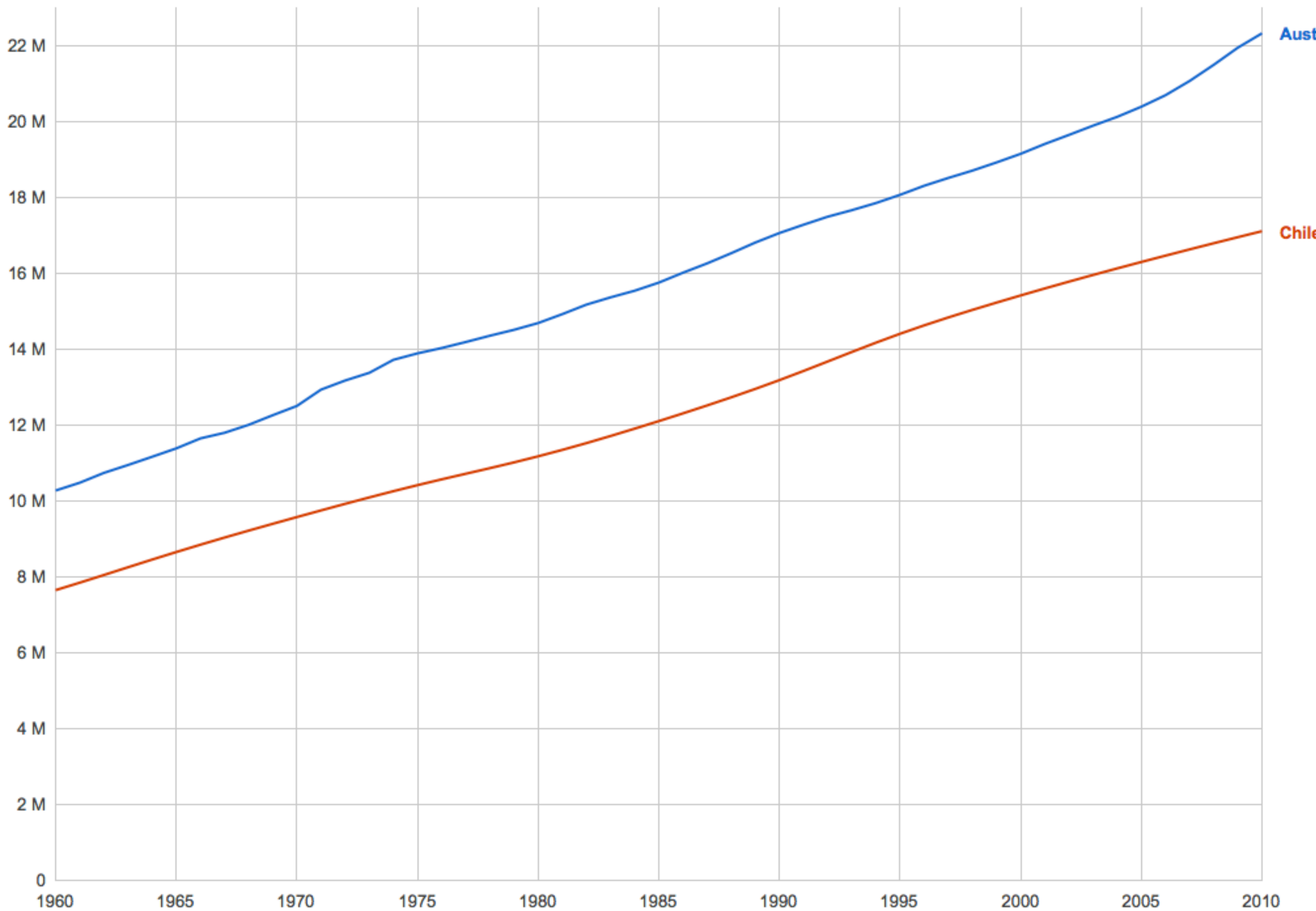


The Potential of Astronomy as a motor of economic development

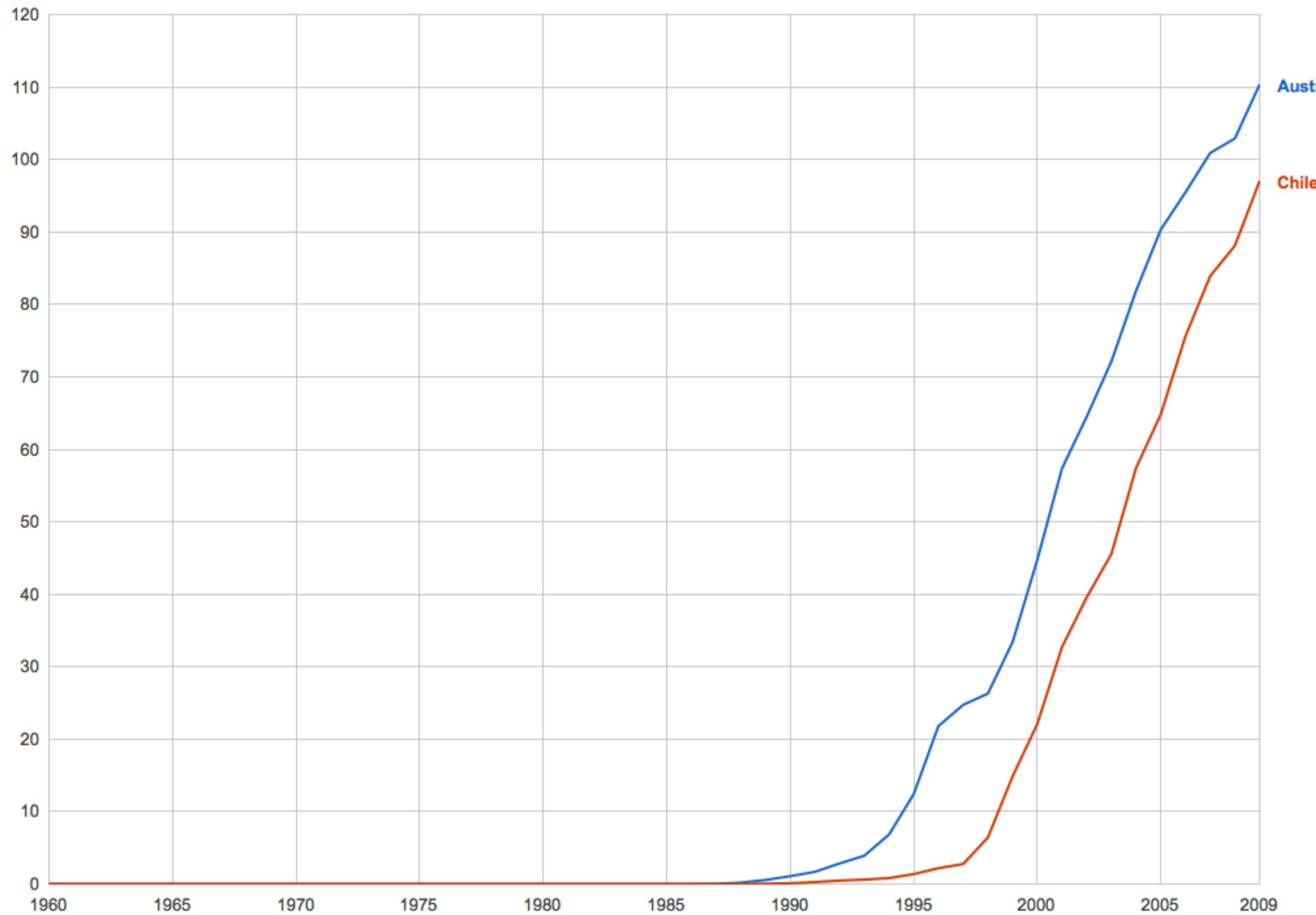
Brian P. Schmidt

