CONFOEDERATIO, RESEARCH DIVISION (CRD).

ERROR CORRECTION:

Estimating the GDP/PC of European Microstates, 1500-2025AD.

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Abstract.

Some World Bank jurisdictions within Europe, specifically Andorra and Liechtenstein, are missing from the Maddison Project Database, presumably due to their small size and scarcity of data. Using official records and the historiography of these nations, we attempt an estimate of their GDP per capita between 1500 and 2025AD. These are expressed in terms of modern GDP per capita, PPP in 2011\$ (International).

As this is primarily a preliminary estimation paper intended to eventually redress these errors, we do not go about very many fancy figures.

Andorra.

Official data for GDP per capita, PPP as expressed in current International Dollars for Andorra are given by the World Bank and World Health Organisation (GDP per capita, nominal), going back to 1990AD [1] and 1970AD [2] respectively. These measures require standardisation due to obvious differences in metrics, and can broadly be resolved using PPP deflators. This data is shown in the following table:

| Year | GDP nominal per capita (WHO) | GDP (PPP) per capita, current International \$ (World Bank) | WHO GDP Growth Rates | World Bank GDP (PPP) Growth Rates |
|------|---------------------------------|--|-------------------------|---|
| 1970 | 3.239 | | 1,079654214 | |
| 1971 | 3.497 | | 1,206176723 | |
| 1972 | 4.218 | | 1,266477003 | |
| 1973 | 5.342 | | 1,183264695 | |
| 1974 | 6.321 | | 1,134155988 | |
| 1975 | 7.169 | | 0,9974891896 | |
| 1976 | 7.151 | | 1,08404419 | |
| 1977 | 7.752 | | 1,17750258 | |

| 1978 | 9.128 | | 1,294697634 | | | |
|------|--------|--------|--------------|--------------|--|--|
| 1979 | 11.818 | | 1,047469961 | 1,047469961 | | |
| 1980 | 12.379 | | 0,8379513693 | 0,8379513693 | | |
| 1981 | 10.373 | | 0,9264436518 | | | |
| 1982 | 9.610 | | 0,8350676379 | | | |
| 1983 | 8.025 | | 0,9631152648 | | | |
| 1984 | 7.729 | | 1,006080994 | | | |
| 1985 | 7.776 | | 1,332433128 | | | |
| 1986 | 10.361 | | 1,217546569 | | | |
| 1987 | 12.615 | | 1,133967499 | | | |
| 1988 | 14.305 | | 1,06011884 | | | |
| 1989 | 15.165 | | 1,244906034 | | | |
| 1990 | 18.879 | 24.908 | 1,034694634 | 0,984021198 | | |
| 1991 | 19.534 | 24.510 | 1,052011877 | 0,9716850265 | | |
| 1992 | 20.550 | 23.816 | 0,8036982968 | 0,9639737991 | | |
| 1993 | 16.516 | 22.958 | 0,9829861952 | 1,024000348 | | |
| 1994 | 16.235 | 23.509 | 1,136926394 | 1,060615084 | | |
| 1995 | 18.458 | 24.934 | 1,030230794 | 1,064450148 | | |
| 1996 | 19.016 | 26.541 | 0,9652923854 | 1,097208093 | | |
| 1997 | 18.356 | 29.121 | 1,029363696 | 1,032656846 | | |
| 1998 | 18.895 | 30.072 | 1,019423128 | 1,050478851 | | |
| 1999 | 19.262 | 31.590 | 1,134565466 | 1,059132637 | | |
| 2000 | 21.854 | 33.458 | 1,051111925 | 1,102725805 | | |
| 2001 | 22.971 | 36.895 | 1,091245483 | 1,051280661 | | |
| 2002 | 25.067 | 38.787 | 1,287469582 | 1,060845129 | | |
| 2003 | 32.273 | 41.147 | 1,176401326 | 1,03815588 | | |
| 2004 | 37.966 | 42.717 | 1,055259969 | 1,043542384 | | |
| 2005 | 40.064 | 44.577 | 1,065170727 | 1,051035287 | | |
| 2006 | 42.675 | 46.852 | 1,120210896 | 1,01385213 | | |
| 2007 | 47.805 | 47.501 | 1,019140257 | 0,9439590745 | | |
| 2008 | 48.720 | 44.839 | 0,8929392447 | 0,9483485359 | | |
| 2009 | 43.504 | 42.523 | 0,9389941155 | 1,031277191 | | |
| 2010 | 40.850 | 43.853 | 1,060807834 | 1,058901329 | | |

