

3 Switzerland

THE DIFFUSION OF INNOVATION

At first sight, Switzerland is hardly a paradise of equality. It is better known for luxury: private banking, ski holidays, and diamond watches. In 2019 the Gini coefficient of household income inequality was 0.316, far below that of the United States (0.375) but well above that of Sweden (0.276).¹

Yet Switzerland is one of the best countries in the world in which to be a worker. While the share of national income going to the labor force has declined in many countries, Switzerland has bucked this trend. The share of pretax income going to the bottom 40 percent of income earners is higher than in Finland or Denmark.² And it achieves this situation without big-state redistribution: government spending is significantly lower in Switzerland even than in the United States, and the state does relatively little to redistribute income.³

Like much else about the country, innovation in Switzerland is unusual. One of the world's most innovative countries, it is one of the few to combine German-style niche production in historic industries with US-style disruptive innovation in radical new technologies. It

has strong domestic firms but also attracts multinationals,⁴ and there are relatively good jobs, even for those without university education. The result is that Swiss income distribution is relatively more equitable *before* taxes than that of other countries. The Swiss model is one of predistribution, not redistribution.

This chapter examines key elements of the Swiss model that allow the diffusion and adaption of innovation and enable Swiss workers to benefit. A combination of technical skills, niche production, and geographically balanced growth allows Swiss workers to derive significant gains from innovation and the use of new technology even if they are not at the cutting edge. Labor regulation and high costs provide powerful incentives for firms to create good jobs. Switzerland is often feted as a highly innovative country, but it also has an institutional structure that helps distribute the benefits.

THE SONDERFALL SCHWEIZ

For a small country with few natural resources, Switzerland is remarkably rich. GDP per capita PPP (GDP based on purchasing power parity) is the fourth highest in the OECD: in 2020 it was just over US \$83,000, behind that of Luxembourg, Norway and Ireland.⁵ Disposable household income is high, despite high prices. This is the special case (*Sonderfall*) of Switzerland.

Underpinning this success is one of the world's most innovative economies. Innovation is hard to measure. But Switzerland regularly ranks first in the Global Innovation Index, produced by the World Intellectual Property Organization. In one scholarly set of rankings, Switzerland comes first in six of eight measures of innovation, and second in the other two.⁶ The country has historic strengths in innovation-intensive niches and more recent strengths in radical innovation and tech. Old, slow-cycle innovation clusters such as Basel's pharmaceutical industry have combined with newer strengths in radical tech in Zurich. The Swiss industrial base is distinguished

by its focus on quality production, and this quality is sustained by innovation.

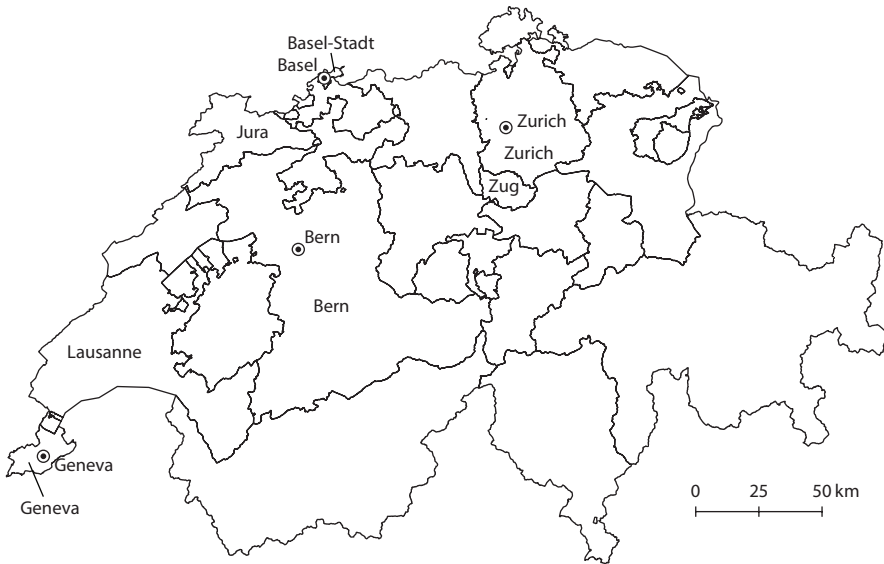
Swiss economic success comes from a diverse set of industries. Major multinational firms include domestic firms such as Nestlé, Novartis, and Roche. But the headquarters of foreign multinationals such as Boots and Glencore are also based there, attracted by the tax advantages offered by some cantons—the semiautonomous states that date to the thirteenth century. The Swiss bankers famous in popular media are important to the economy but not disproportionately so: finance and insurance accounts for around 9 percent of total value added ~~in the economy~~, compared to 8 percent in the United States, the United Kingdom, and Australia.⁷

