A Macroeconometric simulation tool for long-term international travel demand

User’s manual and illustration for Switzerland

Long-run Economic and Demographic Influences
on International Tourism (LORINT) project

Thomas Davoine, Ronald Sone

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Part A

The simulation tool (user's manual)

A.1 Goal

The objective of the tool is to investigate the long-run impact of future demographic, key macroeconomic, and selected environmental trends on international travel demand over time. Specifically, the future demographic trends are population size and age structure of the population in departure countries. The age structure is measured with two indicators: the old-age dependency ratio (OADR) and the young-age dependency ratio (YADR). The first indicator is defined as the number of people 65 years old or older divided by the number of people aged between 15 and 64 years. This ratio is frequently used to investigate the impact of increasing life expectancy on the economy. The second indicator is defined as the number of people who are 14 years old or younger divided by the number of people aged between 15 and 64 years. It is often used to investigate the impact of fertility variations. Together, the two ratios capture the impact of population ageing, the fact that there are more and more older people in society and fewer and fewer younger people, due to life expectancy gains and drops in birth rates (e.g. Weil, 1997).

The macroeconomic trends are gross domestic product (GDP) per capita in the departure country and relative prices between departure and arrival countries. A third, related trend used in the simulation is the growth rate of GDP per capita, which is calculated from the first trend. Other macroeconomic factors are known to influence the demand for international travel, such as GDP per capita in the destination country, which provides an indication of the quality of the tourism infrastructure (e.g. Fourie, and Santana-Gallego, 2011). These additional trends are excluded to keep the simulation tool user-friendly. The selected environmental trend is the average yearly temperature in the destination country. On average, tourists prefer to travel to warmer countries (e.g. Klenosky, 2002). Current and future changes in the environment may influence tourism in other ways, which are still hard to grasp and even more difficult to predict. For instance, a rise in sea levels may change coastlines and potentially affect summer beach tourism. Given the novelty and uncertainty about future environmental changes and tourism, more refined indicators other than temperature are excluded from the tool.

A.2 How the tool is built

The tool relies on econometric analyses investigating the impact of the selected long-run trends on international travel. These analyses deliver what is called elasticity. For instance, the elasticity with respect to GDP per capita answers the following type of questions: If GDP per capita in the departure country increases by 10%, how much will international travel out of this country increase?

The following table provides the values of elasticities found in the econometric analysis (Davoine, 2024) and used in the simulation tool:

Elasticity	Value
GDP per capita in departure country	0.739
GDP per capita growth in departure country	-0.019
OADR in departure country	1.041
YADR in departure country	-0.309
Relative prices destination / departure countries	-0.048
Average temperature in destination country	0.145

The first value in the table implies that a 10% increase in per capita GDP in a departure country will lead to an increase of 0.739 x 10% = 7.39% in international trips out of that country. Note that the tool allows the user to change the value of such parameters.

The tool combines elasticities with projected demographic, macroeconomic and environmental trends. These trends need to be provided as inputs to the tool and may come from any source chosen by the user of the tool. The United Nations provides for instance trends on OADR and YADR, using assumptions on future fertility, mortality and migration. Part B of this document will provide other illustrative sources. The precise mechanism to combine elasticities and trend information is described in the associated econometric analysis (Davoine, 2024).

Combining the elasticities and trends delivers a projection of future travels out of each departure country. From these projections, the variation of travel is computed, compared to current travel flows for each departure country. This variation is applied to the current travel volumes between each departure and destination country, assuming travelers do not change their current preferences. For instance, if today 10% of international travels from country A go to country B, the tool assumes that it will remain so in the future.

A.3 How to use the tool

The simulation tool is prepared in MS Excel format and covers 168 countries (or territories) in the world as departure or destination countries[1]. The tool allows users to modify future trends based on inputs for the period between 2025 and 2070.