| 2011 | 43.334 | 46.436 | 0,8927170351 | 0,9799078301 |
|------|--------|--------|--------------|--------------|
| 2012 | 38.685 | 45.503 | 1,02204989 | 1,002329517 |
| 2013 | 39.538 | 45.609 | 1,044615307 | 1,06349624 |
| 2014 | 41.302 | 48.505 | 0,8660839669 | 1,045933409 |
| 2015 | 35.771 | 50.733 | 1,047636353 | 1,046853133 |
| 2016 | 37.475 | 53.110 | 1,03975984 | 0,99951045 |
| 2017 | 38.965 | 53.084 | 1,072577955 | 1,040690227 |
| 2018 | 41.793 | 55.244 | 0,9785849305 | 1,040384476 |
| 2019 | 40.898 | 57.475 | 0,9148858135 | 0,9063940844 |
| 2020 | 37.417 | 52.095 | 1,150493091 | 1,138919282 |
| 2021 | 43.048 | 59.332 | | 1,154014697 |
| 2022 | | 68.470 | | 1,047612093 |
| 2023 | | 71.730 | | |
| 2024 | | | | |
| 2025 | | | | |

Table 1. WHO and World Bank GDP data for Andorra and annualised growth rates, 1970-2022AD.

To properly scale these two indices, we annualised the growth rates of World Bank and WHO data and measured the average discrepancy in their growth rates by 3 relevant intervals: pre-COVID discrepancies (1990-2019), pre-GFC discrepancies (1990-2008), and pre-Eurozone discrepancies (1990-1999). These came out to -0,16%; -2,03%; and 1,20% respectively. We decided to use the main pre-Eurozone discrepancy for backcalculating Andorran GDP per capita between 1970-1990 according to WHO growth rates, such that:

 $GDP_{PCyearl\$} = GDP_{I\$}/(growth\%_{WH0} + 1, 19029165\%)$ for 1970 – 1990. This may not be the most optimal way of performing such a calculation, but we take it as a relatively good approximator, given a discrepancy variance over the same time period of 0,007337261312. We then extended I\$ GDP per capita calculations by looking at Modern IMF and UK government reports and estimates for real GDP per capita growth at 1,5% and 1,6% for 2024 and 2025 respectively [3][4]. These calculations yielded the following table result for 1970-1990:

| Year | GDP (PPP) per capita, current international \$ (World Bank) | Year | GDP (PPP) per capita, current international \$ (World Bank) |
|------|---|------|---|
| 1970 | 4.273,373166 | 1980 | 16.332,22798 |
| 1971 | 4.613,765348 | 1981 | 13.685,6128 |
| 1972 | 5.565,016367 | 1982 | 12.678,9491 |
| 1973 | 7.047,965252 | 1983 | 10.587,78007 |
| 1974 | 8.339,608454 | 1984 | 10.197,25261 |
| 1975 | 9.458,416865 | 1985 | 10.259,26204 |
| 1976 | 9.434,668574 | 1986 | 13.669,7806 |
| 1977 | 10.227,59765 | 1987 | 16.643,59447 |
| 1978 | 12.043,02262 | 1988 | 18.873,2952 |
| 1979 | 15.592,07289 | 1989 | 20.007,9358 |
| | | 1990 | 24.908 |

Table 2. Standardised WHO-World Bank GDP (PPP) calculations for 1970-1990AD.

Given the nature of Andorra's small economy and population, reliable economic data for Andorra prior to 1970 is only well-documented up until 1930 by a doctoral thesis from the University of Barcelona: *Desenvolupament econòmic als Pirineus: el clúster bancari andorrà en perspectiva històrica, 1930–2007* [5]. We take the geometric mean of the growth rate in motor vehicle registration, combined electricity production and consumption, aggregate bank deposits, and factor in inflation (given that aggregate bank deposits appear to be presented nominally) to backproject general economic growth to 1929:

| Year | Electricity (Production + Consumptio n, Gwh) | Total Motor Vehicles Registered | Aggregate Bank Deposits (Spanish Pedestas, Nominal) | Annual Growth %, Geomean | Est. GDP per capita, 2025\$I: |
|------|--|---------------------------------------|--|--------------------------------|-------------------------------------|
| 1929 | | 33 | | 1,07407483 | 1.650,781445 |
| 1930 | | 41 | | 1,084150634 | 1.773,062801 |
| 1931 | | 49,5 | 252.000 | 0,9458096108 | 1.922,26716 |
| 1932 | | 58,5 | 186.000 | 1,713542067 | 1.818,098755 |

