metals and machinery (5%), and higher than the watch-making (2.5%) and food (2%) industries.

The most important ingredients for the innovation process are the scientific and technological know-how and the skills of the workforce. Today, the chemicals industry is one of the major industrial employers in Switzerland, and the most important employer of research staff, employing almost 30% of the total research personnel in Swiss industry. In addition to the well-known large companies, the sector consists of around 1,000 SMEs, spread across the country but with a higher concentration in Switzerland's northwestern region. Ninety-five percent of Switzerland's chemical companies have staffs of fewer than 250 people, while only 10–15 companies have workforces of more than 1,000 people.

Safety, health, and environmental progress

The Swiss chemicals industry, which consumes 3% of Switzerland's total energy and 15% of the energy used by Swiss industries overall, has good reasons to focus on the efficient use of energy. From 2002 to 2007, the Swiss chemical industry's energy consumption increased from 27,000 TJ/yr to only 30,000 TJ/yr, despite a 50% increase in the production volume.

Significant reductions in CO₂ emissions have also been made during the past two decades — from 8,000 tons of CO₂ per unit of production to 3,000 tons/unit between 1993 and 2010. In the same period, similar trends have been observed for volatile organic compound (VOC) emissions (decreasing from 3,500 to 1,000 tons/yr), and process water

consumption (reduced from 46 million to 17 million m³/yr).

Besides these factors, one might also note Switzerland's low lost-time incident rate (LTIR) of approximately 6.0 accidents per one million working hours (in 2007) — an improvement of almost 100% over the nation's LTIR in 1993. The average LTIR in Europe is 10% higher, at 6.6.

Wrap-up

In an article in an internal company publication, an employee of Novartis Pharamalytics explained her preference for living and working in Switzerland, characterizing the nation's values as “precision, efficiency, tidiness, and quality.” An editorial in the same publication, entitled “Living the Swiss Principle” and written by Christopher Snook, Novartis's Head of Group Country Management, reflected on the importance of such principles in the growth and success of the company — one of the leading pharmaceutical firms of Swiss origin.

These principles, practiced in an innovative environment, have provided a foundation for Switzerland's competitive position in the global economy, and have paved the road to the economic success of the Swiss chemicals and pharmaceuticals industries.

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LITERATURE CITED

1. **Geschichte-Schweiz**, “History of the Industrialization in Switzerland,” <http://history-switzerland.geschichte-schweiz.ch/industrialization-switzerland.html> (2004).
2. **HandelsZeitung**, “Switzerland's Top-Ten Chemical Companies, 2012,” www.handelszeitung.ch (June 27, 2013).

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