



University of St.Gallen

Institute for Law and Economics

SWISS TRADE MONITOR

Edition 14:
Dynamic Gravity

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From insight to impact.

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Suggested Citation (APA 8th edition):

Legge, Stefan, Helbig, Florian, Oberholzer, Ronny, and Rosenthal, Jason (2024). *“Dynamic Gravity”*, Swiss Trade Monitor, 14th Edition, University of St.Gallen.

Date: August 5, 2024

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Publisher: Institute for Law and Economics
Tax & Trade Policy
Varnbühlstrasse 19
CH-9000 St.Gallen

Electronic Publication: <https://ile.unisg.ch/>

Key Findings

- The so-called gravity model of trade holds that nations trade most with countries that (i) have a large GDP and (ii) are geographically close.
- The implications of this model are valid for Switzerland, too. Its trade flows are weaker with distant and small economies in contrast to geographically close and big economies.
- One corollary that follows from the gravity model is that a country's trade flows should increase most strongly with nations that feature the largest growth rate of their GDP. Again, data for Switzerland supports this empirically.
- Among countries that have experienced large absolute increases in their GDP in the recent decade, Switzerland has no free trade agreement (FTA) in force with the US, India, Australia, or Vietnam. In this regard, our analysis sheds light on priorities for Swiss trade policy negotiations.

The Swiss Trade Monitor

Switzerland is a small open economy. The international exchange of goods and services is crucial for the nation's economic prosperity. The aim of the *Swiss Trade Monitor* is to document key trends in Switzerland's foreign trade. Its fourteenth edition analyzes the validity of the gravity model for Switzerland's trade flows. The data source for this report is the Swiss Federal Office for Customs and Border Security (FOCBS). Unless stated differently, the trade data exclusively considers goods trade without gold and other precious metals (the FOCBS refers to this as "Total 1").

The Gravity Equation

The study of international trade is about the value of goods and services that countries exchange with each other. When looking at Switzerland, we quickly identify that geographically close countries (Germany, France, Italy, the UK) as well as China and the United States are the most important trading partners.

If we seek to answer *why* Switzerland trades most with these nations, economists turn to what is called the gravity equation. It uses an insight from physics: The gravitational force between two objects is proportional to their two masses and the distance between them. Similarly, countries trade more with each other if their economies are bigger and the geographic distance between them is smaller.

This idea was first suggested by German-English geographer Ernst Georg Ravenstein and later presented by Dutch economist Jan Tinbergen in 1962. We can formally express it as follows:

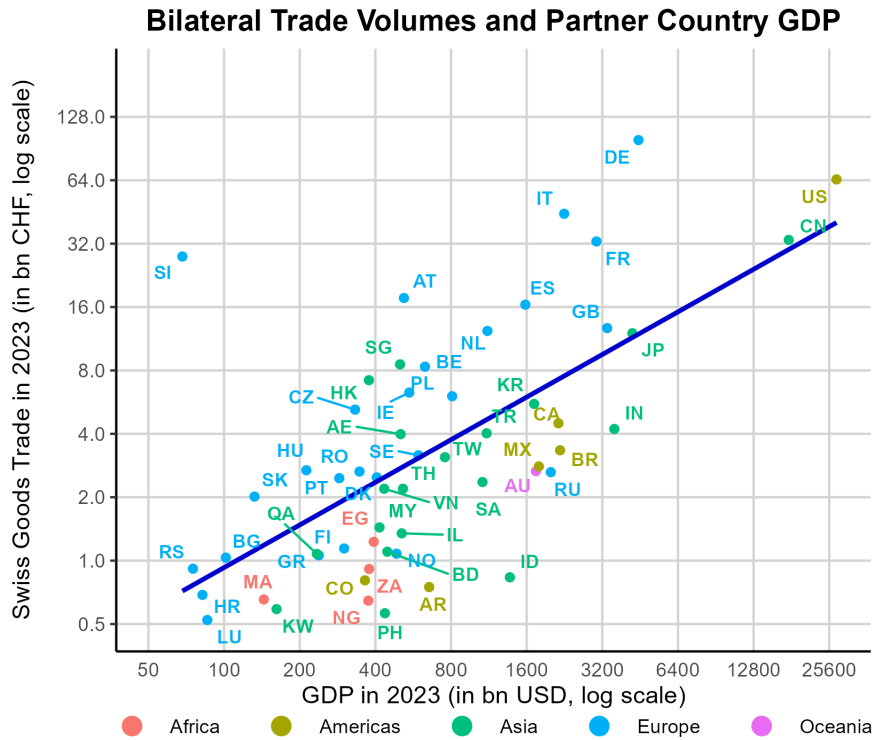
$$\text{Trade between A and B} \sim \frac{\text{GDP}_A * \text{GDP}_B}{\text{Distance}_{AB}}$$