| 1933 | | 75,5 | 438.000 | 1,085672608 | 3.115,388698 |
|------|--------|---------|-------------|--------------|--------------|
| 1934 | 13,47 | 98,5 | 405.000 | 1,46500931 | 3.382,292172 |
| 1935 | 20,68 | 119,5 | 665.000 | 0,8037279906 | 4.955,089522 |
| 1936 | 11,89 | 132,5 | | 0,835506859 | 3.982,544144 |
| 1937 | 9,98 | 145,5 | 1.228.000 | 0,9143801279 | 3.327,442949 |
| 1938 | 8,96 | 166,5 | | 1,320573437 | 3.042,547709 |
| 1939 | 16,26 | 256,5 | | 1,277995319 | 4.017,907687 |
| 1940 | 34,57 | 361,5 | | 0,9755487462 | 5.134,867214 |
| 1941 | 34,22 | 540,5 | 4.805.000 | 1,052878842 | 5.009,313272 |
| 1942 | 41,3 | 627,5 | 6.617.000 | 0,9685026289 | 5.274,199959 |
| 1943 | 58,17 | 705,5 | | 0,7721145706 | 5.108,076526 |
| 1944 | 44,18 | 726,5 | | 0,8897668971 | 3.944,020313 |
| 1945 | 67,8 | 777,5 | 24.304.000 | 0,8250465544 | 3.509,258716 |
| 1946 | 54,37 | 882,5 | 36.778.000 | 0,5883604338 | 2.895,301812 |
| 1947 | 52,86 | 999,5 | 16.079.000 | 1,099862379 | 1.703,48103 |
| 1948 | 60,7 | 1.139,5 | 42.821.314 | 0,7986392418 | 1.873,594698 |
| 1949 | 66,69 | 1.209,5 | 28.228.103 | 0,9869874143 | 1.496,326249 |
| 1950 | 72,11 | 1.294,5 | 33.902.250 | 1,052173621 | 1.476,855176 |
| 1951 | 85,07 | 1.484,5 | 42.837.658 | 0,9249348593 | 1.553,908057 |
| 1952 | 91,24 | 1.870,5 | 34.662.963 | 1,034569677 | 1.437,26373 |
| 1953 | 99,06 | 2.012,5 | 37.429.463 | 0,9098793831 | 1.486,949473 |
| 1954 | 71,87 | 2.118,5 | 43.363.620 | 1,357290983 | 1.352,944669 |
| 1955 | 103,46 | 2.215,5 | 85.208.854 | 1,063455338 | 1.836,339599 |
| 1956 | 85,47 | 2.343,5 | 145.495.897 | 0,9784658821 | 1.952,86515 |
| 1957 | 80,06 | 2.631,5 | 158.032.916 | 1,057747595 | 1.910,811922 |
| 1958 | 87,97 | 3.000,5 | 215.519.827 | 1,015649708 | 2.021,156714 |
| 1959 | 106,27 | 3.214,5 | 222.383.246 | 1,073836975 | 2.052,787227 |
| 1960 | 135,49 | 3.566,5 | 239.795.935 | 1,005223203 | 2.204,358827 |
| 1961 | 119,08 | 4.043,5 | 299.389.328 | 1,041608407 | 2.215,872641 |
| 1962 | 108,96 | 4.658,5 | 401.034.312 | 1,152741008 | 2.308,071571 |
| 1963 | 136,33 | 5.304,5 | 465.689.182 | 1,072324184 | 2.660,608749 |
| 1964 | 138,62 | 6.131,5 | 529.211.221 | 1,147336022 | 2.853,035107 |
| 1965 | 148,98 | 7.098,5 | 677.707.569 | 1,034232657 | 3.273,389951 |

| 1966 | 134,66 | 8.123 | 771.508.171 | 1,126092823 | 3.385,446787 |
|------|--------|--------|---------------|-------------|--------------|
| 1967 | 151,03 | 8.851 | 942.667.490 | 1,03546577 | 3.812,32733 |
| 1968 | 138,44 | 9.559 | 1.108.732.015 | 1,067519796 | 3.947,534456 |
| 1969 | 143,15 | 10.441 | 1.278.556.682 | 1,014072375 | 4.214,071177 |
| 1970 | 147,82 | 11.388 | | | 4.273,373166 |

Table 2. Andorran economic growth indicators and estimated GDP per capita based on geometrically averaged annual growth rates, 1929-1970AD.



Figure 1. Annualised inflation rate in France vs. Spain from 1929-1970AD; note that Spain has near-decadal resolution instead.

Data for Spanish and French inflation, from which we proxied Andorran inflation in accordance weighted to its share of trade with each nation, was taken from Jonas 2023 and Pikkety and Zucman 2013 respectively [6][7]. More precise Spanish inflation data was also available from de la Escosura's Measuring Worth, though we believed annualised rates from mainly decadal resolution data to be sufficient for this task [8].

Prior to 1929, the Andorran economy appears by demographic standards and written sources to have been primarily agrarian and heavily based on cash crops used in smuggling; in particular, tobacco smuggling - with which cigarettes could pass through to the Spanish economy. There were also a few extant iron forges developed during the course of the mid-18th and early 19th century.

'By the 19th century the population was still only around 4,000-5,000. The shortage of agricultural land meant a Malthusian regime, with emigration becoming necessary whenever the population risked increasing substantially'. - Emerson, pg. 30 [9].

Many works on the topic make mention of a mystical paper by J.M. Bricall entitled *Estructura y perspectivas de la economía andorrana*. Unfortunately, I cannot access it since it was ironically paywalled, leaving us to settle for proxy indicators. Firstly, we have to solve intermittent years between 1900 and 1930, during which the national population was essentially stagnant according to Lahmeyer [10], although Rinschede claims a population decline of ~1400 inhabitants from 1900 to 1930 [11].