The great historian of Switzerland, Jonathan Steinberg, links the country's political economy to its geography: it is both at the center of Europe and, because of its mountainous terrain, separate from it. Most of medieval Europe developed feudal societies in which an established nobility owned the land, and a peasantry farmed it in exchange for produce. But this model didn't work in the Swiss mountains. The geography required a form of communalism for people to survive, involving the common maintenance of passes and roads and the regulation of military service.⁸ With distinct topographic boundaries between communities, it was clear how to allocate and share civic responsibilities. The mountains made it hard to import food from elsewhere, giving the peasantry unusual leverage: landowners had no option but to buy local. It was also harder to take isolated communities by force: some valleys were allowed self-rule in a tacit exchange for "peaceful compliance," and others were just seen as impossible to control. This meant that "the sheer variety of Swiss and legal authorities prevented uniform control by elites in any of the cantons which in its turn permitted an explosion of 'proto-industrial' activity in the least likely places." Swiss society developed in smaller units, a cellular structure that remain characteristic of national life.⁹

The herder culture of Swiss society—an "archaic, independent, quasi-aristocratic form of life"—still shapes the Swiss political

economy. It has had two major effects. First, it molded the political system: a highly decentralized structure based on slow-moving, direct democracy that allowed only gradual change. For Steinberg, “What differentiates Swiss history from the European pattern is the outcome. Swiss communities built from the bottom up, growing out of free peasant or urban associations, are in a curious sense bottom-heavy, rather like those dolls which spring up no matter how often the child pushes them over. The weight is at the base. The communities have a deep equilibrium to which, as the point of rest, the social and political order tends to return.”¹⁰ Many of the twenty-six cantons developed from sovereign states. They maintain core powers over tax, health, and education and vary significantly in their size and resources. The principle of subsidiarity means that decisions are made at the most local level possible, and direct democracy means that referenda can change local policy.¹¹ Policymaking is usually slow, local, and consensual. This reluctance to change can be beneficial but has also had some horrific results: after a failed referendum in 1959, it took until 1971 for women to gain the right to vote in federal elections, fifty-three years after they did so in Germany.¹²

The second consequence of Switzerland’s idiosyncratic history and geography is a polycentric economic geography. Historically, cantons were able to defend their economic interests and tailor policy to their specific circumstances. But after the Industrial Revolution, the Swiss economy developed in a distinctive way. The major source of power was coal, which was, to some degree, transportable. Larger countries with lower transport costs often focused on mass production for internal markets, while centralized political systems focused infrastructure investments in a small number of cities. In contrast, Switzerland was already decentralized. Integration into wider European markets helped shape the country’s economic geography: from an early stage there were multiple entry and exit points to the country, meaning that commerce did not focus on a single city.¹³ The mountainous terrain helped encourage a decentralized economy: “The growth of industry had mainly taken the form of small-scale,



Map 1. Polycentric Switzerland.

high-quality production (watches and precision machinery in the Jura and the textile industry of central and eastern Switzerland). There were no natural resources but there was water power. The free, relatively well-educated population and highly developed mercantile communities were an additional strength of the Swiss economy. As a result industry fanned out in small units of production along the rushing streams.” The result of this process was a country with dispersed industrial bases, a strong traditional of local autonomy, and none of the inequality of a feudal system.¹⁴

The economy started to outpace that of neighboring countries as early as the 1700s, when Switzerland underwent a form of industrialization that led to relative, if unevenly shared, wealth. Growing wealth was reflected in the patterns of economic development of the late 1800s and early 1900s, which, as in other countries, was accompanied by urbanization. Christian Stohr, an economic historian at

the London School of Economics and Political Science, identifies three reasons why Switzerland has no single core: a strong federalist structure with no strong central government to draw resources into a capital city, strong transport networks that meant there was no major periphery, and a deeply integrated market and state apparatus.¹⁵

Today Switzerland is still multipolar and decentralized, but it is no longer isolated. High-quality transport infrastructure has made it one of the most accessible nations in Europe.¹⁶ At the same time, Switzerland's unique economic geography has resulted in pockets of specialized production that enable workers throughout the country to gain from Swiss innovation.