This implies that the trade volume between two countries A and B correlates positively with the size of both economies (i.e., their GDP) and negatively with the geographic distance between them. The present report analyzes this interdependence for Swiss trade flows.

Impact of GDP

We first study the impact of partner countries' GDP. The chart below clearly visualizes that Switzerland's bilateral trade volume increases with the size of the economy of the trade partner. The world's largest economies such as the United States, China, and Japan are important trading partners for Switzerland — even though these countries are geographically far away. For example the trade volume with the US is higher than the trade volume with France, although Switzerland is much closer to France than to the US. The trade volume is higher because the GDP of the USA is about \$25 trillion while that of France is only about \$3 trillion.

We can also observe several outliers in the chart. Slovenia (SI), Austria (AT), Italy (IT), France (FR) and Germany (DE) are all well above the regression line. This is not surprising given that they are all European countries — and Slovenia is a special case we discussed in the 8th edition of the Swiss Trade Monitor.



Note: Switzerland's partner countries' trade volume (imports + exports of goods) is plotted against their GDP (expressed in current US Dollar). Partner countries with a GDP of less than \$50 billion or trade volume below 0.5 billion CHF are omitted. Sources: FOCBS – Trade statistics, IMF World Economic Outlook April 2024 – GDP data.

Impact of Geographic Distance

However, trade between two countries is not only determined by the GDP of the two economies. The distance between them also plays a major role. National borders increase trade restrictions because goods and services are subject to tariffs, quality controls, and other requirements based on laws and regulations. If two countries are separated by oceans or land mass, there are also high logistics costs for container ships, cargo planes, or trucks. All of this means that trade costs tend to increase — and thus trade volumes decrease — with the geographic distance between two countries.

The figure below shows this relationship for Switzerland. One can observe a negative correlation between the trade volume with a partner country and its distance to Switzerland. To avoid GDP distorting the chart, we use bilateral trade volume relative to the partner country's GDP on the vertical axis. As expected, Switzerland's trade with European countries is higher relative to GDP than trade with more distant countries in Asia or South America. Trade volumes with Austria (AT) or Germany (DE) are particularly high. This is a result of a common language and common border. Put differently, these countries are “close” to Switzerland not only geographically but also culturally. Finally, Slovenia (SI) again stands out for reasons discussed above.

The scatter plot displays the relationship between the geographic distance to Switzerland (log scale, x-axis) and the ratio of Swiss goods trade to partner GDP (log scale, y-axis). A blue regression line indicates a negative correlation. Data points are labeled with country codes. Notable outliers include SI (Slovenia) at a low distance and high trade ratio, and AU (Australia) at a high distance and low trade ratio.