Given that the Andorran economy was described as being principally Malthusian and dependent on population and tobacco farming, one can take the Rate of Natural Increase (RNI), as determined by tree ring width, as a good proxy indicator for both agriculture and population, and ergo, economic growth. Indeed, this data for Andorra is available to 1575 [12]. This is implied in the paper as being additive:

'RNI is defined as the birth rate minus the death rate. The number of marriages remains stable and similar in both parishes and confirms overall populations of comparable size. Due to their small size, marriage numbers are, however, fairly low and not very useful for reconstructing total population levels. Conversely, annual RNI data fluctuate to a much larger extent.

By means of a linear fitting function, data from both series can be combined to give a single reconstructed time series that represents a 'pseudo' Andorran parish of comparable population size'. - Jover et al., pg. 102.

Using the equation $\frac{value_{next}}{value_{next}-RNI} = growth_rate$, we can convert this RNI into a normalised growth rate that can then be backmultiplied from our extant \$2.309 GDP per capita estimate for 1900. Taking this RNI growth rate into account yields broadly stable GDP per capita estimates from 1583 to 1900, being broadly in line with a Malthusian, agrarian economy ranging from \$2.149 in 1583 to \$2.309 in 1900. This data is given decadally below due to its relative length:



Figure 2. Estimated RNI-based GDP per capita in current international dollars, alongside RNI and normalised growth rates.

Note that 'Population' refers to Rate of Natural Increase based population and is therefore most similar to a Leslie Matrix based outcome.

| Decade, Midpoint/Nearest Year | RNI | RNI Population | Normalised Growth Rate per annum: | GDP (PPP) per capita |
|-------------------------------------|-------|----------------|---|-------------------------|
| 1580s | 0,96% | 4.624,93 | 0,02% | 2.150,33 |
| 1590s | 1,31% | 4.634,60 | 0,03% | 2.154,82 |
| 1600s | 1,38% | 4.648,42 | 0,03% | 2.161,25 |
| 1610s | 1,59% | 4.662,60 | 0,03% | 2.167,84 |
| 1620s | 1,53% | 4.672,62 | 0,03% | 2.173,86 |
| 1630s | 1,67% | 4.685,27 | 0,03% | 2.180,90 |
| 1640s | 1,69% | 4.697,93 | 0,03% | 2.187,96 |
| 1650s | 1,63% | 4.710,59 | 0,03% | 2.195,02 |
| 1660s | 1,58% | 4.723,26 | 0,03% | 2.202,10 |
| 1670s | 1,64% | 4.735,93 | 0,03% | 2.209,19 |
| 1680s | 1,64% | 4.748,60 | 0,03% | 2.216,29 |
| 1690s | 1,61% | 4.761,28 | 0,03% | 2.223,40 |
| 1700s | 1.54% | 4.773,96 | 0,03% | 2.230,52 |
| 1710s | 1,59% | 4.786,64 | 0,03% | 2.237,65 |
| 1720s | 1,55% | 4.799,32 | 0,03% | 2.244,79 |

| 1730s | 1,52% | 4.812,01 | 0,03% | 2.251,94 |
|-------|-------|----------|-------|----------|
| 1740s | 1,47% | 4.824,70 | 0,03% | 2.259,10 |
| 1750s | 1,45% | 4.837,40 | 0,03% | 2.266,26 |
| 1760s | 1,45% | 4.850,10 | 0,03% | 2.273,43 |
| 1770s | 1,43% | 4.862,80 | 0,03% | 2.280,61 |
| 1780s | 1,44% | 4.875,51 | 0,03% | 2.287,79 |
| 1790s | 1,41% | 4.888,22 | 0,03% | 2.295,00 |
| 1800s | 1,32% | 4.900,93 | 0,03% | 2.302,21 |
| 1810s | 1,36% | 4.913,65 | 0,03% | 2.309,43 |
| 1820s | 1,29% | 4.926,37 | 0,03% | 2.316,65 |
| 1830s | 1,27% | 4.939,10 | 0,03% | 2.323,88 |
| 1840s | 1,26% | 4.951,83 | 0,03% | 2.331,11 |
| 1850s | 1,21% | 4.964,56 | 0,03% | 2.338,35 |
| 1860s | 1,18% | 4.977,30 | 0,03% | 2.345,59 |
| 1870s | 1,15% | 4.990,04 | 0,03% | 2.352,84 |
| 1880s | 1,11% | 5.002,79 | 0,03% | 2.360,09 |
| 1890s | 1,08% | 5.015,53 | 0,03% | 2.367,35 |
| 1900s | 1,00% | 4.966 | 0,02% | 2.308,90 |

Table 3. Decadal RNI-based GDP (PPP) per capita estimates for Andorra, currentinternational dollars.

With this, GDP per capita data has been rectified for Andorra, particularly for the years 1820-2025. This complete data is broadly presented below, although it is also available in appendix form (Appendix 1).

