

## The Resilient Trade Surplus, the Pharmaceutical Sector, and Exchange Rate Assessments in Switzerland

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### Abstract

With its cost- and time-intensive research and development, the pharmaceutical sector can generate large trade imbalances. These imbalances may arise because investment and output occur in different years; they are sizable if pharmaceuticals account for a large and growing share of exports. Switzerland's recent trade surplus results from this effect, which also explains why the Swiss trade surplus is exceptionally resilient. The Swiss trade surplus is, therefore, a poor indicator for exchange rate assessments.

**JEL Codes:** F10, F14, F41

**Keywords:** Trade imbalances, exchange rate elasticity, exchange rate assessment, R&D costs

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Switzerland's real effective exchange rate (REER) appreciated heavily in recent years, reaching close to its historical peak in 2012. The same year, Switzerland ran its largest trade surplus in more than 50 years, with net exports of goods accounting for 4.2 percent of GDP. Swiss export goods sold particularly well precisely at a time when they were very expensive by historical standards. This fact seems at odds with basic economic intuition.

Some observers have suggested that the positive trade balance was proof of an undervaluation of the Swiss franc. Were Swiss goods really excessively cheap, despite the strong Swiss franc? Is balanced trade the desired—and in some general sense the “natural”—outcome?

This paper addresses these questions and suggests that the answers to both are negative. Its argument is based primarily on the effects of one large and growing component of Switzerland's export basket: pharmaceuticals.

The strong secular increase in Swiss pharmaceutical exports that began in the 1990s drove Switzerland's net exports into surplus. But the importance of Switzerland's pharmaceutical exports does not derive from a simple accounting exercise. It is based on a particularly prominent characteristic of the industry: cost- and time-intensive research and development (R&D). Production and cross-border trade of pharmaceutical goods are largely the result of R&D activity that took place years or even decades earlier.<sup>1</sup>

This paper shows that the time lag between development costs and sales can generate large trade deficits and surpluses of the type Switzerland has recently experienced. In a situation in which the global pharmaceutical industry scales up R&D activity in anticipation of rising future demand, capital will flow into a country with a large pharmaceutical sector and the country will run trade deficits. In subsequent periods the same country will run trade surpluses, balancing trade on an intertemporal basis. This paper shows that this narrative is a fair description of Switzerland's trade dynamics over the past few decades and that its recent trade surplus was a natural counterpart to earlier trade deficits.

From this perspective, Switzerland's trade surplus can be viewed as neither a source nor proof nor evidence of an undervalued Swiss franc. This crucial observation gives rise to a key message: The role of net exports as an indicator of over- or undervaluation is spurious and should not be overemphasized when trade is dominated by products that require cost- and time-intensive R&D.

There is also a strong political component to Switzerland's recent trade surplus. The substantial increase in Swiss exports of pharmaceuticals and the resulting Swiss trade surplus overlapped with the financial crisis and the euro crisis that began in 2007. In those turbulent times, financial flows related to safe-haven effects made the Swiss franc appreciate, prompting the Swiss National Bank to impose, in September 2011, an exchange rate floor of CHF 1.20 per euro as a safeguard against imported deflation. In view of the unfolding great trade collapse and the fact that many countries aimed to jump-start their

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1. Deutsche Bank (2012) provides a good overview of the cost structures. For earlier estimates, see DiMasi, Hansen, and Grabowski (2003). Acemoglu and Linn (2004) show that R&D activity begins up to 20 years before it generate sales.

economies through the export sector, this floor was criticized as unwarranted and sometimes labelled a beggar-thy-neighbor policy.

Against this backdrop, it is important to state explicitly what this paper does not do. It does not provide a quantitative assessment of the Swiss franc's fair value for a specific period and according to specific criteria. It does not claim that the Swiss franc has been under- or overvalued. It does not deny that appreciation pressures on the Swiss franc were evident, especially during the euro crisis, and that these pressures recently resulted in appreciations of the Swiss franc.<sup>2</sup>

Instead, the paper argues that the reasons for these appreciation pressures on the Swiss franc are unlikely to stem from the real side of Switzerland's cross-border trade. It thus sides with observers who claim that purely financial factors—particularly safe-haven effects, uncertainties in the euro area, and the unwinding of carry trades—are the main determinants of the Swiss franc's value in recent years.

Finally, the paper addresses the question of how much the Swiss REER would need to appreciate to make trade balance. It first shows that exports of pharmaceuticals are insensitive to exchange rate changes. It then shows that because of the large share of pharmaceuticals in the Swiss trade basket, Switzerland's trade surplus is especially resilient to exchange rate changes. Indeed, estimations imply that the Swiss franc would have to appreciate by a staggering 40 percent over the historically high levels of 2013. The paper argues that these levels (which would reflect the “equilibrium exchange rate,” for those observers who rely on the trade balance for their assessments of exchange rates) would be absurdly high.

## THE CASE OF THE SWISS TRADE BALANCE

Do Switzerland's net exports indicate that the Swiss franc is undervalued? How much would the Swiss franc have to appreciate to balance trade? To address these questions, this section highlights the important role of long-run trends in pharmaceutical exports, which drove Swiss trade into surplus.

Why does it make sense to analyze the trade surplus instead of the current account? After all, on theoretical grounds the current account, not net exports, is required to balance in the very long run, and the current account (particularly in Switzerland) consists of more than net exports of goods (figure 1).

The primary reason to focus on trade in goods is the fact that it is typically considered to be the main channel of adjustment for external imbalances (see Obstfeld and Rogoff 2005; IMF 2007; Chinn and Wei 2014), because net exports constitute the most important component of the current account in most countries.<sup>3</sup> Therefore, attention and policy advice typically focus on the trade balance.

Against this backdrop, the details and the evolutions of the Swiss trade balance are looked at next.

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2. When the Swiss National Bank abandoned the exchange rate floor, in January 2015, the Swiss franc appreciated significantly against the euro, indicating that there had been substantial appreciation pressures.

3. An important additional virtue of focusing on trade in goods is data quality. Trade in goods is traditionally recorded in detail in terms of both products and trade partners. By comparison, data on investment income and service trade are collected through surveys, with substantially less detail and accuracy. Data on bilateral trade and exchange rates are very useful in identifying the exchange rate sensitivity of trade.

## Secular Trends of Net Exports

Around 2012 Switzerland was facing a large trade surplus, and the Swiss franc was at historical highs. What led to this situation? Figure 2 plots Switzerland's yearly net exports as a percentage of GDP (solid blue line) jointly with its real effective exchange rate (REER, orange line) for 1980–2013.<sup>4</sup>

A secular positive trend in Swiss net exports is immediately apparent from the figure. This trend, present for the entire period, is particularly clear from the 1990s onward. For most of the past decades, net exports of goods were negative; they turned positive during the 1990s and have steadily increased since the early 2000s. During the same period, the REER fluctuated significantly.<sup>5</sup> In recent years, it appreciated to unprecedented levels.

A number of recent studies analyze the drivers of the secular trend in Swiss net exports (see SNB 2011; Auer and Sauré 2011; Sauré 2012; Gaillard 2013). The spotlight regularly falls on the pharmaceutical industry.