Indeed, the small-town location of some Swiss niche production provides advantages. Lower population density requires that firms invest in the skills of their existing workforce rather than rely on the wider labor market and local suppliers, and that they become more purposive and targeted when interacting and collaborating with other firms. Moreover, this geography reduces division between social (or educational) classes in the local economy.¹⁷ The vast majority of Swiss live in the same canton where they work.¹⁸

INNOVATION IN SWITZERLAND: INVENTION, APPLICATION, AND DIFFUSION

Switzerland became prosperous early and has stayed so: it was the world's second richest country between 1880 and 1950.¹⁹ Three key features of the Swiss economy have shaped its economic structure. The first is the lack of raw materials. Unlike countries such as Germany and the United Kingdom, Switzerland lacked the coal needed for mass production.

This lack of resources was exacerbated by a second feature of the Swiss economy: its small size and central geographic location. Because of its size, Switzerland had to trade with its larger neighbors. Several cities served as entrepôts for trade with different countries:

Basel with western Germany and northern France; Geneva with eastern and southern France; Zurich with Germany, and so on. This polycentric structure forced the Swiss economy to focus on niche production. Trade could happen only through quality production, not mass production. The Swiss economy was built, as Steinberg observes, with the aim of “dominating markets rather than lands.”²⁰

Third, Swiss firms have a tradition of sharing new technologies. There was no patent protection in the early period of Swiss industrialization. New technologies did not have the same effect of concentrating production in the hands of the original inventors as they did in other countries.²¹ As a result, technologies could be stolen, reconfigured, and integrated into production across Switzerland. This was ~~an early form~~ of the diffusion of technology. The cellular structure of Switzerland allowed new technologies of production to develop, and lack of regulation meant they diffused through the wider economy.²²

This history has made Switzerland strong in niche production in sectors such as manufacturing, where export-focused, medium-sized firms succeed in international markets. Such *Mittelstand* firms are seen as characteristic of the German economy, but they are also important in Switzerland. One good example of Swiss innovation is G Bopp and Co., a manufacturer of wire mesh—which sounds like a product that should be mass-produced in a way impossible in a high-cost economy such as Switzerland. Founded in 1881, the company still makes wire mesh and gauze, including the mesh that protected the microphone in early iPhones. The company has focused on precision, offering services such as design and prototyping, experimenting with new materials, and technical advice along with manufacturing. This is *Feinmechanik*, precision engineering in niche production.

SWISS WATCHES: INNOVATION FOR ADAPTATION

Two of Switzerland’s historically successful industries are watch-making and pharmaceuticals and chemicals. Both are relatively

research-intensive manufacturing industries, and both have focused on niche production, quality, and innovation to maintain a competitive position.

The Swiss watch is a classic technology, symbolizing luxury production, craftsmanship, and punctuality. It is possible to see the development of the industry in three phases: a slow ascent to dominance, a near-death technological shock, and a clever reinvention as a luxury good. Although clockmaking technology was developed in China, Europe later took the lead, for reasons that remain opaque. Part of the explanation was that Europe had demand: Benedictine monks needed to know when to pray, aristocrats had the money to purchase these prestigious technologies, and Renaissance cities provided an affluent market of busy people whose time was money. The Industrial Revolution supercharged these trends, as industrialists wanted to get a full day's work from their labor forces, and workers eventually wanted to know when they were allowed to stop work.

Yet these were European advantages, not specifically Swiss advantages, and the Swiss became leading producers of timepieces only later. Initially the dominant producers were the English, who introduced the minute hand of the clock—a significant innovation—in the late 1600s. But English clockmaking was focused on small-scale production for the elites and the navy, and the guild system was resistant to change. The Swiss undercut them on price and then quality, leapfrogging them by copying technologies used elsewhere in a manner akin to recent intellectual property issues in Chinese manufacturing (ironically, the Federation of the Swiss Watch Industry's website now has a Trump-like plea to “stop the fakes!”). In the first half of the 1900s the Swiss were major world producers. When other countries stopped production during the Second World War, Swiss neutrality gave them a near-hegemonic position in world markets.