Chile and Australia are similar

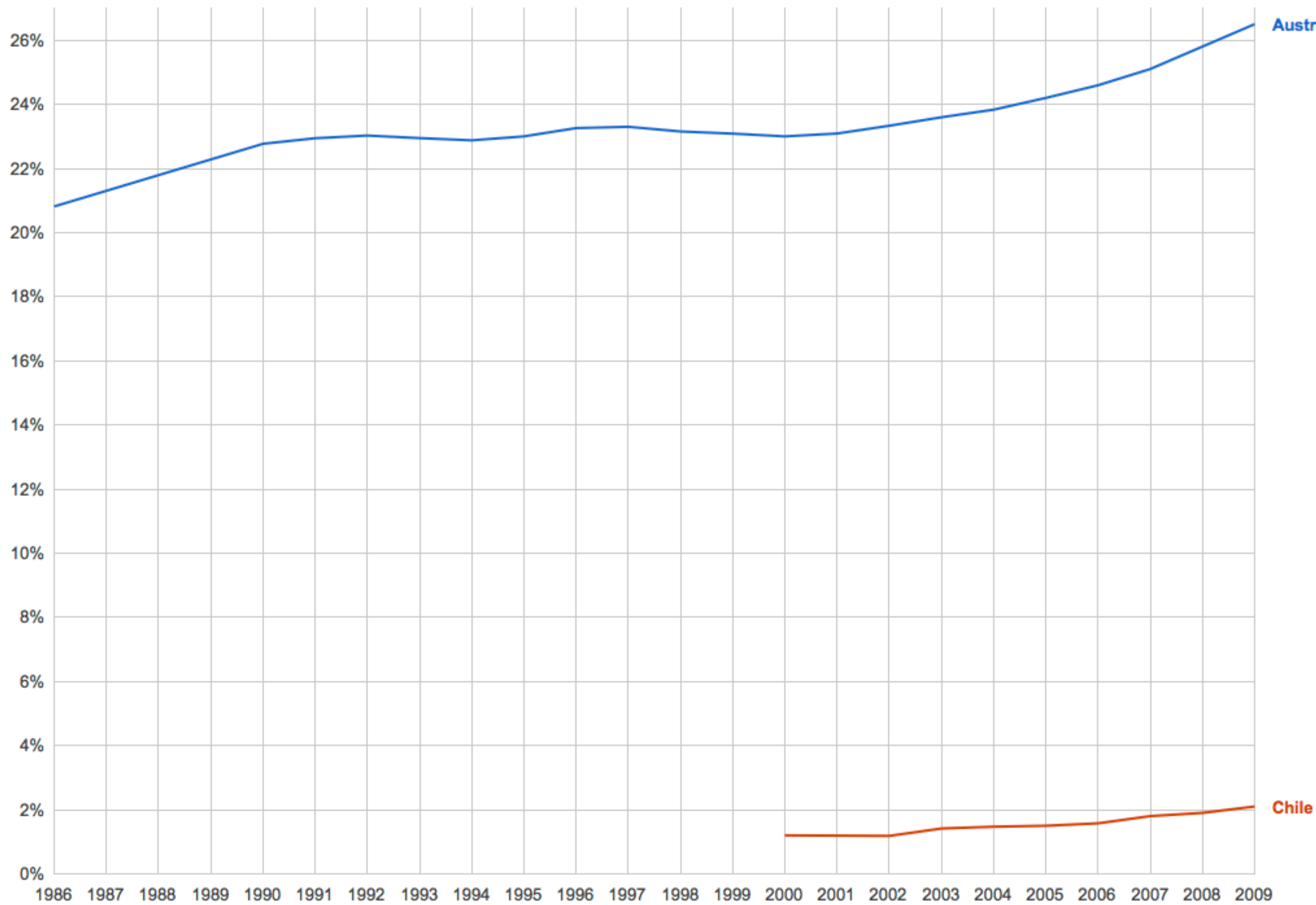
- ✦ Economy dominated by commodities including mining, and agriculture