Since the 1990s, Swiss pharmaceutical exports increased so rapidly that they account for virtually all of the increase in Switzerland's net exports. Figure 2 illustrates this fact, plotting the nonpharmaceutical trade balance (nonpharmaceutical exports minus nonpharmaceutical imports, normalized by GDP) as a dotted blue line. It shows that the nonpharmaceutical trade balance was always below the total trade balance, reflecting Switzerland's status as a net exporter of pharmaceuticals. Over the same period, the nonpharmaceutical trade balance moved essentially sideways. Hence pharmaceuticals account for all of the increase in Switzerland's net exports in the past two decades.<sup>6</sup> In trying to understand the secular increase in the Swiss trade balance, it thus seems important to analyze exports of pharmaceuticals and to identify some of the peculiarities of the sector.

Before taking a closer look at the pharmaceutical sector, a qualification is in order. It is not exceptional for one sector to contribute substantially to a country's trade surplus, in terms of shares or growth rates. Trade theory predicts the international specialization of production, resulting in possibly very specialized export baskets. It is also not unusual for one sector to grow faster than others and for this sector to become dominant in a country's exports during certain periods. That said, some features of the pharmaceutical sector are important for understanding the Swiss trade surplus and thus deserve special attention.

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4. The trade data in figure 2 are based on the Balance of Payment Manual 5 (BPM5) standards and therefore exclude merchanting trade (i.e., trade organized by Swiss firms but occurring between third countries). The data used in figure 1 are based on BPM6 standards. Because Switzerland is an important hub for merchant trade, the differences between the two datasets are large. See Beusch et al. (2013) for an analysis of merchant trade and its potential influence on the current account.

5. Increases in the REER indicate appreciations of the Swiss franc. Between 1980 and 2010, the mean REER was 92.0, with a standard deviation of 4.4.

6. The total trade balance increased from about zero at the start of the millennium to a surplus of about 4 percent of GDP in 2013; the dotted line in figure 2 fluctuates around 2 percent of GDP over the same period.

## Peculiarities of the Pharmaceutical Sector

At least two important characteristics of the pharmaceutical sector are important in understanding the recent evolution of Swiss trade flows: the growth rates of the global pharmaceutical industry and the substantial costs of R&D. This section examines both.

### *The Global Growth Trend in Trade in Pharmaceuticals*

One striking characteristic of the pharmaceutical industry is its rapid growth rates, in both Switzerland and the world as a whole (figure 3). Factors related to income and demography raised global demand for medical and pharmaceutical goods (see Gerdtham and Jönsson 2000; Folland, Goodman, and Stano 2013). This increase in demand was matched by increasing supply and innovation, which together generated a boom in the pharmaceutical industry over the past decade or two. The World Bank reports that health expenditure in the three largest markets grew at annual rates of 5.6 percent (the United States), 4.7 percent (the European Union), and 4.1 percent (Japan) between 1996 and 2012. These rates are far above the growth rates of per capita GDP during the same period (3.7 percent, 3.6 percent, and 1.5 percent, respectively [own computations, based on data from the World Bank's *World Development Indicators*]).

In an increasingly globalized market, the growth of the pharmaceutical sector has also affected cross-border trade in pharmaceuticals. The value of trade in pharmaceuticals increased much faster than the value of trade in other sectors. Figure 3 plots pharmaceutical exports as shares of total export values for Switzerland and for the rest of the world.<sup>7</sup> It illustrates that the boom in pharmaceutical trade generated comparable dynamics in Switzerland and the world as a whole: In Switzerland the trade shares of pharmaceuticals increased by a factor of four between 1990 and 2007 (from 6.8 percent to 27.6 percent); for the rest of the world, the figure rose by a factor of 2.6 (from 1.1 percent to 2.8 percent). The trend toward higher export shares of pharmaceutical goods is particularly important and prevalent for the Swiss export basket, because Switzerland is an important exporter of pharmaceuticals.<sup>8</sup> The trend itself, however, is a global phenomenon and is not specific to the Swiss economy. In the context of the strong general increase in trade in pharmaceuticals, the performance of Swiss exports appears less exceptional.

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7. The “rest of the world” consists of an unbalanced sample of 74 (in 1962) to 158 (in 2007) countries. The changes in the sample are likely to bias the growth of pharmaceuticals downward in the rest of the world, because less developed countries that are missing in initial periods typically do not produce pharmaceuticals.

8. The strong growth of Switzerland's exportation of pharmaceutical goods could have been expected, because two of the world's largest pharmaceutical firms (Novartis AG and Hoffman La Roche AG) conduct research, produce pharmaceuticals, and are headquartered in Switzerland. In a period in which the global demand for pharmaceuticals grows, the importance of pharmaceuticals in the Swiss export basket is bound to increase.

### *Time- and Cost-Intensive R&D*

A second important characteristic of the pharmaceutical industry is its high R&D intensity. R&D costs for a new drug or compound range from \$1 to \$2 billion, according to recent industry estimations (Deutsche Bank 2012).<sup>9</sup> Costs include not only basic research activity but also extensive clinical tests. These costs make the pharmaceutical industry perhaps the most prominent example of an intensive R&D industry (see, for example, Cohen and Klepper 1992; Acemoglu and Linn 2004; Boldrin and Levine 2008).

R&D costs in the pharmaceutical sector are also incurred long before physical production and sales occur. The typical R&D process is reported to take 10–20 years, with an effective production period covered by protected patent rights of generally less than two decades.<sup>10</sup> A large share of overall production costs accrues years to decades before physical production and sales begin.<sup>11</sup> These cost and production structures imply that changes in the supply of pharmaceutical goods are determined largely by past R&D activity.

### **Growth of Pharmaceutical Trade: A General Equilibrium Perspective**

The two important characteristics of the pharmaceutical sector—fast growth and cost- and time-intensive R&D—can explain the fundamental dynamics of Switzerland’s net exports over the past two decades. In particular, they explain why exports in nonpharmaceutical sectors did not decline enough to compensate for the increase in pharmaceutical trade. More important, they indicate that the appreciation of the Swiss franc was not a reaction to the increase in pharmaceutical exports. They are useful in assessing the role of relocation of production outside Switzerland.

These arguments are based on a general equilibrium logic and must be addressed through a general equilibrium framework. Therefore, the insights summarized here rest on a formal model, the description of which is relegated to an accompanying research paper.<sup>12</sup> This model features a stylized economy with

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9. An earlier study, by DiMasi, Hansen, and Grabowski (2003), reports somewhat lower costs.

10. See Abbott and Vernon (2005) and Deutsche Bank (2012) for benchmarks on the length of the typical innovation process. Acemoglu and Linn (2004) report that “pharmaceutical research responds to anticipated changes in market size with a lead of 10–20 years.” The World Trade Organization’s Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement grants minimum standards of patent protection in member countries, including 20 years of patent protection. The patent period begins before clinical tests and the licensing phase and thus overlaps with the R&D period.