A.3.1 Inputs

To capture the selected demographic, macroeconomic and environment trends, the following inputs need to be provided to the tool:

Trend	Excel tab	Units
GDP per capita in departure country	GDPpc	USD per people (in real, PPP terms)
OADR in departure country	OADR	Percent (ex: 32 for a ratio of 32%)
YADR in departure country	YADR	Percent (ex: 15 for a ratio of 15%)
Population size	Population	Million people
Relative prices in destination country	RPO	Average prices relative to the US (in real, PPP terms)
Average temperature in destination country	Temperature	Degree celsius

There are three further optional input tabs. The associated "GDP per capita growth in departure country" trend can also be provided as input (in the "GDPgr" tab of the tool), but it is not necessary. By default, the tool calculates this trend directly out of the "GDPpc" tab. This input is provided as a percentage (for instance, 3 for a 3% growth rate, not 0.03). The initial international travels, for year 2025, are provided in the "TRIPS0" tab. The current values in the tool correspond to the measurements preceding the COVID-19 crisis, namely the 2018 flows provided by the UNWTO. The values can be changed by the user if desired. This input is provided as the number of international travels from one country to another. Finally, the elasticity values used in the simulation (see A.2) are provided in the "Parameters" tab. In principle, these values are not intended to be changed by users, although it is possible to do so.

Most inputs are provided for each of the 168 countries in the sample and each year between 2025 and 2070. The "TRIPS0" input has a different format, with departure countries listed in the first column and destination countries listed in the first row.

Inputs need to be provided with correct units for simulation outcomes to be meaningful. One restriction needs to be mentioned: negative and zero values should be avoided,

[1] Countries or territories not included in the tool are excluded because data is missing.

except for temperatures, because the econometric model uses elasticities and applies a natural logarithm to inputs, which is undefined for zero or negative values.

If the user wishes to shut down one factor, a value of 1 should be provided in the corresponding input (rather than a value of 0)[2].

A.3.2 Outputs

The outcomes of the simulation are provided in the “ARRIVALS” and “DEPARTURES” tabs.

The projected total number of arrivals into a country appears in columns FR to MD in the “ARRIVALS” tab, for each year.

The projected total number of departures from a country appears in columns AX to CR in the “DEPARTURES” tab, for each year.

Note: The first columns in those tabs (A to FR) are only for calculation purposes and should not be modified.

A.3.3 Other

Advice: Because of the large size of the Excel tool, it can be slow to process information. Choosing the option “Manual workbook calculations” in the “Formula” Excel options allows one to gain some time (pressing the F9 key when one is ready to see outcomes, launching the calculations).

Other tabs: The tabs “2025”, “2026”, in the Excel tool are calculation tabs and should not be modified.

[2] The natural logarithm of 1 is indeed equal to 0. The only exception are temperatures. If a country on average has a temperature below 0 Celsius (for instance Canada), the tool automatically considers that other reasons than warm temperatures motivate travel to such a country and thus ignores the temperature information altogether for the country.

A.4 Limitations

The tool has several limitations.

First, only positive values can be provided for future trends. For example, the tool cannot simulate the impact of an economic crisis (with a drop in GDP per capita and thus a negative growth rate).

Second, the tool assumes that current destination preferences remain unchanged. If 10% of travel out of country A is made towards country B today, one assumes it will still be the case in the future. Whether this assumption is realistic or not is left to the judgement of the tool's user.

Third, the tool is built to investigate the impact of several demographic, macroeconomic and environmental trends on international travel (see A.1). Other factors are known to influence travel decisions, such as the quality of tourist infrastructure, the transportation time and cost, the presence of natural and cultural sights, political stability or corruption (for an overview, Lim, 2006). The tool is designed to investigate no more than the impact of demographic changes, growth or average temperature on international travel. Projections made by the tool should thus not be taken as likely developments: they are intended to estimate the impact of the trends within the scope of the tool, such as quantifying the impact of a change in future (GDP) growth on international travel.

Fourth, the tool is built to investigate the impact on the demand for international travel. The reality of travel also depends on the supply side of the market. It may be that suppliers cannot cope with the increase in demand, for instance, such that actual international travel increases to a lesser extent than what the tool simulates.