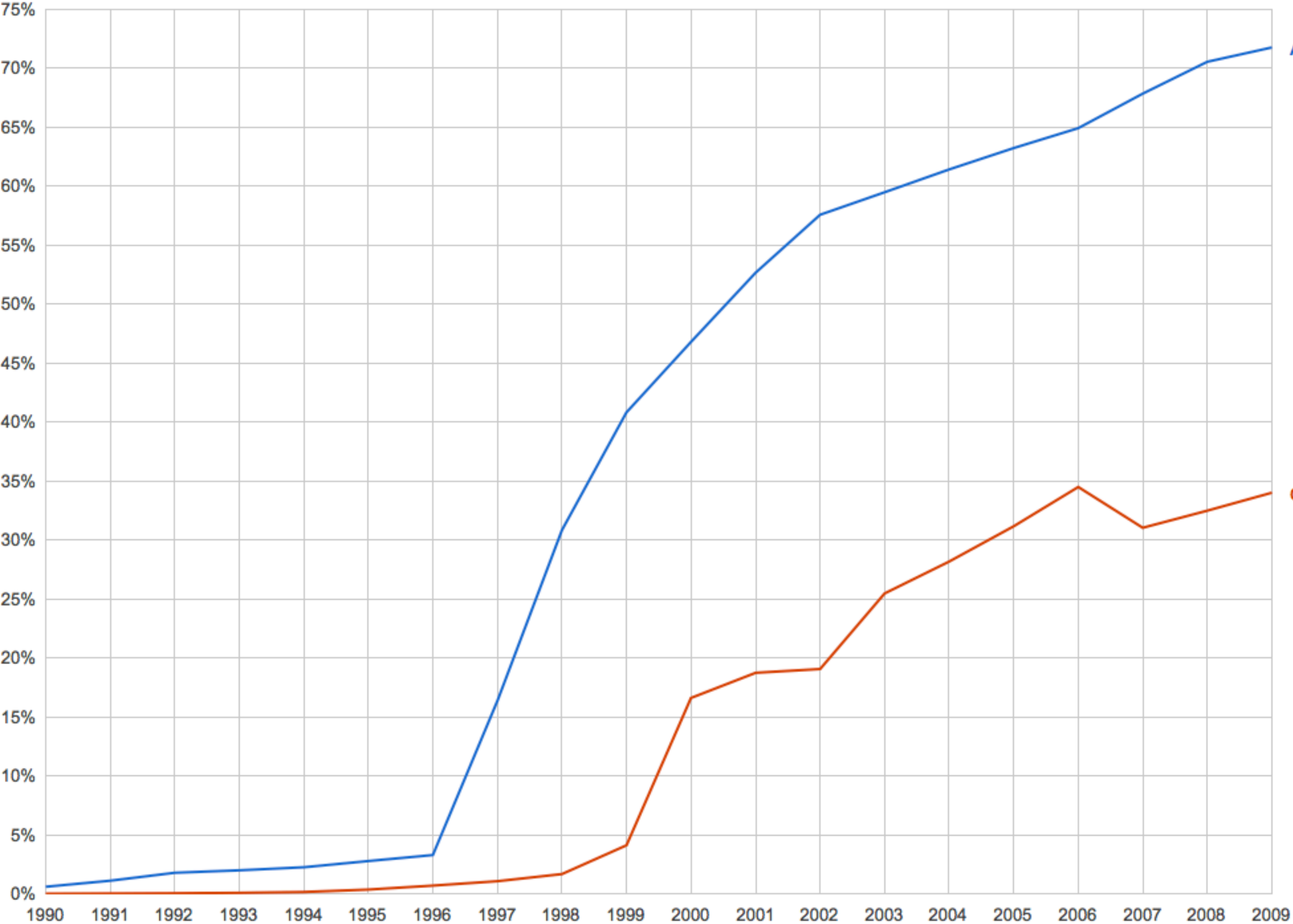
Mobile phone subscribers (% of total population) ?