11. Estimates of R&D costs as a share of total expenditure depend heavily on assumptions about the assumed interest rate. The instantaneous share of R&D of close to 20 percent of sales reported by Deutsche Bank (2012)—which is consistent with the R&D share of value added computed from the Organisation for Economic Co-operation and Development’s STAN database—can serve as a lower bound.

12. Sauré (2015) describes the model. It is based on the standard trade model of Krugman (1980), which endogenizes intertemporal borrowing and lending. Corsetti, Martin, and Pesenti (2007, 2013) use a similar framework to analyze external adjustments and international transfers.

two countries that trade in two consecutive periods. One of these countries (Switzerland) is home to a sector (pharmaceuticals) in which demand is growing but R&D activity is necessary before production in a later period. Investment opportunities in the R&D-intensive sector, in combination with individuals' desire to smooth consumption, generate trade imbalances in both periods. In the first period, the Swiss pharmaceutical sector attracts foreign investment, so that Switzerland runs a trade deficit. In the second period, returns on foreign investment generate capital outflows and the earlier trade deficit becomes a trade surplus.

The following main message emerges from the theory: Given the circumstances Switzerland faced in recent years, a surplus of trade in goods is the equilibrium, or natural, outcome. Put differently, one cannot reasonably expect Swiss trade to be balanced. These observations imply that under these circumstances, a trade surplus cannot be read as an indication of an undervalued currency.

This narrative of Switzerland's external sector raises a number of questions, which are addressed next.

### *Why Don't Decreasing Nonpharmaceutical Exports Offset Increasing Pharmaceutical Exports?*

This question essentially amounts to asking whether trade should be balanced every period. The answer is no, precisely because international borrowing and lending (early capital flows into Switzerland and later outflows) is necessary for optimal resource allocation. Forcing trade to balance in both periods would amount to impeding foreign financing of pharmaceutical R&D. It would thereby undermine consumption smoothing, induce inefficiently low R&D activity, or both. Imbalanced trade is a prerequisite of efficiency. It has nothing to do with under- or overvaluations of currencies.

### *What Is the Role of Offshoring Production?*

An important aspect of Switzerland's two dominant pharmaceutical companies is the fact that they manufacture their products in a global network of production sites.<sup>13</sup> Some standardized production procedures are typically performed outside Switzerland. In contrast, most research center and headquarter facilities are in Switzerland.<sup>14</sup>

What does the offshoring of production imply for the application and interpretation of the theory? The main message is preserved, because key R&D activities are located in Switzerland. Past R&D expenditures are typically transferred through cross-border trade of intermediate products within

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13. Two of the world's largest pharmaceutical firms, Novartis AG and Hoffmann La Roche AG, are located in Switzerland. The two firms account for virtually all Swiss exports in this sector.

14. In 2013 Novartis exported products worth CHF 29.5 billion from Switzerland and imported products worth CHF 17.3 billion to Switzerland. These trade flows were accounted for largely by within-firm trade and suggest a Swiss production share of 41.4 percent, accounted for largely by R&D (see Novartis 2014 and [www.novartis.com/about-novartis/locations/worldwide-offices.shtml](http://www.novartis.com/about-novartis/locations/worldwide-offices.shtml)).

pharmaceutical firms.<sup>15</sup> Hence the value of (net) exports largely reflects R&D costs incurred in the past. The crucial aspect of the time lag—through which the value of current exports covers past R&D expenditure—is thus preserved.

Finally, Swiss pharmaceutical companies relocated production only moderately in response to the appreciations of the Swiss franc.<sup>16</sup> Part of the reason for their reaction is that pharmaceutical production plants are subject to substantial rigidities, which are likely to be higher than in other industries.<sup>17</sup> Relocation thus occurs relatively slowly.

### *Was Pharmaceutical R&D Large Enough to Affect the Current Account?*

For a first check of plausibility, one may ask whether the magnitudes of pharmaceutical R&D are large enough to affect the Swiss current account in a nontrivial way. It turns out that investment opportunities in the Swiss pharmaceutical sector were substantial. Over the period 1994–2012, Switzerland’s two large pharmaceutical companies, La Roche and Novartis, together spent an average of 2.2 percent of GDP a year on R&D and capital investment (figures are simple time averages, reported in Sauré 2015).<sup>18</sup> These magnitudes are large enough to generate nontrivial capital inflows and contribute substantially to the Swiss current account.<sup>19</sup>

### *Did Past R&D Match Current Export Volumes?*

One may also wonder whether the magnitude of early deficits is matched by later surpluses under standard discount rates. In particular, can the large Swiss trade surplus really have resulted from past R&D? Would pharmaceutical exports of almost 10 percent of GDP in 2013 not have required excessively large inflows in the past?

The following back-of-the-envelope computation provides an answer to these questions. Assuming that the average time period between R&D and sales is about 10 years and the industry-specific annual

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15. Such intertemporal profit and cost shifting within a firm may also occur through royalties (see Grubert 1998). In that case, the same intrafirm transfers are recorded in the service component of the current account.

16. Novartis undertook major investments, such as a vaccine manufacturing facility in Marburg, Germany (construction started in June 2008) and a pharmaceutical manufacturing facility in Saint Petersburg, Russia (construction started in June 2011).

17. The time-intensive compulsory licensing of production plants (which is different from the market licensing of a product) generates additional rigidities that are absent in other sectors. The resulting rigidities imply that once a production site is established and equipped, relocation is less profitable.

18. Data availability is restricted by the fact that Novartis was founded in 1996 through a merger of Ciba-Geigy and Sandoz.

19. The trade balance ranged from –1.0 to 2.8 percent of GDP. The current account ranged from 2.0 to 13.9 during the same period.



interest rate is 10 percent,<sup>20</sup> investment of about 0.45 percent of GDP in 2000 would yield 1 percent of GDP in 2010.<sup>21</sup> The fact that R&D accounts for about 20–40 percent of production costs implies that pharmaceutical exports of 10 percent of GDP in 2010 corresponded to 0.9–1.8 percent of GDP in 2000 ( $0.45 \cdot 10/5 = 0.9$  or  $0.45 \cdot 10 \cdot 2/5 = 1.8$ ). These numbers are not excessively high and correspond to the R&D expenditure of Switzerland's two large pharmaceutical firms.

### *Did Pharmaceutical Firms Transit from an Investment Phase to Profit Collection?*

The model distinguishes between an early stage (investment in R&D) and a later stage (the reaping of profits stemming from that R&D). The left-hand panel of figure 4 shows that operating income of Switzerland's two pharmaceutical firms, measured as a share of their net income, almost doubled between 1993 and 2013. This trend indicates that the reaping of the returns on earlier investments became more and more dominant over the last two decades (see Sauré 2015). The expenditure of Switzerland's two large pharmaceutical firms devoted to R&D was roughly stable over this period (figure 4, right-hand panel).

### *Did Sheer Luck Drive Swiss Pharmaceutical Exports?*

In the pharmaceutical sector, the development of a single compound can make a big difference; blockbuster drugs can make up a large share of revenues even for large pharmaceutical companies.<sup>22</sup> Developing a successful drug can thus be compared to winning the lottery.