Swiss watch production was localized in the Jura region. The industry was both horizontally and vertically disintegrated, with

multiple small manufacturers producing similar items. Production was small-scale, high-quality, and, apparently, flexible.²³ But while the Swiss watch industry was superb at making incremental improvements, it found it difficult to make giant leaps. So when it was hit by a technology shock—the so-called quartz crisis of the 1970s—it was unable to sustain its position.

In the space of a decade, the state of the art in watchmaking went from mechanical to electronic and then to quartz based.²⁴ This technology shock led to a trade shock, as it allowed new, lower-cost producers in the United States, Japan, and Hong Kong to gain market share. Ironically, quartz watch technologies had been invented by a consortium of Swiss companies in the 1960s. But they were unable to innovate, clinging to old mechanical technologies as new ones came into being. To paraphrase Amy Glasmeier, science replaced art in watch manufacturing.²⁵ The artists didn't adapt.

It took four years to train a Swiss watchmaker, and technology was changing rapidly. Small firms lacked the scale to make major investments in **technology** and the coordination or leadership to make a big jump to a new technology. The Swiss went from a situation of near-global monopoly after World War II to apparent near-extinction in the early 1980s.

Swiss watch companies had to adapt or die, and many closed. But two changes saved the industry. The first was an innovation of sorts—a new form of watch, building on existing technologies, that opened a new market. Two bankrupt Swiss watchmakers merged to form a new company, SMH, later renamed Swatch—a portmanteau of *Swiss* and *watch*—in 1985. The company launched relatively high-quality, mass-market watches in the early 1980s. The innovation was the brand, not the technology. Fashionable, colorful, well-designed Swatch watches reached new markets.²⁶

The second change was new forms of marketing. The problematic characteristics of the Swiss watch—its expense, its reliance on old technology, and its old-fashioned production processes—were repackaged as strengths. This shift in strategy is portrayed in pains-

taking research by Ryan Raffaelli.²⁷ Mechanical watches were portrayed as luxurious and precise. Older production methods were portrayed as painstaking rather than archaic.

The Swiss now dominate the luxury watch market: in 2016 the Swiss produced only 3 percent of watches sold, but these accounted for 60 percent of total value. Swiss watches are technically brilliant, but this isn't the point—few people can distinguish between the timekeeping of a \$20,000 Rolex and a \$20 Timex. Instead they serve as status symbols and holders of value (gold Swiss watches are, apparently, popular bribes in China).²⁸

To some extent, both types of reinvention of the Swiss watch—the mass-market Swatch and the luxury production of firms such as Rolex and Omega—are based on an old technology. But to see them only in this light is to misinterpret the nature of innovation. Both enterprises involved heavy spending on research and development and production processes (luxury watch manufacturers often used this R&D to symbolically distance their products from the failed **products** of the earlier period).²⁹ They involved complementary investments in marketing and manufacturing processes that improved and showcased quality. Soft innovations in branding created real value and helped the industry recover.

PHARMACEUTICALS: NICHE INNOVATION

A second Swiss industry is more classically innovative. Basel, the center of Swiss pharmaceutical production, spans the Rhine, crossed by tourist boats and swimmers towing brightly colored floats. On one shore the dominant building is the Münster, parts of which are over one thousand years old. But the other side is dominated by a modern white skyscraper, the headquarters of Roche—a family-owned Swiss firm that is the largest pharmaceutical company in the world. Novartis, another massive pharmaceutical company, has headquarters is a little way **upriver**. Because of their presence,

the city of Basel has more patents per capita than Silicon Valley and a strong claim to the title of the most innovative city on earth. Yet it remains a good place to live. This is not a story of disruptive start-ups, but one of industrial evolution since Roche was founded in 1896.