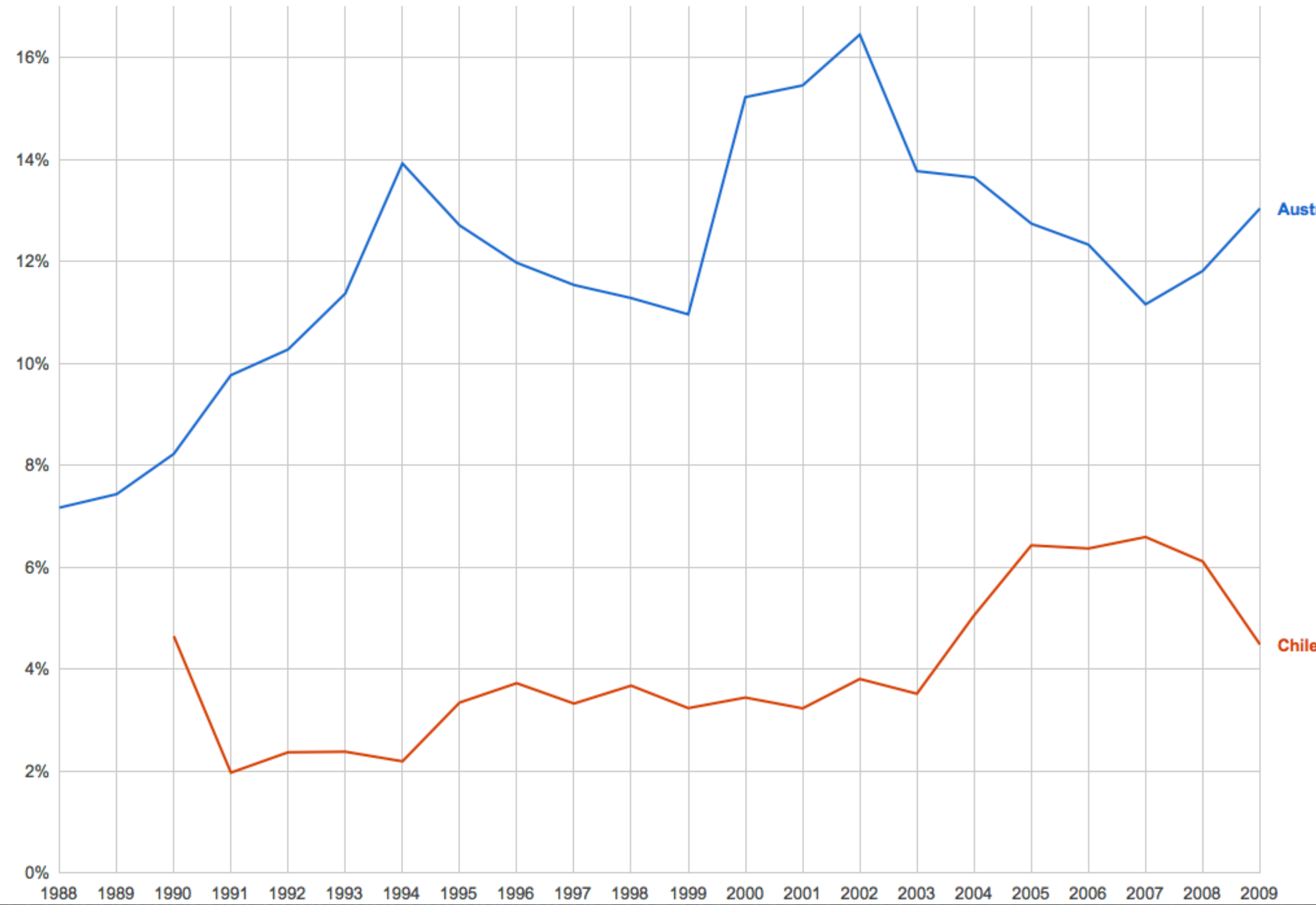
But Chile and Australia are Different

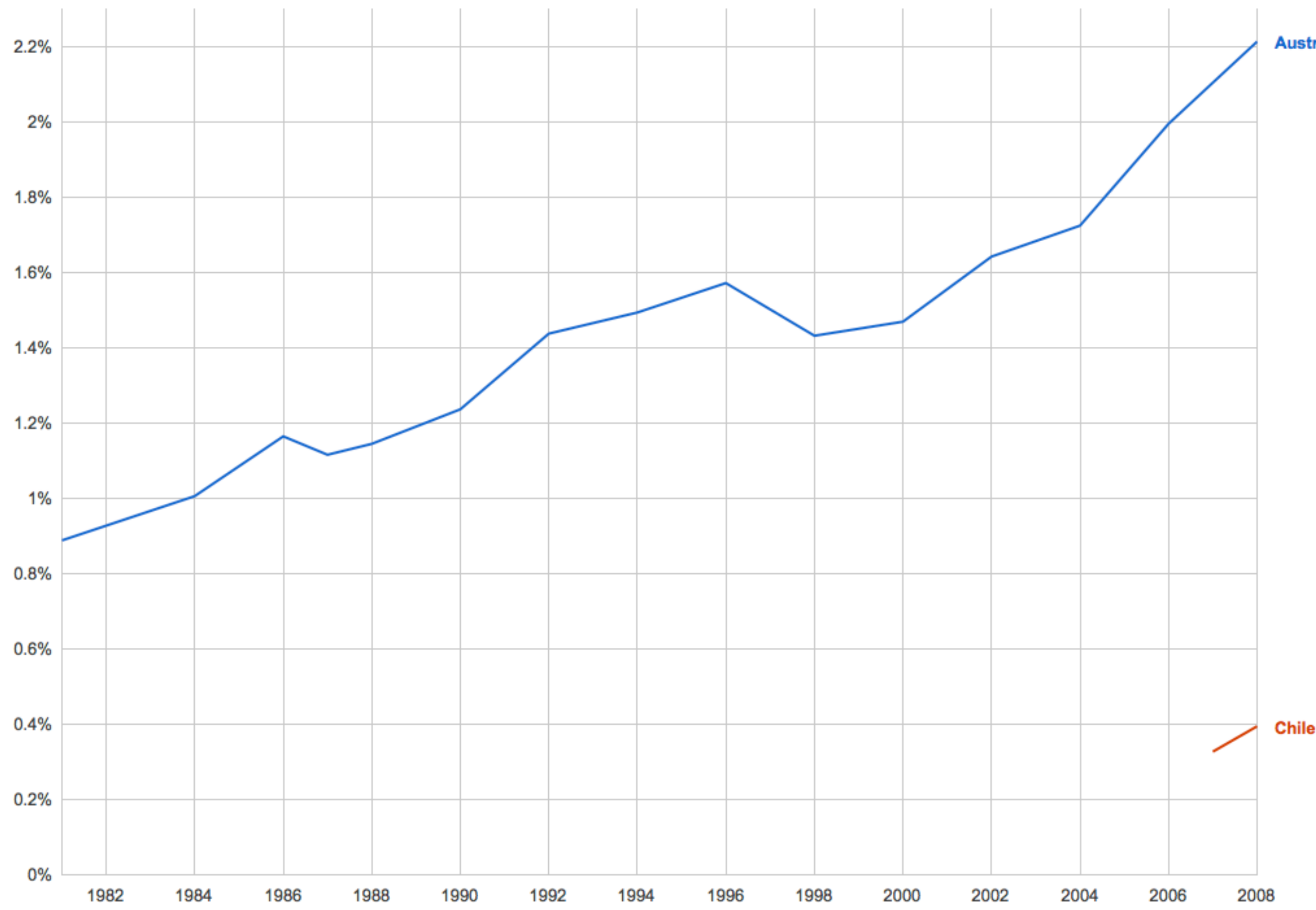