Liechtenstein.

Fortunately, Liechtenstein has relatively better data available than Andorra, particularly from Clio-Infra and the World Bank, so it is not nearly as tough of a nut to crack.

In terms of methodology, data on its GDP (PPP) were not as available, and so we were forced to calculate its GDP PPP by comparing Liechtensteiner CPI to US CPI using base years for which its nominal GDP per capita in PPP were known, since GDP PPP is always equal to GDP nominal for the United States in dollar terms, as it is the base reference country for such datasets. World Bank data given was adjusted to current international dollars.

| Year | GDP per capita, nominal | Liechtenstein GDP growth rate, nominal | Liechtenstein CPI (2017=100) | US CPI (2011=100) |
|------|----------------------------|--|--|-------------------|
| 1970 | 4.262 | 1,139371187 | | 16,85776375 |
| 1971 | 4.856 | 1,162479407 | | 17,83551404 |
| 1972 | 5.645 | 1,289991143 | | 18,60244115 |
| 1973 | 7.282 | 1,135814337 | | 19,21632171 |
| 1974 | 8.271 | 1,249183896 | | 20,40773365 |
| 1975 | 10.332 | 1,096205962 | | 22,67299209 |
| 1976 | 11.326 | 1,096238743 | | 24,73623437 |
| 1977 | 12.416 | 1,405927835 | | 26,14619973 |
| 1978 | 17.456 | 1,127062328 | | 27,84570271 |
| 1979 | 19.674 | 1,0652638 | | 29,96197611 |
| 1980 | 20.958 | 0,9509018036 | | 33,34767941 |
| 1981 | 19.929 | 0,9977921622 | | 37,84961614 |
| 1982 | 19.885 | 0,9964294694 | | 41,7481266 |
| 1983 | 19.814 | 0,9537700616 | 63,71 | 44,29476232 |
| 1984 | 18.898 | 1,041591703 | 66,025 | 45,71219471 |
| 1985 | 19.684 | 1,453566348 | 68,337 | 47,67781909 |
| 1986 | 28.612 | 1,335313854 | 69,203 | 49,34654276 |
| 1987 | 38.206 | 1,08799665 | 69,865 | 50,28412707 |
| 1988 | 41.568 | 0,9514770978 | 70,747 | 52,14463977 |
| 1989 | 39.551 | 1,25046143 | 73,292 | 54,28257 |
| 1990 | 49.457 | 1,027377318 | 76,666 | 56,88813336 |
| 1991 | 50.811 | 1,083564582 | 80,187 | 59,96009256 |
| 1992 | 55.057 | 1,009935158 | 85,075 | 62,47841645 |
| 1993 | 55.604 | 1,149827351 | 87,006 | 64,35276894 |
| 1994 | 63.935 | 1,234206616 | 88,272 | 66,28335201 |
| 1995 | 78.909 | 1,022544957 | 90,595 | 68,00671916 |
| 1996 | 80.688 | 0,9120315289 | 91,139 | 69,9109073 |
| 1997 | 73.590 | 1,064030439 | 91,665 | 71,93832361 |

| 1998 | 78.302 | 1,055937269 | 91,961 | 73,59290505 |
|------|-----------|--------------|---------|-------------|
| 1999 | 82.682 | 0,920236569 | 92,476 | 74,77039153 |
| 2000 | 76.087 | 0,9865942934 | 93,727 | 76,41534015 |
| 2001 | 75.067 | 1,062983735 | 94,605 | 79,01346171 |
| 2002 | 79.795 | 1,129243687 | 95,874 | 81,22583864 |
| 2003 | 90.108 | 1,112886758 | 96,361 | 82,52545206 |
| 2004 | 100.280 | 1,050009972 | 97,304 | 84,42353746 |
| 2005 | 105.295 | 1,084258512 | 98,454 | 86,70297297 |
| 2006 | 114.167 | 1,142992283 | 99,497 | 89,65087405 |
| 2007 | 130.492 | 1,097760782 | 100,182 | 92,51970202 |
| 2008 | 143.249 | 0,8797548325 | 102,231 | 95,20277338 |
| 2009 | 126.024 | 1,119540722 | 101,89 | 98,82047877 |
| 2010 | 141.089 | 1,120328303 | 102,238 | 98,42519685 |
| 2011 | 158.066 | 0,416446295 | 103,563 | 100 |
| 2012 | 148.842 | 1,161117158 | 102,531 | 102,1 |
| 2013 | 172.823 | 1,03420841 | 102,093 | 103,6315 |
| 2014 | 178.735 | 0,9353903824 | 101,919 | 105,289604 |
| 2015 | 167.187 | 0,9891618367 | 100,302 | 105,3948936 |
| 2016 | 165.375 | 1,031274376 | 100,3 | 106,7650272 |
| 2017 | 170.547 | 1,026039743 | 100,9 | 109,0070928 |
| 2018 | 174.988 | 0,9538196905 | 101,5 | 111,623263 |
| 2019 | 166.907 | 0,986603318 | 101,8 | 113,6324818 |
| 2020 | 164.671 | 1,195007014 | 101,3 | 114,9960715 |
| 2021 | 196.783 | 0,9472362958 | 100,9 | 120,4008869 |
| 2022 | 186.400 | 1,057 | 102,6 | 130,0329578 |
| 2023 | 197.028 | 0,9998741275 | 106,9 | 135,3643091 |
| 2024 | 197.000 | 1,0435 | 108,4 | 139,695967 |
| 2025 | 205.569,5 | | 108,4 | 143,0486702 |