Did sheer luck drive the performance of the Swiss pharmaceutical sector? If it did, the profits of Swiss pharmaceutical firms would appear to be a windfall to Switzerland (with the potential downsides of Dutch disease). Data at the firm level, however, show that revenues were considered typical for the industry. In 2000 Novartis reported R&D investments of CHF 4.189 billion. Assuming that sales occur a decade after the R&D and discounting at an annual interest rate of 10 percent, these costs amounted to CHF 10.865 billion in 2010 (in 2000 CHF or CHF 1,011.797 billion in 2010 CHF based on consumer price index inflation), corresponding to 21.4 percent of Novartis' 2010 sales (CHF 50.624 billion) (see

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20. DiMasi et al. (1991) and DiMasi, Hansen, and Grabowski (2003) assume a 14 percent interest rate for the earlier (R&D) period and a 10 percent interest rate for the later (production and sales) period.

21. At a constant GDP, this number would be  $1.1^{-10} = 0.3855$ . However, Switzerland's output totaled \$223.45 billion in 1998 and \$325.19 billion in 2011, an average annual growth rate of 1.65 percent, implying that 1 percent of GDP in a given period corresponds to 1.178 percent of GDP 10 years earlier.

22. Sales of blockbuster drugs are large even for multinational pharmaceutical companies. In 2011, 10 percent of the industry's worldwide revenue was from the 10 best-selling drugs (see Deutsche Bank 2012).

Novartis' 2010 annual report).<sup>23</sup> This R&D share, based on net present value, is not exceptionally small; it indicates that the returns to R&D are well within the normal range.<sup>24</sup>

The same issue can be addressed through financial market data. Between 1996 (the first full year for which data are available for Novartis) and 2013, the market values of La Roche and Novartis increased by factors of 3.17 and 2.77, respectively (measured in US dollars). WORLD-DS Pharm, an index of the global pharmaceutical industry from Datastream, increased by a factor of 2.64 over the same period. The margins by which Swiss pharmaceutical firms outperformed their global peers are too small to attribute large parts of the overall performance of Switzerland's pharmaceutical firms to sheer luck. These numbers provide little evidence for the hypothesis that the Swiss trade surplus was driven mainly by Swiss pharmaceutical firms winning the lottery.

### *Were Other Characteristics of the Pharmaceutical Industry Important?*

Other characteristics also make the pharmaceutical industry special. Some of them relate to the demand side. Drugs that are essential and potentially life-saving face intrinsically inelastic demand.<sup>25</sup> In addition, the fact that health insurance by employers typically covers large parts of health expenditures makes demand insensitive to price changes. The particularly low demand elasticities faced by pharmaceutical firms are documented below. They highlight the implications for the Swiss trade surplus. These factors do not contradict the theory's main message that the decoupling of R&D and production can lead to imbalanced trade.

### *What Are the Implications for the Swiss Franc?*

What are the implications of Switzerland's trade surplus for its exchange rate? The class of models used for the analysis implies that an expansion of a country's production (and trade) is accompanied by an appreciation of its (real) exchange rate. In a qualitative sense, the model employed to analyze the dynamics of Swiss trade is no exception: The exchange rate is predicted to appreciate as the trade balance turns positive. Quantitatively, however, these effects are minimal. A series of calibrations shows that the appreciations consistent with the increase in Switzerland's trade in pharmaceuticals are 0.1 percent or less (see Sauré 2015). Compared with the appreciations documented in figure 2 (orange line), these appreciations are negligible.

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23. More sophisticated models consider longer periods between R&D and sales and rely on overlapping generations of product innovation.

24. This effective R&D share increases when considering higher interest rates and longer time periods between R&D and sales. Interest rates of 14 percent, also considered in DiMasi, Hansen, and Grabowski (2003) for early R&D phases, imply an effective R&D share of 30.6 percent.

25. Insulin is a textbook example of inelastic demand (see Hoffer, Shughart, and Thomas 2013).

These results show that the appreciation of the Swiss franc cannot be read as the result of the large increase in Switzerland's net exports. In that sense, the appreciations of the Swiss franc since the start of the financial crisis of 2007/08 were excessive. The reasons for these appreciations must therefore lie outside of the general equilibrium forces discussed here. Exchange rate changes due to safe-haven effects in times of uncertainty and the unwinding of carry trades are part of the explanation.<sup>26</sup>

### Exchange Rate Elasticities

The previous section explained why Swiss trade should not be expected to be balanced. It showed that appreciations of the Swiss franc were unlikely to result from trade dynamics. The underlying argument leaves one puzzle unexplained: Given that the strong appreciations did not originate from the real, trade-related side, why did the Swiss trade surplus prove resilient to these appreciations? One explanation—the inelastic demand for pharmaceuticals—was cited above.

This section analyzes this phenomenon quantitatively. It provides estimates of the exchange rate elasticity of Swiss trade and shows the extent to which potential further appreciations of the Swiss franc reduce the Swiss trade surplus. The analysis accounts for the special importance of trade in pharmaceuticals for the Swiss trade balance.

There are several reasons why trade flows of pharmaceutical goods can be expected to exhibit particularly low exchange rate sensitivity. The first derives from the fact that demand for medical products is inelastic to price changes, because these products are essential, sometimes life-saving goods. The effect of health insurance reinforces this inelasticity. As a result, demand—and thus trade flows—do not react strongly to price and exchange rate changes.

Low demand elasticity also stems from the fact that a relatively small number of blockbuster products tends to drive sales.<sup>27</sup> The sales of a company can thus increase substantially as important products are licensed and become marketable. Conversely, the expiration of property rights may induce drops in sales values (the “patent cliff”), which are significant for even large companies' performance. These jumps in trade volumes and trade values are not systematically linked to exchange rate shocks and thus generate low measures of exchange rate sensitivity of trade flows.

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26. A report by the IMF (2013) observes that decreasing interest rates in major currency areas “reduced the attractiveness of the franc as a funding currency, setting the stage for ... [an] appreciation cycle for the Swiss currency.” As “problems in the euro zone periphery mounted, the franc has been increasingly seen as a ‘safe haven’ currency.” See also IMF (2014) and Jordan (2013).

27. In 2013, for example, just two products—Gleevec (used to treat of cancer) and Diovan (used to treat hypertension)—accounted for more than a quarter of the total sales of Novartis Pharmaceuticals, the largest division of Switzerland's largest pharmaceutical company (see the 2013 Novartis financial report [<http://www.novartis.com/investors/financial-results/index.shtml>]).

These characteristics related to demand and supply factors suggest that trade in pharmaceutical goods is insensitive to exchange rate changes. Exchange rate elasticities are therefore presented separately for total trade flows, trade in pharmaceutical goods, and trade in nonpharmaceutical goods.

Two estimation approaches confirm that trade in pharmaceuticals does not show a statistically significant reaction to exchange rate changes. In contrast, nonpharmaceutical trade reacts to exchange rate changes in the way that is expected, with appreciations reducing a trade surplus (see the appendix for details). Given the large and growing share of pharmaceutical goods in the Swiss trade balance, total Swiss exports show a moderate but marginally significant reaction to exchange rate changes.