Putting all these points together, the user of the tool is urged to make a cautious interpretation of the simulation outcomes. In particular, none of the simulated outcomes should be taken as reliable predictions of future developments. The tool only estimates the impact of a few selected factors on the demand for international travel.

A.5 Disclaimer

The simulation tool is meant to be easy and flexible to use. Simulation outcomes should however be interpreted with care. In case of doubt about the interpretation of simulation outcomes, do not hesitate to contact research experts or the authors of the tool.

The simulation tool is provided "as-is", without any warranty of any kind. Neither the authors of the tool nor their employer shall be held liable for any consequences from the usage of the simulation tool.

Part B

Illustration

This part of the report illustrates the use of the simulation tool and how its outcomes can be interpreted, focusing on Switzerland. It also describes inputs that are used in the simulation, which can be useful for other investigations.

B.1 Investigation goal and approach

The main goal is to define a baseline scenario relying on well-accepted trends produced by reputable sources and investigate the impact on future international travels to Switzerland. The secondary goal will be to investigate which of these trends (demographic, macroeconomic or environmental factors) have the largest impact on future travel decisions to Switzerland.

Once data sources have been identified and used, the simulation tools will deliver the expected outcomes for the baseline scenario. To achieve secondary goals, certain trends are held constant. For example, we will assume the OADR, YADR, and population size stay at their 2025 values indefinitely and compare this result with the baseline scenario.

B.2 Data sources

The baseline trends, as inputs for the simulation, come from standard sources and rely on generally accepted assumptions. The resulting trends can be used for simulation exercises other than those presented in this document. These inputs are included by default in the simulation tool, but users can modify them if needed.

Demographic trends (OADR, YADR, population size) are all taken from the medium variant scenario in the World Population Prospects (United Nations, 2024).

GDP per capita in departure country**:** Future GDP per capita values are constructed in two steps. First, 2025 values are defined as the average between 2014 and 2018 (to remove business cycle fluctuations and avoid the COVID-19 crisis). Second, the same yearly growth (1.47%) is assumed to continue to infinity and is equal to the average growth across OECD countries between 2025 and 2060 forecasted by OECD (2023).

Relative prices in the destination country: Prices in the destination country are given relative to prices in the US. The relative prices between any two countries, or the relative cost of living between the two countries, is measured by the purchasing-power-parity (PPP) conversion factor between the two countries divided by the nominal exchange rate. That measure is also known as the real exchange rate. It is taken from the Penn World Table version 10.0 (variable pl_con) for the year 2019 (Feenstra et al, 2015). It is assumed to remain constant indefinitely (given the uncertainty in the long-run evolution of exchange rates).

For interested readers, the following describes how relative prices in destination countries are used. What matters for travel decisions is the relative prices between the departure and destination countries or the relative cost of living between the two countries. The simulation tool builds this relative price by dividing the input for the destination country (prices in the destination country relative to prices in the US) by the input for the departure country (prices in the departure country relative to prices in the US).

Average temperature in the destination country: It is taken from the Climate Change Knowledge Portal (World Bank, 2025), using the SSP2-4.5 scenario (CMIP6 0.25-degree collection, mean values). As the data is missing for Hong Kong, Macau and Taiwan, the current average temperatures are used for these three destinations and kept constant over time.

Initial travels between countries**:** The number of international trips is given by the number of international arrivals of all travelers from one country into another. It is provided by the UN World Tourism Organization (UNWTO). Inbound travels by foreign temporary and permanent workers are not counted. The initial legs of travels are counted but not the return legs. Values for the year 2018 are taken, as the most recent year unaffected by the COVID-19 crisis.