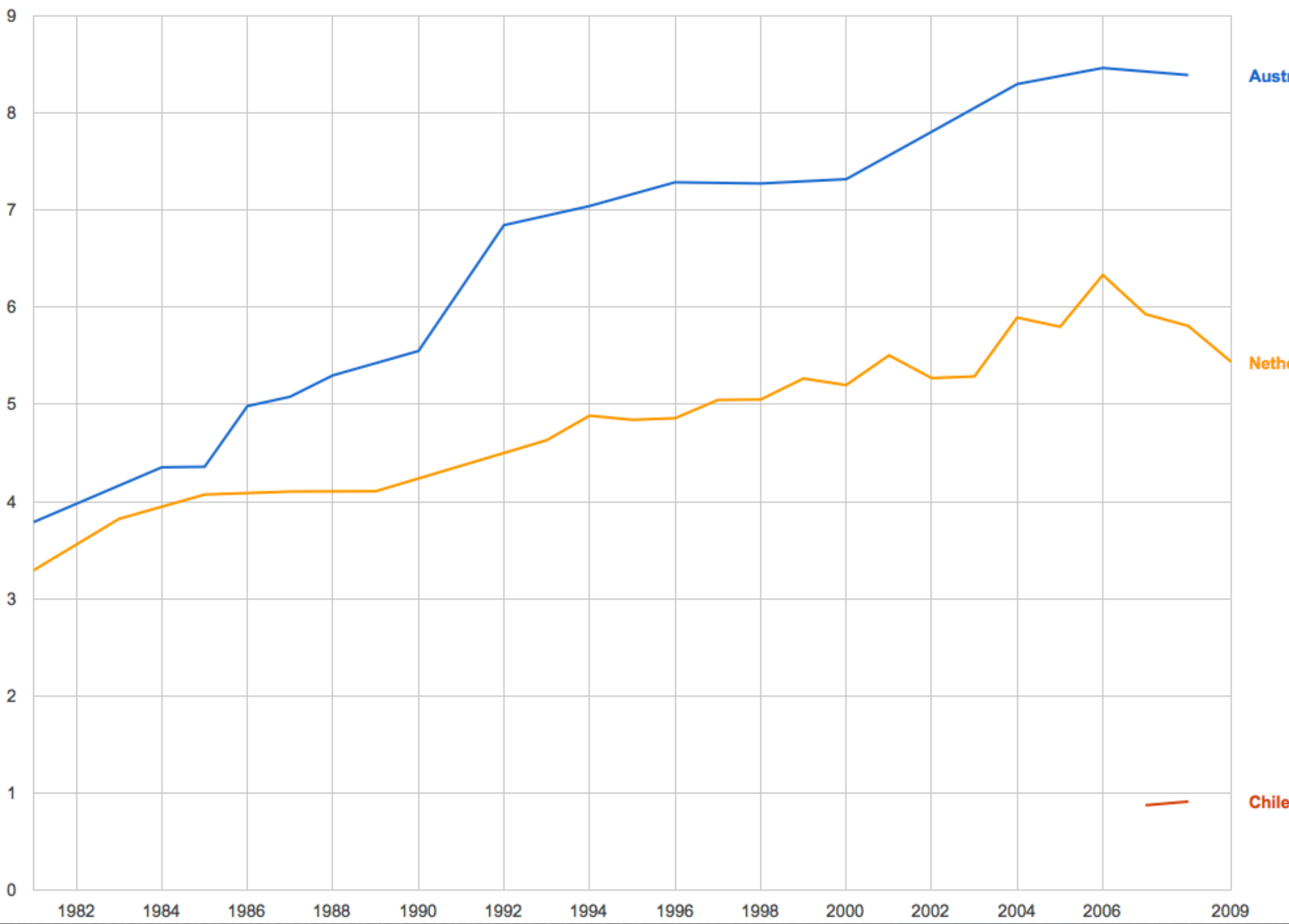
Internet users as percentage of population ?