### *Panel Regressions*

Standard panel estimations in which bilateral trade balances are regressed on a contemporary and lagged bilateral exchange rate provide weak evidence that the reaction of total Swiss net exports to exchange rate changes is indeed moderately negative: A 10 percent appreciation of the Swiss franc is associated with less than a 4 percent decrease in net exports. This effect is significant in only one of the specifications (table 1 reports the estimation results; see the appendix for a detailed description of the underlying estimation technique). When pharmaceutical goods are excluded, a 10 percent appreciation of the Swiss franc is associated with a decrease in the trade balance of almost 5 percent (this effect is statistically significant). When only pharmaceutical goods are considered, no statistically significant effect can be detected.

These results allow for quantitative statements to be made about how much the Swiss franc would have to appreciate to balance trade in goods. Because pharmaceuticals do not react to exchange rate changes, the adjustment falls to trade in nonpharmaceutical goods. Assuming that imports and exports of nonpharmaceutical goods react to rate changes in opposite directions but at roughly the same magnitudes, the following computations apply to the 2013 values: When nonpharmaceutical imports (worth CHF 176.2 billion) rise by a factor of  $\theta$ , nonpharmaceutical exports (worth CHF 163.3 billion) fall by a factor of  $1/\theta$ . To close the gap between total exports and imports of CHF 25.6 billion (CHF 200.1– CHF 225.7 billion),  $\theta$  must equal 1.08 (solve  $\theta * 176.2 - \theta^{-1} * 163.3 - (176.2 - 163.3) = 25.6$ ). Inducing this drop in exports and rise in imports would require the exchange rate to appreciate by more than 40 percent.<sup>28</sup> In nominal terms and ceteris paribus, the Swiss franc would have to fall from 1.20 to approximately 0.72 against the Euro (a decline of about 80 percent since the summer of 2007).

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28. The 40 percent follows from the calculation  $1.08^{2/0.455} = 1.403$ . According to table 1, the response of nonpharmaceutical exports over imports is 0.45 times the log change of the underlying change in the exchange rate ( $\Delta \ln(Exp/Imp) = \ln(\theta^{-1} Exp/\theta Imp) - \ln(Exp/Imp) = -2\ln(\theta) = 0.455\Delta \ln(xrate)$ ).

## Vector Auto Regressions

An alternative approach to assessing the exchange rate sensitivity of Switzerland's net exports is to use vector auto regression (VAR) estimations. The virtue of the VAR is that given the adequate identification of structural shocks, it reveals the causal effects of exchange rate changes on the trade balance.<sup>29</sup>

Figure 5 shows the key results from these VAR estimations by plotting the cumulative response of the trade balance (nonpharmaceutical goods in the left-hand panel and pharmaceuticals in the right-hand panel) to a shock to the REER. The left-hand panel shows that net exports of nonpharmaceutical goods respond to a permanent change in the REER: A 10 percent appreciation of the Swiss REER induces a drop in net exports of about 3 percent of GDP after approximately 12 quarters. In contrast, the right-hand panel shows that net exports of pharmaceutical goods do not react significantly to changes in the REER (see the appendix for the full sets of impulse response functions). Although the VAR estimations do not replicate the exact numbers of the panel regression presented above (a drop of approximately 17 percent in the long run), they do correspond well with the overall message: Whereas net exports of nonpharmaceutical goods tend to react negatively to real appreciations of the Swiss franc, net exports of pharmaceutical goods do not.<sup>30</sup>

These results show that Switzerland's trade flows can be divided into two qualitatively different classes. On the one hand, there is a basket of goods for which trade flows react to exchange rate changes in the way that is typically assumed. On the other hand, there are pharmaceuticals, which seem unresponsive to exchange rate changes. The fact that pharmaceuticals constitute a large share of the Swiss export basket implies that the exchange rate sensitivity of the total trade balance decreased over the past decade or two. Trade in pharmaceuticals is thus both particularly important for Switzerland and particularly insensitive to exchange rate changes.

## CONCLUSION

In the past two decades, pharmaceuticals came to dominate exports of goods from Switzerland in terms of both growth rates and absolute values. In fact, the secular increase in net exports since the 1990s is accounted for exclusively by trade in the pharmaceutical sector.

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29. The vector of time series reported here consists of Swiss GDP over the GDP of the rest of the world; Swiss net exports, normalized by GDP (in differences); and the Swiss REER (in differences). Structural shocks to the Swiss REER variables do not affect the other variables contemporaneously. Data are reported on a quarterly basis. See the appendix for details on the methodology.

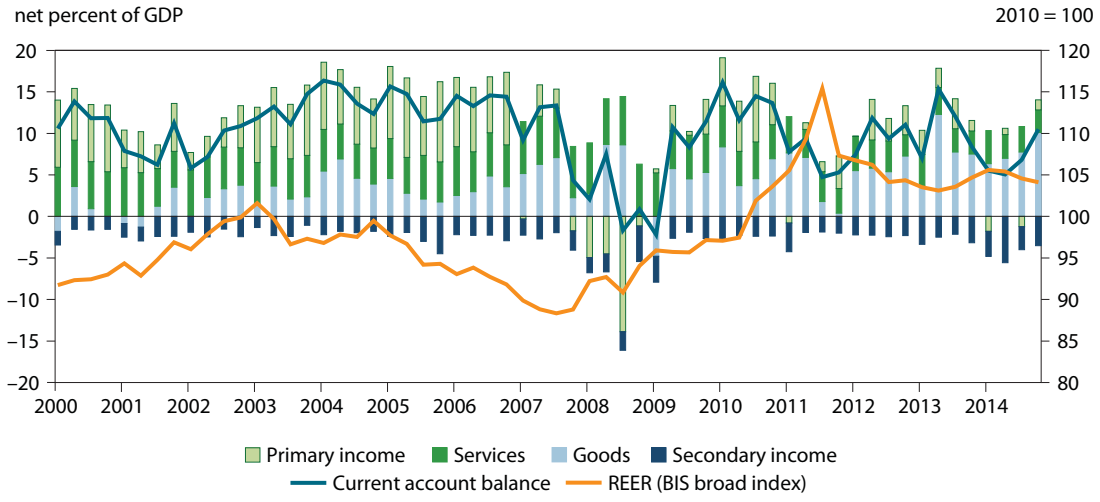
30. The less precise VAR estimations suggest that an appreciation of the Swiss franc of 23 percent would be needed to balance trade in the very long run (i.e., six to eight years).

The Swiss trade surplus can be understood as the natural outcome of large R&D investments incurred in recent years and decades. The key question of whether the surplus is an indicator of an undervalued Swiss franc is therefore answered negatively.

This statement does not contradict the fact that the Swiss franc was under considerable appreciation pressures during the euro crisis. In fact, these pressures recently resulted in further appreciations of the Swiss franc. However, the paper sides with observers who claim that safe-haven effects, uncertainties in the euro area, and the unwinding of carry trades (i.e., purely financial factors) were the main drivers of the Swiss franc's appreciations.