Country Code	Geographic Distance to Switzerland (km, log scale)	Swiss Goods Trade / (Partner GDP / 1000) (log scale)
SI	~500	~1000
AT	~600	~32
DE	~800	~16
BE	~500	~16
CZ	~600	~16
IT	~700	~16
SK	~600	~16
FR	~500	~16
NL	~600	~16
HR	~700	~16
RS	~800	~16
ES	~1000	~16
IE	~1200	~16
TN	~1000	~16
BG	~1200	~16
PT	~1500	~16
MA	~1800	~16
EG	~2000	~16
JO	~2500	~16
AE	~4000	~16
QA	~4500	~16
OM	~5000	~16
UZ	~6000	~16
SA	~4000	~16
NG	~4500	~16
CI	~4500	~16
GH	~3500	~16
IL	~3000	~16
KW	~3000	~16
RU	~2000	~16
GR	~1500	~16
FI	~1800	~16
TR	~1800	~16
JA	~1500	~16
NO	~1200	~16
DZ	~1000	~16
BY	~1200	~16
LU	~300	~8
GB	~700	~4
DK	~900	~4
PL	~800	~4
LT	~1200	~4
SE	~1200	~4
RO	~1500	~4
MA	~1800	~4
EG	~2000	~4
JO	~2500	~4
AE	~4000	~4
QA	~4500	~4
OM	~5000	~4
UZ	~6000	~4
SA	~4000	~4
NG	~4500	~4
CI	~4500	~4
GH	~3500	~4
IL	~3000	~4
KW	~3000	~4
RU	~2000	~4
GR	~1500	~4
FI	~1800	~4
TR	~1800	~4
JA	~1500	~4
NO	~1200	~4
DZ	~1000	~4
BY	~1200	~4
TH	~8000	~4
VN	~10000	~4
CR	~8000	~4
GA	~8000	~4
IN	~6000	~4
KE	~6000	~4
US	~6000	~4
OM	~5000	~4
UZ	~6000	~4
SA	~4000	~4
NG	~4500	~4
CI	~4500	~4
GH	~3500	~4
IL	~3000	~4
KW	~3000	~4
RU	~2000	~4
GR	~1500	~4
FI	~1800	~4
TR	~1800	~4
JA	~1500	~4
NO	~1200	~4
DZ	~1000	~4
BY	~1200	~4
TH	~8000	~4
VN	~10000	~4
CR	~8000	~4
GA	~8000	~4
IN	~6000	~4
KE	~6000	~4
US	~6000	~4
OM	~5000	~4
UZ	~6000	~4
SA	~4000	~4
NG	~4500	~4
CI	~4500	~4
GH	~3500	~4
IL	~3000	~4
KW	~3000	~4
RU	~2000	~4
GR	~1500	~4
FI	~1800	~4
TR	~1800	~4
JA	~1500	~4
NO	~1200	~4
DZ	~1000	~4
BY	~1200	~4
TH	~8000	~4
VN	~10000	~4
CR	~8000	~4
GA	~8000	~4
IN	~6000	~4
KE	~6000	~4
US	~6000	~4
OM	~5000	~4
UZ	~6000	~4
SA	~4000	~4
NG	~4500	~4
CI	~4500	~4
GH	~3500	~4
IL	~3000	~4
KW	~3000	~4
RU	~2000	~4
GR	~1500	~4
FI	~1800	~4
TR	~1800	~4
JA	~1500	~4
NO	~1200	~4
DZ	~1000	~4
BY	~1200	~4
TH	~8000	~4
VN	~10000	~4
CR	~8000	~4
GA	~8	

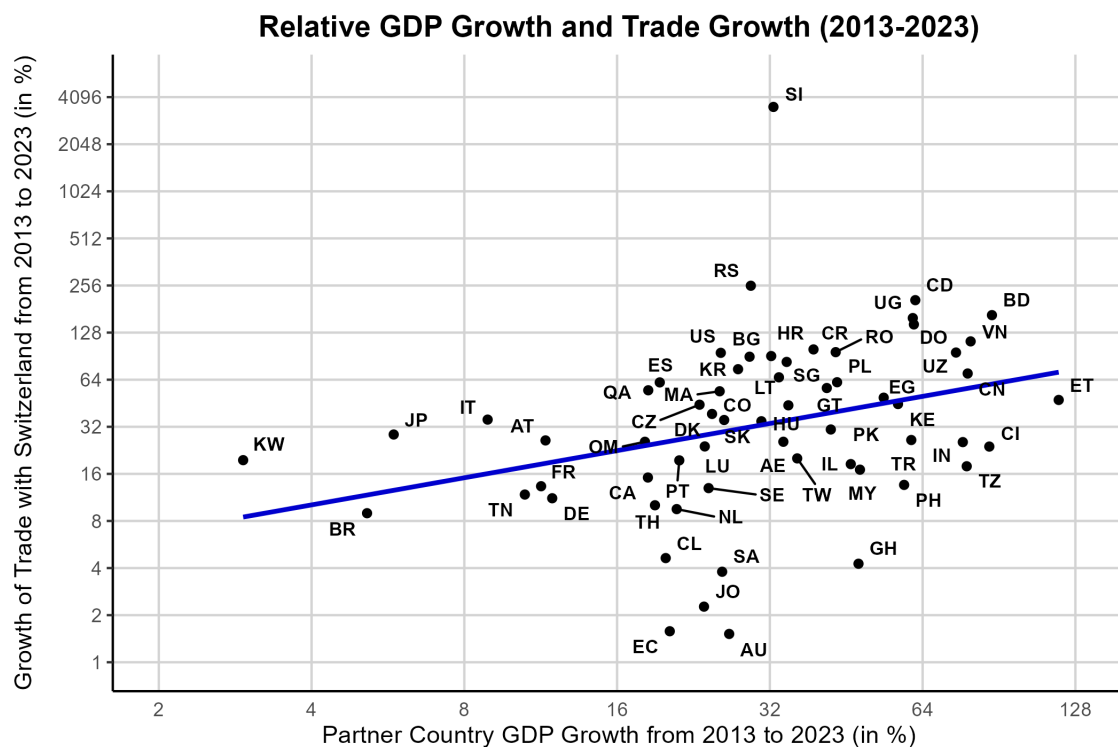
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Dynamic Gravity