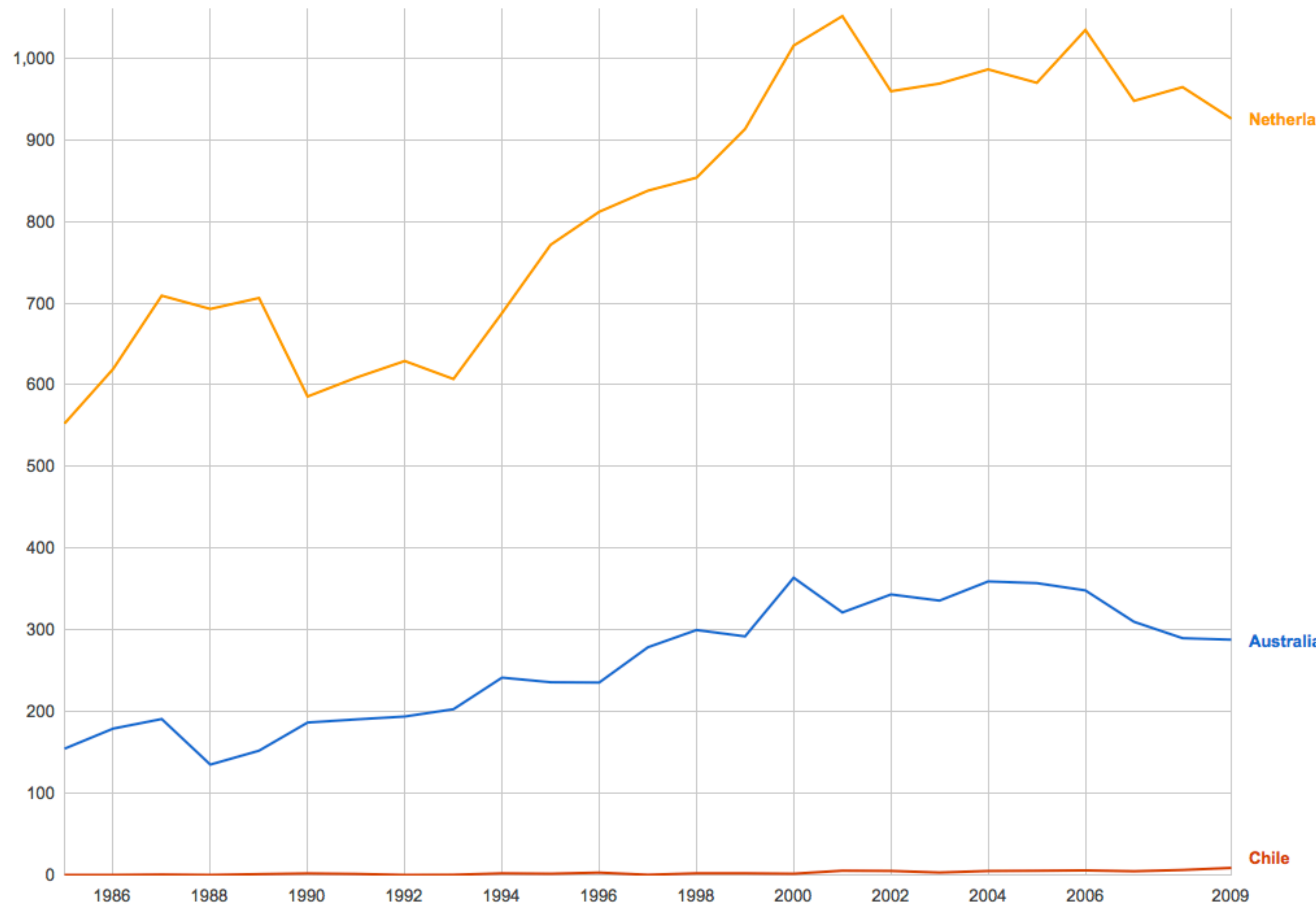


High-tech as % of manufactured exports ?