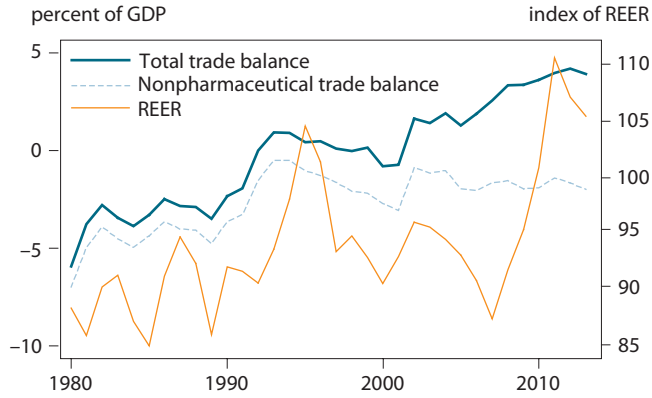
Finally, the paper shows the extent to which the Swiss franc would have to appreciate to balance trade. The resilience of Swiss exports to exchange rate changes implies that the exchange rate would have to appreciate by about 40 percent above 2013 levels, an increase that is clearly excessive.

**Figure 1 Components of the Swiss current account, 2000–2014**



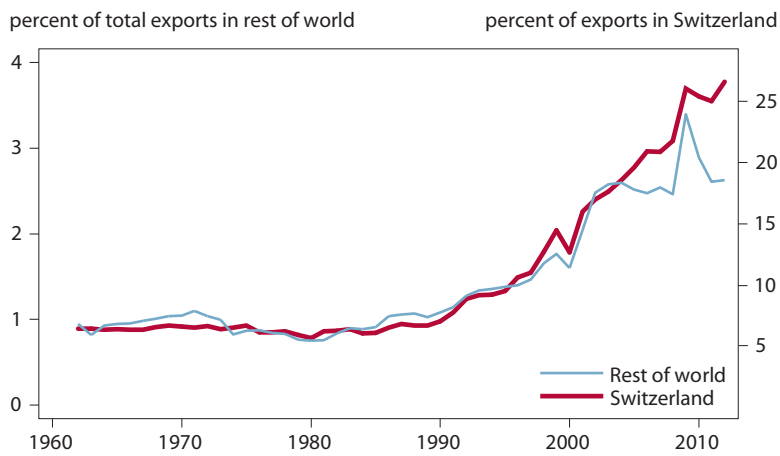
Source: Swiss National Bank.

**Figure 2 Net export of goods by Switzerland, with and without pharmaceuticals, 1980–2013**



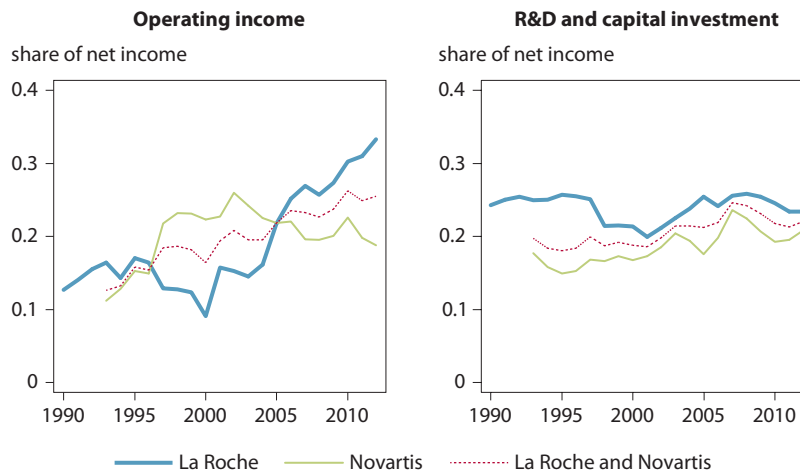
Sources: Data from UN Comtrade and Bank for International Settlements.

**Figure 3 Exports of pharmaceuticals as percent of total exports, in Switzerland and rest of world, 1962–2013**



Source: UN Comtrade data.

**Figure 4 Profits of and investment by Swiss pharmaceutical firms, 1990–2013**



Source: Data from Datastream.

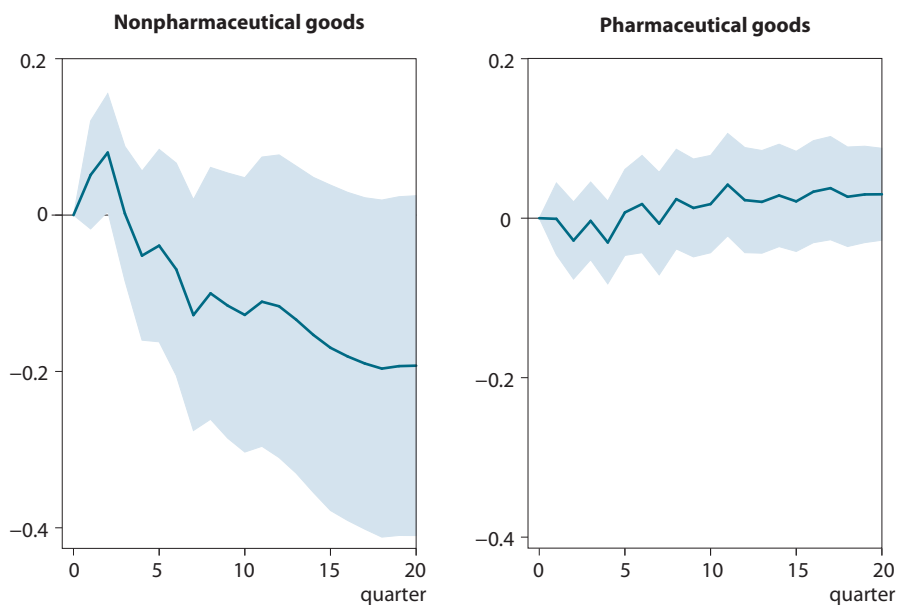


**Table 1 Sensitivity of bilateral Swiss trade flows to exchange rates**

| Item                  | Nonpharmaceuticals |                      | Pharmaceuticals   |                     | Total             |                      |
|-----------------------|--------------------|----------------------|-------------------|---------------------|-------------------|----------------------|
|                       | Panel              | Arellano-Bond        | Panel             | Arellano-Bond       | Panel             | Arellano-Bond        |
| <i>Dxrate</i>         | -0.305<br>[0.236]  | -0.213<br>[0.197]    | 0.141<br>[0.355]  | 0.220<br>[0.449]    | -0.264<br>[0.224] | -0.203<br>[0.198]    |
| <i>L. Dxrate</i>      | -0.083<br>[0.178]  | -0.242**<br>[0.104]  | -0.649<br>[0.594] | -0.574<br>[0.643]   | -0.063<br>[0.159] | -0.185*<br>[0.097]   |
| <i>Dxrate cumul</i>   | -0.388***<br>0.135 | -0.455**<br>0.214    | -0.509<br>0.540   | -0.353<br>0.772     | -0.327**<br>0.132 | -0.387*<br>0.210     |
| <i>Dgdp</i>           | 0.441*<br>[0.233]  | 0.365<br>[0.357]     | 0.160<br>[0.578]  | 0.649<br>[0.881]    | 0.317<br>[0.218]  | 0.116<br>[0.354]     |
| Trend                 | -0.000<br>[0.002]  | 0.001<br>[0.003]     | -0.001<br>[0.003] | -0.001<br>[0.004]   | -0.000<br>[0.002] | 0.000<br>[0.003]     |
| <i>L.DEF</i>          |                    | -0.341***<br>[0.099] |                   | -0.099**<br>[0.050] |                   | -0.324***<br>[0.096] |
| Observations          | 402                | 377                  | 402               | 377                 | 402               | 377                  |
| Country fixed effects | yes                | yes                  | yes               | yes                 | yes               | yes                  |