The roots of the Swiss pharmaceutical and chemical industry are based in the dyestuff industry of the mid-1800s. Some important inventions from the University of Basel were allowed to spread because there was no patent protection. The city specialized in the production of ribbons, the dyeing of which used technologies complementary to pharmaceutical production. Its position on the Rhine facilitated trade. Yet even in the late 1800s, it was clear that the Swiss industry could not compete with the economies of scale in the much larger German market. Instead, it had to compete through niche products, quality, and novelty. These could be achieved only through innovation.³⁰

Innovation in pharmaceuticals is generally slow. The long timescale of developing, testing, and marketing new drugs makes it harder for companies to enter the market—particularly given the need for skills and the capital-intensive nature of the sector. Returns are skewed, with a few new products or processes creating most of a firm's income. Firms need to place a lot of bets in order for one to come off. Firms such as Roche and Novartis have used innovation as a way of staying ahead of market trends.

These firms are bound to Swiss cities like Basel not by low taxes (or they would be headquartered in a lower-tax canton like Zug), but by the need for skilled workers to produce these innovations. Some parts of the Swiss economy are, of course, anchored in tax competition between the cantons or between Switzerland and other countries. But the representatives of firms I spoke to were clear on why they were located in Switzerland, despite the costs: in addition to the country's long history of innovation in pharmaceuticals, it offers concentrations of skilled workers in cities like Zurich, links to leading research universities, and a system of vocational education.

INNOVATION IN TECH

Pharmaceuticals and watches are classic Swiss industrial strengths, but what marks the country as special is the expansion into newer tech industries. A focus on niche manufacturing understates Switzerland's success in the disruptive, tech-focused forms of innovation: ~~per capita~~ it has one of the highest numbers of unicorn firms per capita of any country in Europe. Zurich has a developing tech scene, with all the costs and benefits that implies. Switzerland is home to the second most important R&D hub for Google, the most important outside the United States. (This facility has not been immune to the recent layoffs in the tech industry: workers walked out in March 2023 in protest at job losses.³¹) Google executives were attracted not only by the city's quality of life but also by the skilled workforce trained at ETH (the Swiss Federal Institute of Technology) and the University of Zurich, and proximity to ETH's research labs. While the country is known for its vocational education, the federally funded ETH is the largest recipient of Swiss "innovation" funding. It is regularly ranked as the best university in Europe and—according to my interviews—has attracted other foreign tech multinationals, such as Facebook and Microsoft.

Switzerland is unusual because it combines radical innovators in high-tech sectors with niche production of domestic small and medium-sized enterprises (SMEs). Given this strength in innovation, it would be natural to assume that Swiss innovation policy is focused, dynamic, and cutting edge. But this assumption would be wrong. The Swiss political system focuses on subsidiarity, with decisions made at the local level, and a liberal economy. The government of Switzerland is focused on concordance and negotiation—often designed to protect the losers from the consequences of change.³² The result is slow policy. Central policymakers are cautious about the fads of innovation policy. The bulk of innovation funding goes to the ETH and the École Polytechnique Fédérale de Lausanne (EPFL). Both institutions are regularly ranked among the best in Europe and often in the top twenty in the world.

In Switzerland, education is tightly integrated with innovation processes: the federal education ministry is called the State Secretariat for Education, Research and Innovation (SERI). Central policymakers in SERI are cautious, open, and well-educated. This is a strategic federal agency, with responsibilities for this policy area largely at the cantonal level. Strategy means choosing what not to do as well as what to do, and the Swiss are skeptical about initiatives such as the “missions” that feature heavily in policymaking in countries like the United Kingdom. The emphasis is instead on education, including vocational education.

SHARED PROSPERITY IN SWITZERLAND

Switzerland is no progressive utopia. The “gnomes of Zurich,” as the British prime minister Harold Wilson described Swiss bankers, have long been seen as shady characters colluding with the world’s richest people to conceal their wealth. Swiss banks profited in the Second World War; the Swiss were slow to make amends and return money to victims of the Holocaust and slow to come to terms with this legacy. Switzerland remains the center of tax evasion and shady finance. Swiss women gained the right to vote shamefully late, and there are still glaring gender disparities. There is a neoliberal side to the Swiss economy that makes some nervous, and tax competition between different places is a problem.

Yet the Swiss economy delivers for most Swiss people. The Gini coefficient of income inequality is below the OECD average. The share of income that goes to the richest 1 percent is below the OECD average, although it is rising. Relatively few workers are low-paid: in 2021, about 12 percent of workers earned less than two-thirds of median earnings, compared to an OECD average of 13.6 percent. (In contrast, in the United States the figure was 22.7 percent.³³)

One useful measure here is household gross disposable income—income adjusted for expenses such as health and education.³⁴ In

2019, Swiss gross disposable income was around US \$42,000 per capita. On this metric Switzerland comes fourth in the OECD—above Norway and below only the United States, Luxembourg, and (by a fine margin) Germany.