Geographic distance between two countries is a fixed variable that does not change over time. As such it should have no influence on changes in trade flows. In contrast, GDP is a time-varying variable and thus can have an impact in a dynamic sense: As partner countries' economies grow bigger, we should expect that their trade volume with Switzerland increases. In what follows we explore this relationship in two ways. First, we analyze the impact of *relative* growth. Second, we take a look at *absolute* increases.

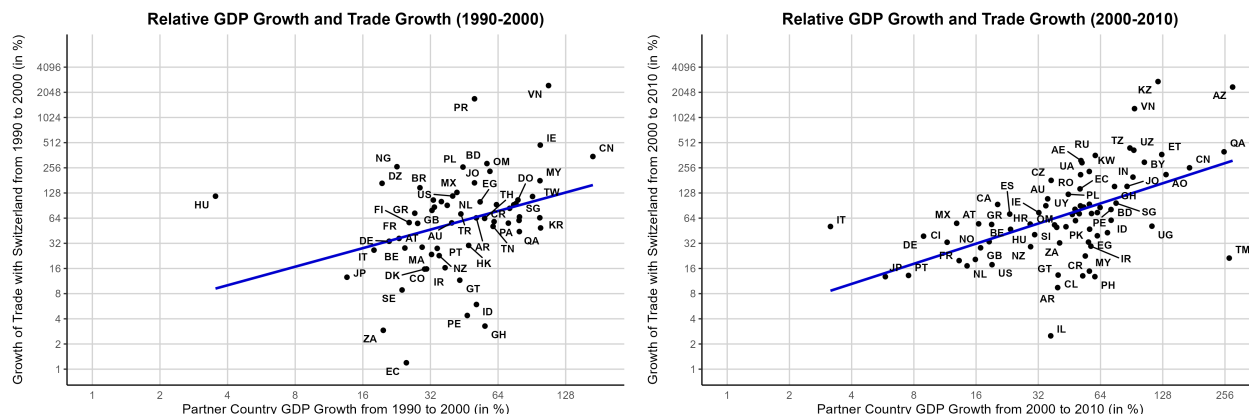
Relative Growth

We begin by looking at *relative* growth of GDP and trade volumes. Is it true that countries that had the highest growth rate of GDP are also the ones that saw bilateral trade volumes with Switzerland grow at the highest rate? The chart below shows that the answer is in the positive. While there is substantial variation, we can generally see that partners with strong economic growth such as China (CN) or Bangladesh (BD) are also among the countries that experienced the fastest relative growth of bilateral trade with Switzerland.



Note: Partner countries growth of trade volume (imports + exports of goods) with Switzerland is plotted against their GDP growth (measured in constant local currency). Sources: FOCBS – Trade statistics, IMF World Economic Outlook April 2024 – GDP data.

When analyzing the dynamic relationship between GDP growth and trade volume growth, the choice of the time period is somewhat arbitrary. In the chart above we used 2013 to 2023.¹ However, as shown by the figures below we obtain the same positive relationship when using the 1990s or 2000s.



Note: Partner countries growth of trade volume (imports + exports of goods) with Switzerland is plotted against their GDP growth (measured in constant local currency). Sources: FOCBS – Trade statistics, IMF World Economic Outlook April 2024 – GDP data.

Absolute Increase

In addition to the analysis of relative growth of GDP and trade volumes, we also study the impact of *absolute* increases in GDP. The chart below again uses the period 2013–2023 but a similar relationship is present for alternative periods.