Note: The dependent variable is the annual log change in Swiss bilateral exports over imports. Data cover 1988–2007 and 25 partner countries.  
 \* Significant at the 10 percent level. \*\* Significant at the 5 percent level. \*\*\* Significant at the 1 percent level. Robust standard errors are in brackets.

**Figure 5 VAR orthogonal cumulative impulse response to a 1 percent shock of the REER for nonpharmaceutical and pharmaceutical goods, first quarter of 1988–fourth quarter of 2007**



Note: Specification includes six lags. Light blue areas represent 10 percent error bands.

## APPENDIX PANEL ESTIMATION

A first assessment of the exchange rate sensitivity of Switzerland's net exports follows Haynes and Stone (1982) and Bahmani-Oskooee and Malixi (1992) by estimating a model of the type:

$$Dtb_{i,t} = \beta_0 \cdot Dxrate_{i,t} + \beta_1 \cdot Dxrate_{i,t-1} + \mathbf{Z}_{i,t} + \varepsilon_{i,t}$$

where  $tb_{i,t}$  indicates the ratio of exports from Switzerland to country  $i$  over imports from country  $i$  to Switzerland in year  $t$ .<sup>31</sup> The variable  $xrate_{i,t}$  indicates the bilateral exchange rate between Switzerland and country  $i$  in year  $t$  (from Bank for International Settlements [BIS] yearly averages).  $D$  indicates the log change between  $t$  and the preceding year, and  $\mathbf{Z}$  is a vector of controls, consisting of country  $i$ 's GDP (in local currency units and logged changes), fixed effects, and a trend. According to the convention adopted, a positive change in  $Dxrate$  indicates an appreciation of the Swiss franc relative to the local currency of the trade partner. Thus according to the conventional narrative that appreciations reduce net exports, the coefficients on  $Dxrate_{i,t}$  and its lag are expected to be negative.

Yearly sectoral trade data are from Comtrade; exchange rate data are from the BIS. The unbalanced panel covers the period 1988–2007 with 24 countries as trade partners of Switzerland.

The first two columns of table 1 in the paper report the estimation results. The first column corresponds to an ordinary panel regression. In this estimation, none of the coefficients on the exchange rate change is individually significant. The cumulative effect of lagged and present exchange rate changes, however, indicates a significantly negative effect of exchange rate appreciation on the trade balance. This cumulative effect suggests that a 10 percent appreciation of the domestic exchange rate decreases the trade balance (the ratio of exports over imports) by approximately 3.4 percent.

Arellano-Bond estimations give consistent estimates in short panels with autoregressive terms and are thus the appropriate specification in table 1. The estimated coefficient of the lagged exchange rate change is slightly larger than in the first specification, but the cumulative effect is only marginally significant.

The two middle columns report estimation results in which the dependent variable is based on bilateral exports and imports excluding pharmaceuticals. The coefficients of interest, particularly the cumulative effect of past and present exchange rate changes, are larger and, in the case of the important Arellano-Bond estimation, significant at the 5 percent confidence level. According to this estimation, a 10 percent appreciation of the domestic exchange rate reduces the trade balance by almost 0.05 percent. Trade in pharmaceuticals does not exhibit any responsiveness to exchange rate changes. The individual and cumulative estimated effect, reported in the last two columns of table 1, is insignificant throughout.

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31. See Bahmani-Oskooee and Ratha (2004) for a review of different specifications. A virtue of this specification is that the currency in which trade flows are denominated is irrelevant, and the estimations are not contaminated by the degree of the exchange rate pass-through.

Pharmaceuticals are, then, not very sensitive to exchange rate changes. Their presence in the trade basket can substantially reduce the exchange rate sensitivity of trade in terms of both estimated elasticities and significance.

### Vector Auto Regressions

In addition to the panel estimation, a VAR model is estimated (following, for example, Demirden and Pastine 1995). The vector consists of three components: GDP, the trade balance, and the REER. GDP is defined as Swiss GDP relative to world GDP ( $gdp_t$ ); the trade balance is defined as exports minus imports as a share of GDP ( $TB_t$ ). Relative GDP is measured as deviations from the trend, and the other two variables are measured as differences. Formally,

$$\begin{pmatrix} \Delta gdp_t \\ \Delta TB_t \\ \Delta REER_t \end{pmatrix} = \sum_{k=1}^L \Phi_k \begin{pmatrix} \Delta gdp_{t-k} \\ \Delta TB_{t-k} \\ \Delta REER_{t-k} \end{pmatrix} + u_t$$

is estimated.

The structural shocks generating the error term ( $u$ ) are identified according to the standards of the Cholesky decomposition: Relative GDP is assumed to be contemporaneously unaffected by innovations on both other variables, and the trade balance is assumed to be contemporaneously unaffected by innovations on the REER. The quarterly data used cover the period between the first quarter of 1988 and the fourth quarter of 2006, which excludes the Great Recession and the euro crisis.