Astronomy in Australia

- ✧ Astronomical Society of Australia has 600+ members
- ✧ We have 15 institutions which have Astronomy Research undertaken -
 - ✧ 13 Universities,
 - ✧ 2 National Observatories

Astronomy History

- ✦ Birth of Radio Astronomy - CSIRO & Sydney University
1940s - 1960s
- ✦ Optical Astronomy - Mt Stromlo Observatory
1940s-60s
- ✦ Parkes & Anglo Australian Observatory - National
Observatories

Astronomical Infrastructure

- ✦ Radio:
 - ✦ Parkes, MOPRA, Australia Telescope, Tidbinbilla, ASKAP Managed by CSIRO (\$400M)
 - ✦ MWA managed by consortium of Universities (\$25M)
 - ✦ Molonglo managed by Sydney University (\$20M)
 - ✦ AUSSCOPE VLBI array managed by UTasmania (\$40M)

Astronomical Infrastructure

- ✦ Optical Infrastructure:
 - ✦ AAT & Schmidt managed by AAO. (\$60M)
 - ✦ SSO smaller telescopes managed by ANU (\$25M)
 - ✦ other small telescopes managed by Universities (\$5M)
 - ✦ Gemini - (\$20M)
 - ✦ GMT - (\$100M)

Australian Astronomy Governance

- Decadal Plan & MidTerm Reviews
 - Academy of Science - National Committee for Astronomy
- Road Maps, manage astronomical infrastructure financially
 - Astronomy Australia Limited - Non-Profit with all research institutions as stakeholders
- Funding through Australian Research Council, Department of Science (DIISRTE), Universities, CSIRO

Astronomical Instrumentation

- ✦ Radio: CSIRO - ~\$3M recurrent in development. Small University groups: \$0.1M/yr (rest is project funding)
- ✦ Optical: AAO: \$2.5M/ yr in recurrent. ANU: \$1M recurrent
 - ✦ Project funds add between 0 and 4 times recurrent.
- ✦ My view is that CSIRO and AAO groups are sustainable, and ANU group is at risk due to funding droughts. Other groups are transient.

Why Does Australia Build Instruments

- ✦ Australian Astronomy performs highly at the World level
- ✦ This has leveraged several very strong groups in instrumentation who help Australia set its own research agenda, despite its small size.
- ✦ SKA: \$2B telescope - Australia willing to invest in at 15% level for Economic Development & Flagship program

A Few Case Studies

- ✦ VIPAC: Partially Created from members of instrument team at Mt Stromlo
- ✦ VIPAC is a multi-disciplinary technical consultancy specialising in mechanical and systems engineering, testing and instrumentation in a range of industries. We have an international reach with offices across Australia and local presence in South East Asia and the Middle East.