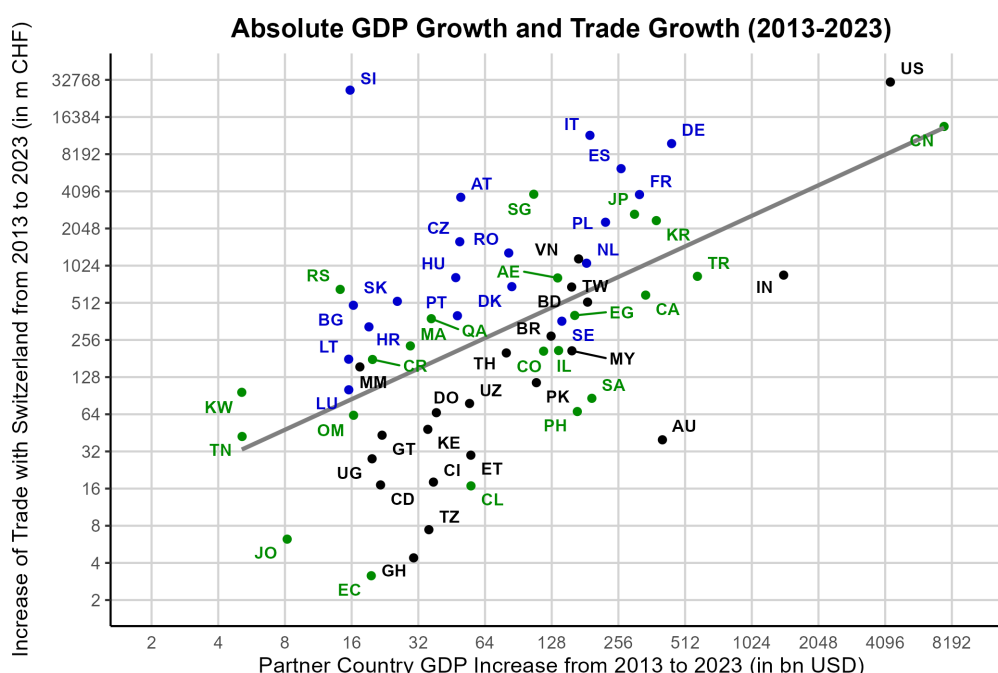
What is particularly noteworthy is that China and the United States contributed by far the most to global economic growth in the recent past. At the same time, none of Switzerland's trade partners witnessed such a large absolute increase in goods trade (again keeping the outlier Slovenia in mind).

¹An important change in the methodology for Swiss trade statistics occurred in 2012 (<https://tinyurl.com/bdz5eu2z>). Hence, we decided to use the decade before the most recent full-year data.

Trade Agreements with the Right Partners?

Free trade agreements (FTA) aim to reduce trade restrictions and therefore increase the trade volumes between the participating countries. In the case of Switzerland they can improve companies' access to export markets. Hence, we can ask whether Swiss trade policy has favored the 'right' partner countries in the past.²