The performance of the Swiss labor market has been underpinned by two unusual, related features. The first is that the Swiss haven't suffered the decoupling of wages from national income that has plagued many developed economies. Across the OECD, the share of national income going to employee compensation started to decline in the mid-1990s, falling from around 56 percent of national income to 46 percent in the late 2010s. But Swiss workers have seen their share of income increase in this period—from near the OECD average in 1995 to around ten percentage points higher now. (See figure 5.)

Second, although Switzerland has seen the same decline in middle-skilled jobs as many other advanced economies, that shift doesn't seem to have increased wage inequality. In Switzerland, the period 2008–15 was accompanied by declining employment in jobs paying less than two-thirds of the median wage, and growth in the middle and the top of the earnings range. The country has experienced job upgrading rather than polarization with growth at the bottom.

This trend may be due to the high cost of living (although PPP calculations partially adjust for this). That is, Swiss wages need to be high because the country is so expensive. High prices force firms to adapt and underpin the Swiss focus on niche production. There is no route to mass production in a high-cost economy such as Switzerland's, and policymakers do not attempt to create one. The structure of the Swiss labor market minimizes low-paying jobs. The strong economy keeps job vacancies low and creates demand for less well-educated workers.

There is no Swiss federal minimum wage, but some cantons have introduced one. Wages are regulated more generally through collective bargaining between employers and trade unions. Wages are high by international standards, and this affects the nature of available jobs.³⁵ Finally, the population is highly skilled, particularly in

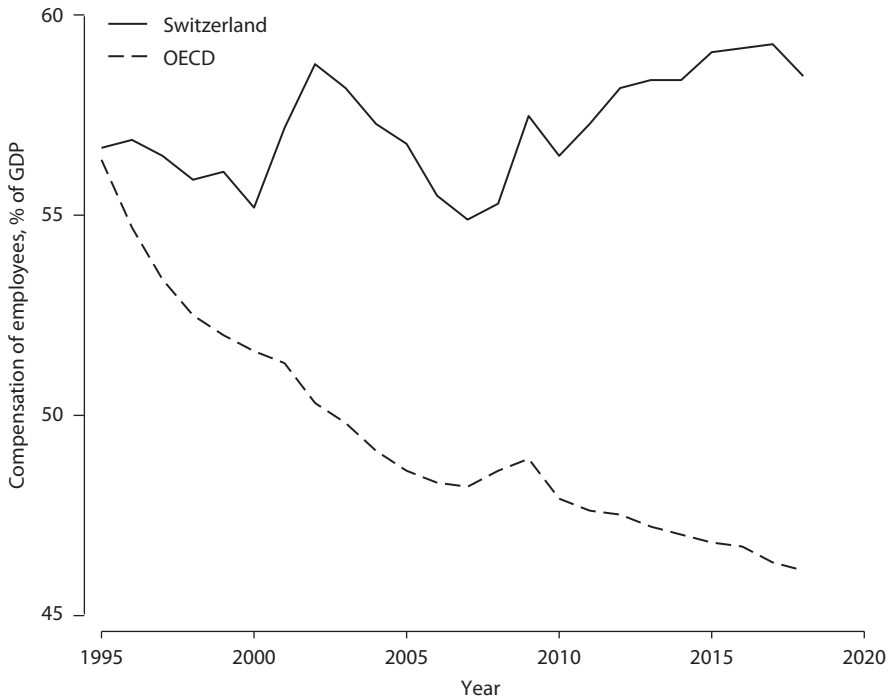


Figure 5. Compensation of employees in Switzerland compared with OECD. *Source:* OECD (2019). *OECD economic surveys: Switzerland 2019*. OECD. <https://doi.org/10.1787/7e6fd372-en>.

mathematics and science.³⁶ Around 43 percent of the labor force have tertiary education, compared to 37 percent across the OECD. And a strong vocational education system means that even those who do not go to university have relatively high skills.