Table 4. Liechtenstein GDP per capita, nominal in current international dollars, alongside standardised Liechtensteiner and US CPI deflators.

The only reliable reference years given for GDP PPP unadjusted for inflation were 2007-2009 at \$122.100, \$141.100, and \$139.100 respectively [15]. CPI data was taken from *Liechtensteinische Landesverwaltung* [16] and the Minneapolis Fed for Liechtenstein and the US [17]. Current international dollars were adjusted down to 2011\$ using the equation:

 $GDP_{PPP_{t}} = GDP_{PPP_{anchor}} \left(\frac{Liechtenstein_{CPI(t)}/Liechtenstein_{CPI(anchor)}}{US_{CPI(t)}/US_{CPI(anchor)}} \right) :$ $GDP_{PPP_{t}} (2011\$) = GDP_{PPP_{t}} \left(\frac{Liechtenstein_{CPI}(2011)}{Liechtenstein_{CPI}(2025)} \right) \text{ as standardised to FY2011 International}$ Dollars. This results in the following table:

| Year | GDP (PPP) per capita, current international \$ | GDP (PPP) per capita |
|------|--|----------------------|
| 1970 | 19.772,3001 | 20.695,78257 |
| 1971 | 22.527,98904 | 23.580,17836 |
| 1972 | 26.188,32334 | 27.411,47176 |
| 1973 | 33.782,70514 | 35.360,55577 |
| 1974 | 38.370,88083 | 40.163,0262 |
| 1975 | 47.932,2864 | 50.171,00553 |
| 1976 | 52.543,65812 | 54.997,75538 |
| 1977 | 57.600,39372 | 60.290,67021 |
| 1978 | 80.981,99684 | 84.764,33144 |
| 1979 | 91.271,75789 | 95.534,68474 |
| 1980 | 97.228,49964 | 101.769,6413 |
| 1981 | 92.454,75567 | 96.772,93546 |
| 1982 | 92.250,63056 | 96.559,27651 |
| 1983 | 91.921,24687 | 96.214,50866 |
| 1984 | 91.536,60466 | 95.811,9014 |
| 1985 | 92.242,61539 | 96.550,88698 |
| 1986 | 94.276,39025 | 98.679,65106 |
| 1987 | 95.157,36071 | 99.601,76802 |
| 1988 | 97.447,96612 | 101.999,3581 |
| 1989 | 97.920,80256 | 102.494,2788 |
| 1990 | 98.104,7454 | 102.686,8129 |

| 1991 | 98.862,0166 | 103.479,4531 |
|------|--------------|--------------|
| 1992 | 97.095,51999 | 101.630,4507 |
| 1993 | 97.788,81232 | 102.356,1239 |
| 1994 | 99.277,91153 | 103.914,7727 |
| 1995 | 99.247,30682 | 103.882,7386 |
| 1996 | 101.417,2466 | 106.154,0273 |
| 1997 | 103.759,5087 | 108.605,6868 |
| 1998 | 105.804,3194 | 110.746,0022 |
| 1999 | 106.898,5353 | 111.891,3244 |
| 2000 | 107.792,1093 | 112.826,6335 |
| 2001 | 110.422,6424 | 115.580,0279 |
| 2002 | 112.011,9849 | 117.243,6021 |
| 2003 | 113.229,0203 | 118.517,4802 |
| 2004 | 114.710,7154 | 120.068,3791 |
| 2005 | 116.431,8398 | 121.869,8902 |
| 2006 | 119.128,5012 | 124.692,5015 |
| 2007 | 122.100 | 127.802,7867 |
| 2008 | 123.122,699 | 128.873,2518 |
| 2009 | 128.229,0803 | 134.218,1311 |
| 2010 | 127.281,4409 | 133.226,2313 |
| 2011 | 127.663,4315 | 133.626,0631 |
| 2012 | 131.656,3119 | 137.805,4345 |
| 2013 | 134.204,4618 | 140.472,5979 |
| 2014 | 136.584,5181 | 142.963,8168 |
| 2015 | 138.925,2264 | 145.413,8499 |
| 2016 | 140.734,0605 | 147.307,1672 |
| 2017 | 142.835,0289 | 149.506,2632 |
| 2018 | 145.398,4604 | 152.189,4219 |
| 2019 | 147.579,4373 | 154.472,2633 |
| 2020 | 150.087,5593 | 157.097,5293 |
| 2021 | 157.764,6346 | 165.133,1691 |
| 2022 | 167.562,6488 | 175.388,808 |
| 2023 | 167.416,247 | 175.235,5684 |

| 2024 | 170.382,7887 | 178.340,6651 |
|------|--------------|--------------|
| 2025 | 174.471,9757 | 182.620,8411 |

Table 5. Liechtenstein GDP PPP as converted to FY2011 International Dollars.