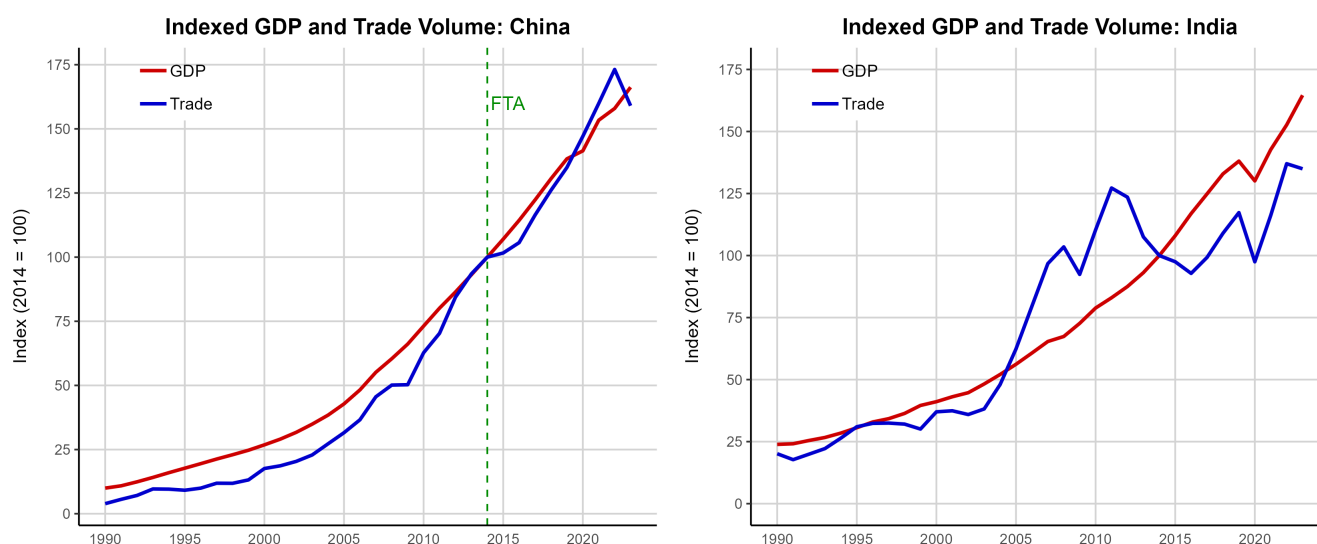
The chart below again plots the absolute increase of partner countries' GDP against the increase of Switzerland's trade volume with them. We colored all nations in green that currently have an FTA with Switzerland in force, EU-27 countries in blue, and the rest in black. It becomes clear that partner countries which have not signed an FTA with Switzerland (shown in black) are mostly below the regression line. The main exception is the United States where we see the largest absolute increase in GDP as well as the largest absolute increase in Swiss bilateral trade volume. Among the countries with high GDP growth, India, Australia, Taiwan, Bangladesh, Thailand, Myanmar, and Pakistan would be next in line for a free trade agreement. The one with India was signed between European Free Trade Association (EFTA: including Iceland, Liechtenstein, Norway, and Switzerland) in March 2024 but is not yet in force.



Note: Partner countries absolute increase in their trade volume (imports + exports of goods) with Switzerland is plotted against the absolute increase in their GDP growth (measured in current US Dollar). Countries that currently have an FTA with Switzerland in force are colored in green, EU-27 countries in blue. Sources: FOCBS – Trade statistics, IMF World Economic Outlook April 2024 – GDP data.

²For further information on the criteria for the prioritization of trade partners, see the chapter “Strategic Areas of Action” (in particular p. 37 et seqq.) in the foreign economic policy strategy of Switzerland (<https://www.seco.admin.ch>).

When looking at individual countries, their development of GDP and trade with Switzerland, we chose China and India as illustrative examples. While both are among the top-3 regarding absolute increase in GDP, China has an FTA with Switzerland in force since 2014. Since then, the Chinese economy has grown by more than 50 percent, similar to the Indian one. However, while Swiss-Chinese bilateral trade increased more than 50 percent, Swiss-Indian goods trade is up less than 40 percent.



Note: The GDP and trade volumes are both indexed to 100 in the year 2014 when the Chinese FTA came into force. GDP is measured in constant local currency. Source: FOCBS – Foreign Trade Statistics, IMF World Economic Outlook April 2024 – GDP figures.

Conclusion

The gravity model shows that the bilateral trade volume between two countries tends to (i) increase with trading partners' GDP and (ii) decrease in the distance between the two countries. For Switzerland, this report documents the two relationships empirically — both in a *static* and *dynamic* way. While Switzerland trades relatively large volumes with close and sizeable economies, our empirical analysis also illustrates the positive effect of an increase in partner countries' GDP on the volume of bilateral trade. In this sense, Switzerland benefits from economic improvements around the world: Swiss companies can produce locally but sell globally.

For policymakers we highlight that FTAs can improve market access and thus foster bilateral trade. Choosing the right partners for FTAs can be supported by analyzing other countries' economic development. Our analysis suggests that after signing an FTA with India, Australia, Bangladesh, the US, or Thailand are worth considering when expanding the FTA network.³

³Switzerland currently negotiates FTAs with a variety of countries: <https://tinyurl.com/vwpzpad3>