A Few Case Studies

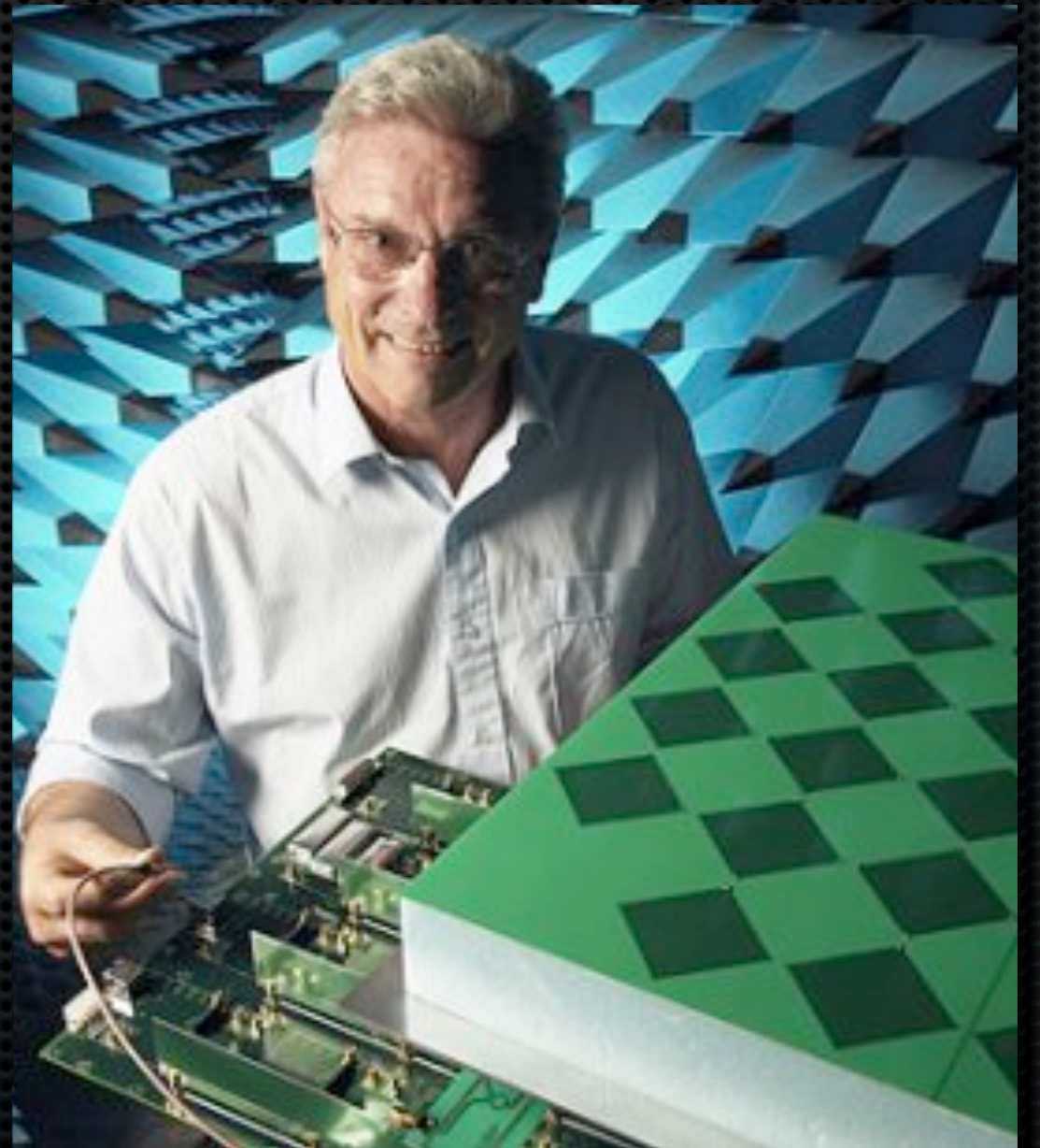
- ✦ AUSpace
- ✦ Largely founded as part of Mt Stromlo's technical program and a satellite program
- ✦ continued to work with us for 2 decades.

A Few Case Studies

- ✦ Radiata (sold to CISCO \$600M)
 - ✦ Set up by CSIRO Astronomers and engineers to develop and promote the 802.11 WIFI standard.
 - ✦ Largest Patent in Australian History - ~\$1B in royalties

The WIFI story

- ✦ John O'Sullivan
 - ✦ Australian Astronomer, Worked in Netherlands for decade
 - ✦ Looked for Evaporating Blackholes predicted by Hawking



The WIFI story

- ✦ Frustrated by doing analog Fourier Transforms, when he returned to Australia he began working on doing digital Fourier Transforms (via FFT) and developed the FFT-on-a-chip in 1987.
- ✦ The did Fourier Transforms Faster than the world's fastest super computer at the time.
- ✦ Used Fourier Transform on a Chip + techniques developed in Radio Astronomy for interference mitigation to develop 802.11 (Patent expires this year)

Other benefits

- ✦ Australia invests in Astronomical Instrumentation primarily to do Astronomy Better...
 - ✦ But provides connection between industry and University
 - ✦ Provides international connections to share technology
 - ✦ trains high-end engineers and scientists in skills useful for industry
 - ✦ Provides a culture and environment for Innovation

Some Key Points

- ✦ Astronomy is not unique as a technology driver
 - ✦ Chile and Astronomy are world leading in the area and that is what makes it special compared to, for example, High energy Physics
- ✦ Innovation is as much about Culture as anything...Innovation culture is essential to gain maximum benefits

My Advice

- ✦ Chile has an opportunity to develop an Astro-engineering group that is world-leading
- ✦ Chilean investment has thus far been organic, but it is time to become strategic, if you wish to become a leader.
- ✦ Non-Strategic investment is expensive for what you get, is risky in terms of delivering against expectations, and unlikely to bring a Long Term Capability to Chile

You want a Long Term Capability, world leading, that spawns an innovative culture and links to industry

My Advice

- ✦ Successful Instrumentation requires a long-term capability of critical mass, supported by a core budget that can be augmented by Project money.
- ✦ This Argues for a Single Group/ Institute with a \$2M/yr budget.
- ✦ Industry Involvement: Joint Appointments with relevant companies, co-location with relevant companies, intern programs from relevant companies [Must be part of the deal, or may not happen]

My Advice

- Strong Leadership - A leader who can lead this effort within the Chilean Scientific Community, negotiate with International Partners, and understands the structures required to be implemented for successful project management.
- Astronomy Innovation Centre needs to be dominated by Engineers with a few key Project Scientists (Astronomers). Detail on Systems Engineering
- Astronomy Innovation Centre requires equipment and facilities dedicated to this effort
- Astronomy Innovation Needs to serve the community and the nation

Patience & Faith Required

- ✦ Astronomical Instrumentation can be successful in Chile - you have the people and the opportunity
- ✦ But development of a Major Capability will take time
- ✦ Innovation requires development of an appropriate Culture and persistence - successes cannot be manufactured or guaranteed - rather they need to become inevitable given the environment
- ✦ Can be a nucleus for Chile Innovation and a template for broader efforts in the future.