Given that Clio-Infra is most associated with the Maddison Project, it appears fitting to use its data for filling in missing entries in the MPD by proxy. In particular, 'Biodiversity naturalness' appears to be a relatively good indicator for GDP per capita growth in Liechtenstein due to it being a proxy for decreasing agricultural land use in exchange for urbanisation and modernisation.



Figure 3. Biodiversity Index in Liechtenstein, according to Clio-Infra. Note its correlation as a proxy for economic growth, apart from a dip between 1950-1990.

We use this measure, alongside urban population growth as a geomean for economic growth; whilst the inverse of agricultural stocks (cattle per capita, cropland per capita, and pasture per capita) were used to measure economic growth from 1950 to 1990 [18]. To verify our back-calculated results, a toy Rosés-Wolf proxy model was constructed from the average estimated GDP per capita of Ostschweiz and Vorarlberg, which compared at \$17.431 to \$19.772 for FY1970, \$6.318,50 to \$6.717,67 for FY1950, and \$1.928,54 to \$3.816,50 for comparison [19].

This latter bit can be explained by the relative neglect of Liechtenstein as a principality compared with its neighbours - the first governor was appointed only in 1861, and royal

visits to the principality were scarce until the end of the Second World War [20]. The Liechtenstein Army had to be disbanded for financial reasons as well by 1868 [21].



Figure 3. Estimated Liechtensteiner GDP PPP per capita, as expressed in 2011 International Dollars from 1500-1970AD, alongside land use and demographic proxies.

Like with previous data, this data is also given decadally for the purposes of brevity, but can be viewed in full in appendix form (Appendix 2). Data was additionally extended from estimates on GDP growth for FY2023 to 2025 [22][23][24][25]:

| Decade, Midpoint/Nearest Year: | GDP per capita, 2011\$1: | Normalised Growth Rate per annum: |
|-----------------------------------|--------------------------|-----------------------------------|
| 1500s | 1.815,44 | 0,56% |
| 1510s | 1.817,47 | 0,57% |
| 1520s | 1.819,5 | 0,58% |
| 1530s | 1.821,54 | 0,59% |
| 1540s | 1.823,57 | 0,60% |
| 1550s | 1.825,61 | 0,61% |
| 1560s | 1.827,65 | 0,62% |
| 1570s | 1.829,69 | 0,63% |
| 1580s | 1.831,73 | 0,64% |
| 1590s | 1.833,77 | 0,65% |

| 1600s | 1.835,81 | 0,66% |
|-------|----------|-------|
| 1610s | 1.837,85 | 0,67% |
| 1620s | 1.839,9 | 0,68% |
| 1630s | 1.841,94 | 0,69% |
| 1640s | 1.843,99 | 0,70% |
| 1650s | 1.846,03 | 0,71% |
| 1660s | 1.848,08 | 0,72% |
| 1670s | 1.850,13 | 0,73% |
| 1680s | 1.852,18 | 0,74% |
| 1690s | 1.854,23 | 0,75% |
| 1700s | 1.856,28 | 0,76% |
| 1710s | 1.858,34 | 0,77% |
| 1720s | 1.860,39 | 0,78% |
| 1730s | 1.862,44 | 0,79% |
| 1740s | 1.864,5 | 0,80% |
| 1750s | 1.866,56 | 0,81% |
| 1760s | 1.868,62 | 0,82% |
| 1770s | 1.870,68 | 0,83% |
| 1780s | 1.872,74 | 0,84% |
| 1790s | 1.874,8 | 0,85% |
| 1800s | 1.876,87 | 0,86% |
| 1810s | 1.878,93 | 0,87% |
| 1820s | 1.880,99 | 0,88% |
| 1830s | 1.883,06 | 0,89% |
| 1840s | 1.885,13 | 0,90% |
| 1850s | 1.887,2 | 0,91% |
| 1860s | 1.889,27 | 0,92% |
| 1870s | 1.891,34 | 0,93% |
| 1880s | 1.893,42 | 0,94% |
| 1890s | 1.895,49 | 0,95% |
| 1900s | 1.897,57 | 0,96% |
| 1910s | 1.899,65 | 0,97% |
| 1920s | 1.901,73 | 0,98% |

| 1930s | 1.903,81 | 0,99% |
|-------|----------|-------|
| 1940s | 1.905,89 | 1,00% |
| 1950s | 1.907,97 | 1,01% |
| 1960s | 1.910,05 | 1,02% |
| 1970s | 1.912,13 | 1,03% |
| 1980s | 1.914,22 | 1,04% |
| 1990s | 1.916,3 | 1,05% |
| 2000s | 1.918,39 | 1,06% |
| 2010s | 1.920,48 | 1,07% |
| 2020s | 1.922,57 | 1,08% |