Appendix I: Trade Partner Abbreviations

ISO	Country	ISO	Country	ISO	Country
AE	Arab Emirates	GR	Greece	NI	Nicaragua
AF	Afghanistan	GT	Guatemala	NL	Netherlands
AL	Albania	GU	Guam	NO	Norway
AM	Armenia	HK	Hong Kong	NP	Nepal
AO	Angola	HN	Honduras	NZ	New Zealand
AR	Argentina	HR	Croatia	OM	Oman
AT	Austria	HU	Hungary	PA	Panama
AU	Australia	ID	Indonesia	PE	Peru
AW	Aruba	IE	Ireland	PH	Philippines
AZ	Azerbaijan	IL	Israel	PK	Pakistan
BA	Bosnia-Herzeg.	IN	India	PL	Poland
BD	Bangladesh	IQ	Iraq	PS	Palestine
BE	Belgium	IR	Iran	PT	Portugal
BG	Bulgaria	IS	Iceland	PY	Paraguay
BH	Bahrain	IT	Italy	QA	Qatar
BL	St Barthélemy	JM	Jamaica	RO	Romania
BO	Bolivia	JO	Jordan	RS	Serbia
BR	Brazil	JP	Japan	RU	Russia
BS	Bahamas	KE	Kenya	SA	Saudi Arabia
BW	Botswana	KG	Kyrgyzstan	SB	Solomon Islands
BY	Belarus	KH	Cambodia	SD	Sudan
CA	Canada	KR	South Korea	SE	Sweden
CD	Congo (RDC)	KW	Kuwait	SG	Singapore
CG	Congo, Rep. of	KY	Cayman Islands	SI	Slovenia
CI	Côte d'Ivoire	KZ	Kazakhstan	SK	Slovakia
CL	Chile	LA	Laos	SM	San Marino
CM	Cameroon	LB	Lebanon	SN	Senegal
CN	China	LK	Sri Lanka	SV	El Salvador
CO	Colombia	LT	Lithuania	SX	St Maarten
CR	Costa Rica	LU	Luxembourg	SY	Syria
CU	Cuba	LV	Latvia	TG	Togo
CY	Cyprus	LY	Libya	TH	Thailand
CZ	Czechia	MA	Morocco	TM	Turkmenistan
DE	Germany	MD	Moldova	TN	Tunisia
DK	Denmark	ME	Montenegro	TR	Türkiye
DO	Dominican Rep.	MG	Madagascar	TW	Taiwan
DZ	Algeria	MH	Marshall Isl.	TZ	Tanzania
EC	Ecuador	MK	North Macedonia	UA	Ukraine
EE	Estonia	ML	Mali	UG	Uganda
EG	Egypt	MM	Myanmar	US	USA
ES	Spain	MN	Mongolia	UY	Uruguay
ET	Ethiopia	MO	Macau	UZ	Uzbekistan
FI	Finland	MT	Malta	VE	Venezuela
FO	Faeroe Islands	MU	Mauritius	VG	Brit. Virgin
FR	France	MV	Maldives	VI	Amer. Virgin
GB	United Kingdom	MX	Mexico	VN	Vietnam
GE	Georgia	MY	Malaysia	XK	Kosovo
GF	French Guiana	MZ	Mozambique	YE	Yemen
GH	Ghana	NE	Niger	ZA	South Africa
GP	Guadeloupe	NG	Nigeria	ZW	Zimbabwe

Appendix II: Switzerland's Free Trade Agreements

Year	Country/Region
1960	EFTA Convention
1973	European Community (EC)
1992	Turkey (modernized agreement in 2021)
1993	Israel
1995	Faeroe Islands
1999	Palestinian Authority
1999	Morocco
2001	Mexico
2002	North Macedonia
2002	Jordan
2003	Singapore
2004	Chile
2006	Tunisia
2006	Republic of Korea
2007	Lebanon
2008	Egypt
2008	Southern African Customs Union (SACU) includes: Botswana, Eswatini, Lesotho, Namibia, and South Africa
2009	Canada
2009	Japan
2010	Albania
2010	Serbia
2011	Colombia
2011	Peru
2012	Ukraine
2012	Montenegro
2012	Hong Kong
2015	Bosnia-Herzegovina
2014	Gulf Cooperation Council (GCC) includes: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE
2014	China
2014	Central American States includes: Panama and Costa Rica
2018	Georgia
2018	Philippines
2020	Ecuador
2021	United Kingdom
2021	Indonesia
2023	Moldova (signed, yet to enter into force)
2024	India (signed, yet to enter into force)