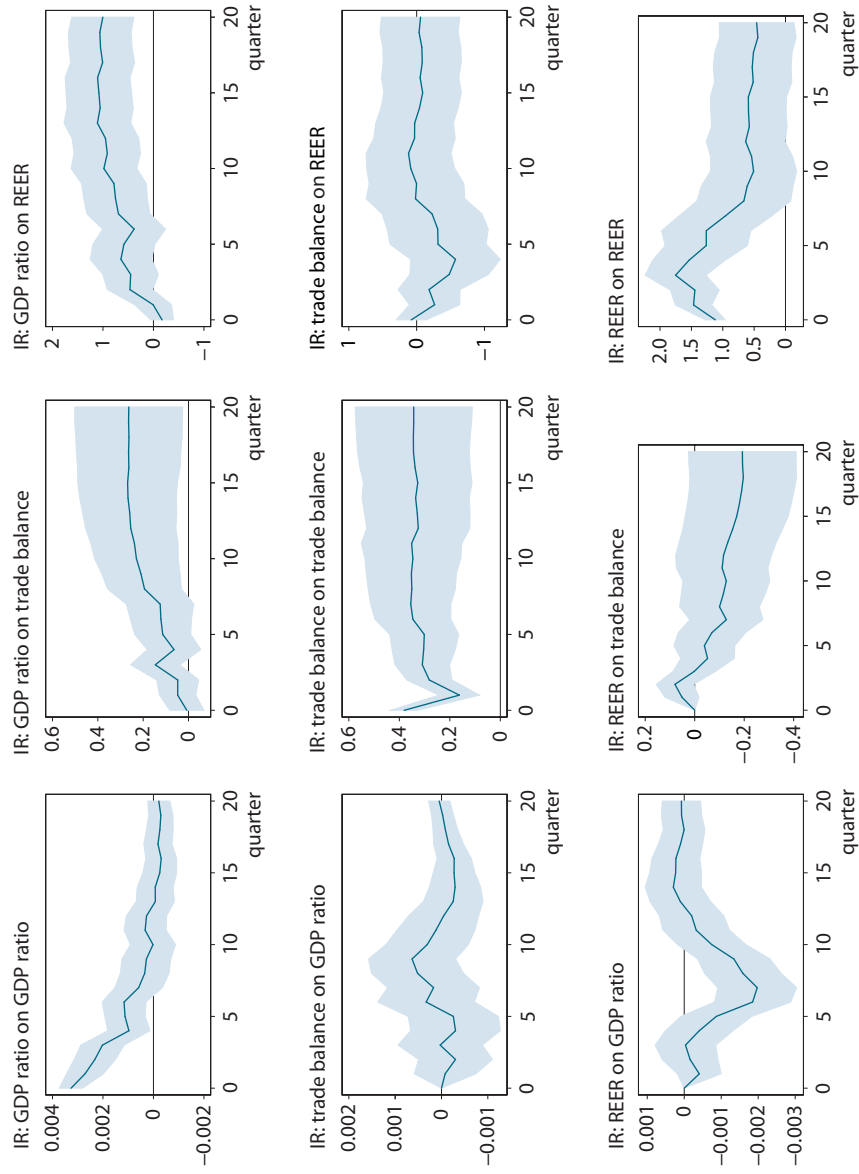
Two specifications are estimated to distinguish between the effect of exchange rate changes on trade in pharmaceutical and nonpharmaceutical goods. The first defines the trade balance based on net Swiss exports excluding pharmaceuticals. The second defines the trade balance based on only pharmaceuticals.

Schwarz's Bayesian information criterion and the Hannan and Quinn information criterion (HQIC) suggest lag orders of two and seven for the first specification and two and four for the second. Six lags are examined throughout. This choice is in line with the fact that exchange rates are passed through with a lag of approximately 18 months, as consistently reported in the literature.

Figure A.1 plots the cumulative impulse response functions of the first specification with trade of nonpharmaceutical goods. The impulse response function of primary interest is the one exhibiting the effect of a structural shock to the REER on the trade balance. The graph in the middle of the bottom row suggests that a 1 percent appreciation of the Swiss REER induces a drop in net exports equivalent to 0.3 percent of GDP after approximately 12 quarters.

Figure A.2 plots the cumulative impulse response functions of the first specification with trade of pharmaceutical goods only. It suggests that the REER has no significant effect on trade in pharmaceuticals.

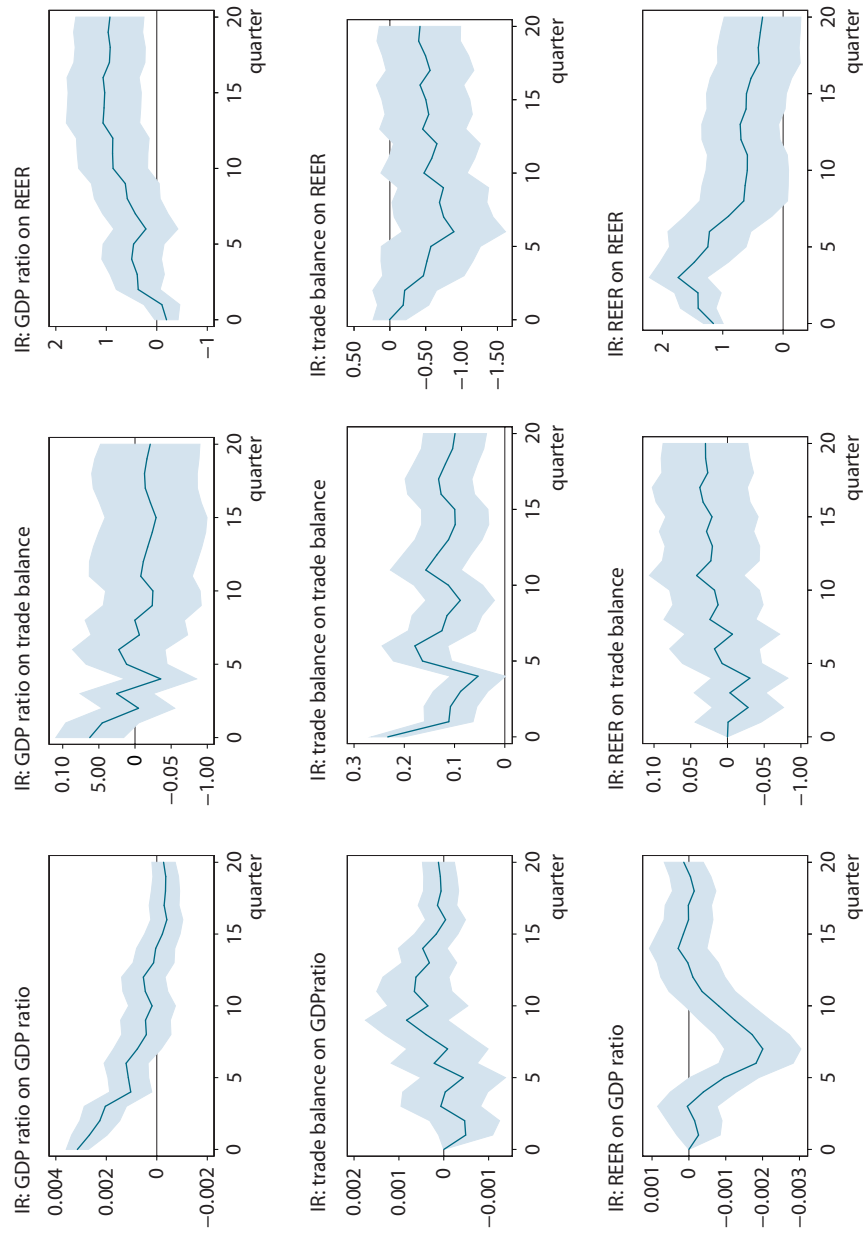
**Figure A.1 Orthogonal cumulative impulse response functions for nonpharmaceutical goods, first quarter of 1988–fourth quarter of 2007**



GDP = gross domestic product

Note: Figure covers six lags. Light blue areas show 90 percent confidence intervals.

**Figure A.2 Orthogonal cumulative impulse response functions for pharmaceutical goods, first quarter of 1988–fourth quarter of 2007**



GDP = gross domestic product

Note: Figure covers six lags. Light blue areas show 90 percent confidence intervals.

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