A final change was made to fix linear interpolation errors with Liechtenstein from 1946-1959 via cubic spline interpolation using GNI records from various other historical sources, which show a nominal figure of 19,3mn CHF in Gross National Income for 1942 from the Statistical Office Switzerland (1945) followed by an 89mn CHF GNI for 1959 utilising cubic spline interpolation [22]. We find a massive jump in GDP (PPP) during this period from \$1.390 per capita to \$6.060 (4,3597x) per capita from 1946-1959 with annual economic growth rates between ~8-15%, broadly in line with the historical record.

In addition to our Rosés-Wolf toy proxy, we also find various government/tourist information sources broadly repeating the same expository line:

'The "Gerätebau-Anstalt Balzers", which opened in 1946, developed into "Oerlikon Balzers", a leading company for vacuum and surface technology. In the 1950s, the country's recently founded industries experienced dramatic growth, with the numbers of employees sometimes increasing fivefold. Some companies developed into internationally successful enterprises in the 1960s, and some even became world market leaders'. - ERIH [23].

As well as: 'Liechtenstein's economy developed significantly from the 1940s onwards. A successful and almost exclusively export-orientated industry emerged. While there was clearly too little labour until the 1940s, by 1950 there was already full employment, so that all jobseekers found work'. - Eurydice; Klaus et al., 'Wege in die Gegenwart' (2012) [24][25].

Brunhart also records high GDP growth over the period, at ~12-14% over the time period from 1955-1956 (and presumably earlier) [26]. Unfortunately, both data series have no figures between 1942 and 1959, so where it is exactly, no one knows, although we can

make a few educated guesses; namely that it was certainly not during World War II during which the country suffered economically and had nearly 7.000 refugees and during which the Historiches Lexikon des Fürstentums Liechtenstein states:

'Die Arbeitslosigkeit hielt bis 1941 an, danach gab es vermehrt Beschäftigung in drei neuen Metallfirmen (Presta, Hilti, PAV), im Reich und in der Schweiz. Presta und Hilti produzierten für die deutsche Rüstung. Das Gesellschaftswesen ging stark zurück und belebte sich ab 1943 wieder. Fluchtort für NS-Vermögen, Raubgut und NS-Funktionäre war Liechtenstein nicht.

Unemployment lasted until 1941, after which there was increased employment in three new metallurgical firms (Presta, Hilti, PAV) in the Reich and Switzerland. Presta and Hilti produced for the German armaments industry. The corporate sector declined sharply and began to be revived from 1943. A refuge for Nazi assets, looted property, and Nazi functionaries, Liechtenstein was not'. - Historiches Lexikon des Fürstentums Liechtenstein [27].

This essentially narrows the period of economic growth to 1946-1954 in the broadest sense, and one assumes that it must have picked up following the Marshall Plan in neighbouring Austria due in principle to the high proportion of refugees as a percentage of the Liechtensteiner population (36,842%) and the fact that much of the disparity between GNI and GDP in the country comes 'largely due to net outflows to foreign workers, and not because MNCs [Multinational Companies] are domiciling operations in the country for financial reasons' [29].

Conclusion.

So where does that leave us? Primarily in hell, as only a masochist would choose Andorra and Liechtenstein as the main topic for which they are to fill in missing data, though all missing Maddison countries that overlap with World Bank jurisdictions need to be filled out to at least 1820AD, and preferably as early as reliable proxy indicators allow. The main reason that one has to do this is to fill in these missing countries on the map for eventual gridmapping and database purposes, as much of a job as data entry may seem.

Given that Maddison has n=27 incomplete countries of the total World Bank dataset, this renders only 2/27 (7,407%) of the incomplete dataset complete for the study years 1820-2025AD. Certainly this means that there must be better pipelines in the future for figuring out missing economic data, though we will attempt our best to be thorough as Eoscala, our economic geostatistical framework is a dataset for the long-term, and so we intend for this to be only the first of a series of papers aimed at filling out these missing jurisdictions.



Figure 4. Estimated Andorran and Liechtensteiner GDP (PPP) per capita and annual growth rates, 1500-2025AD.

As for Andorra and Liechtenstein, we believe that we have done this task as well as one could using available online information, though others may beg to differ. All data used in calculations per year, as well as for proxy indicators, are provided below in appendices.

Appendices.

- Appendix 1: Error Correction Andorra 1500-2025AD
- Appendix 2: <u>Error Correction Liechtenstein 1500-2025AD</u>
- Appendix 3: <u>Error Correction Estimating the GDP Per Capita of European</u> <u>Microstates - 1500-2025AD</u>

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