B.3 Main simulation outcomes

The following table summarizes outcomes of the baseline simulation for two countries selected from the sample, Sweden and Switzerland, between 2025 and 2070:

	International arrivals 2025	International arrivals 2070	Yearly growth 2025-2070
Sweden	12.4 million	33.7 million	2.24%
Switzerland	10.3 million	42.0 million	3.17%

Currently, Sweden is ranked 33rd and Switzerland 36th in the number of international arrivals, compared to other countries in the world. According to the simulations, these two countries are projected to experience different fates over time. By 2070, there should be about 34 million international tourists interested in travelling to Sweden, compared to 42 million interested in Switzerland. Although Sweden currently attracts more international tourists, Switzerland is expected to surpass Sweden in popularity by 2070. The growth differential paints the same picture, with an average yearly growth of 2.2% in Sweden compared to 3.2% in Switzerland.

Switzerland should thus experience a growth in demand similar to the worldwide average, which is significantly higher than the European-wide average[3], at 3.2% versus 2.4%. This should allow Switzerland to maintain its rank, worldwide, dropping only from 36th to 37th. By contrast, Sweden is forecast to drop from its current rank of 33rd to a 2070 rank of 45th.

The main reason for this difference in outcomes is that the two countries receive guests from very different countries. There are, for instance, twice more people living in the US who travel to Switzerland (about 1 million) than Sweden (about 0.5 million). By contrast, there are many more travelers living in Denmark who go to Sweden (2.3 million compared to 57,000 towards Switzerland). Yet, the demographics of Denmark and the US are expected to diverge: the population in Denmark should remain stable at about 6 million people; because of higher fertility rates, the US should continue to grow over time, from its current 350 million people to about 400 million by 2070. This means that the market for international travelers for Sweden is not going to grow much, while that for Switzerland will continue to grow.

Switzerland was the 5th most-visited country by international travelers in the early 1950s. It then experienced a steady decline in the global rankings, falling to the 35th position before the COVID-19 crisis. Most European countries experienced a similar fate (except top-ranked countries like France, Italy and Spain). What the simulations indicate is that demographic and macroeconomics trends should help to halt the decline for Switzerland, but not for all European countries.

[3] Projected growth rates remain well below the 5% growth rate of worldwide international travel between 2010 and 2018 (UNWTO, 2024). Applied over a long period of time, they still lead to sizeable international travel volumes by 2070. It is important to remember that the simulation only provides projections for travel demand, and ignores the supply side of the market. Capacity issues may for instance lead to much lower growth in actual international tourism over the long run. See section A.4 for more.

B.4 Other simulation outcomes

The following table provides the projected average yearly growth rates for the demand for international travel towards different regions and countries between 2025 and 2070, in different scenarios:

Yearly growth 2025-2070	Baseline	Constant demographics	Constant macro-economics	Constant temperature
World	3.18%	1.11%	2.08%	3.16%
Europe	2.42%	1.11%	1.32%	2.40%
Sweden	2.24%	1.11%	1.15%	2.22%
Switzerland	3.17%	1.11%	2.06%	3.14%

Numbers in the "baseline" column are the same as in the previous section and provided for comparison purposes.

The "constant demographics" column shows the predicted growth rates if demographics were constant across all dimensions (OADR, YADR, population size) and if the only changes over time would be macroeconomic and temperature. In that scenario, all countries around the world would experience the same tourism growth, significantly smaller than in the baseline. This scenario shows that demographic changes are key in explaining why tourism growth is expected to be larger in some countries (e.g. Switzerland) than in other countries (e.g. Sweden).

The "constant macroeconomics" column shows outcomes if there were no macroeconomics trends, with constant GDP per capita (and thus zero economic growth). As in the baseline, the fate of countries would differ. The only difference would be slower growth in demand for international travel. Economic growth, as in the baseline, would impact how much tourism demand would increase, but not where.

The "constant temperature" column provides results if global warming stopped such that current temperatures remained constant. Outcomes are essentially the same as in the baseline. The selected environmental trend (variations in average temperature) does not appear to influence the projected outcomes. It is important to note that other environmental trends, such as reduced snowfall, are not included in this analysis and could affect future demand for international travel to certain countries.

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