Yet even the Swiss labor market faces the two familiar challenges of advanced economies. There are significant differences in employment and earnings between immigrants and natives. The number of migrants in Switzerland has increased significantly since 2000, in particular because of a process of labor market integration with the European Union that began in 2002.³⁷ Unemployment rates for

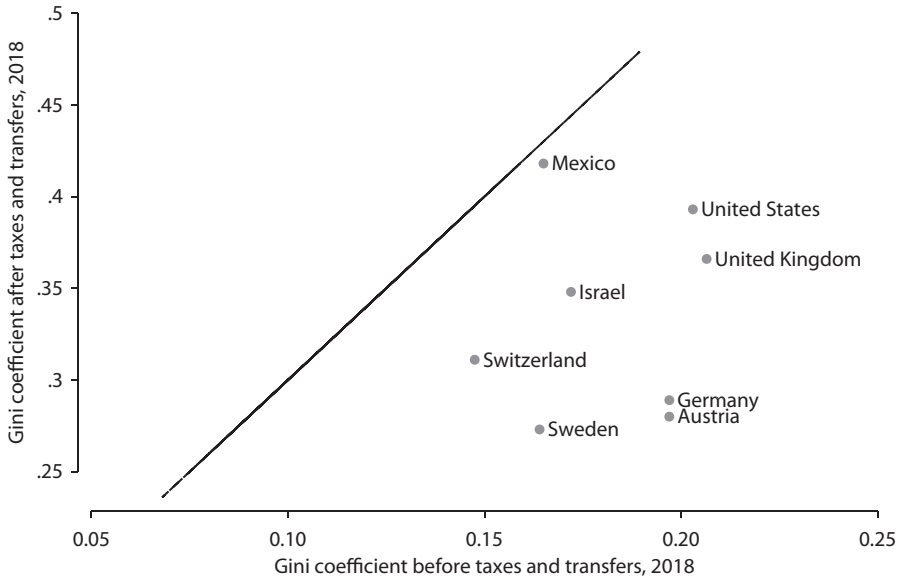


Figure 6. Swiss income inequality before and after taxation. *Source:* OECD (2022). Gross domestic spending on R&D, OECD, <http://stats.oecd.org/Index.aspx?DataSetCode=IDD>.

non-Swiss residents are higher and wages lower, especially for men.³⁸

Alongside this, there are gross gender inequalities. The median income for women in 2021 was 13.8 percent less than that for men, higher than the OECD average but comparable with countries like Germany and the United Kingdom.³⁹ Research by the Swiss government shows a gap of about 18 percent in average monthly pay between men and women. Of this, around 56 percent can be “explained”—if not excused—by factors such as years of service, work experience, qualifications, and sector. But the remainder of the gap likely results simply from labor market discrimination in some form.⁴⁰ It is particularly acute in some sectors, including those that are R&D intensive. Swiss women are underrepresented in STEM fields and in patenting. Only nine out of one hundred Swiss patents

are filed by women inventors, only just below the figure of the United States (9.6), but well below that of France (13.8).⁴¹

The share of national income going to workers is extremely high and has remained so even as it has declined in other economies. Yet Switzerland is not redistributive. The Gini coefficient before taxes is even lower than after transfers are taken into account (see figure 6). This comparison illustrates the Swiss form of predistribution. The Swiss model gives workers the skills to benefit from innovation and ensures that there are good jobs in their location. A process of continual evolution has—so far—helped the country weather change.

DIFFUSION THROUGH APPLIED SKILLS

Switzerland tends to do well in league tables of innovation because it is an all-rounder: it has disruptive innovation as well as more incremental improvements and *Feinmechanik*. But these characteristics alone cannot explain its success in innovation. The Swiss model of innovation is unique because it combines leading-edge innovation in disruptive, short-cycle sectors such as tech with incremental innovation in other parts of the economy. In addition, elements of the Swiss economy—in particular, its vocational education system, its mix of research organizations, and its relatively low regional disparities—help encourage the diffusion of innovation among nonleading firms. Combined with distinctive labor market regulations, these features allow Swiss workers to gain.

Vocational education in Switzerland still provides a plausible career path for ambitious young people. Consider an eighteen-year-old with reasonable rather than stellar grades considering what they want to do after leaving school. In the United Kingdom or the United States, middle-class parents would probably be suspicious of vocational education. They would know few people who had taken that route and be uncertain of its benefits. Vocational education relies on employers willing to work with apprentices who learn on the job,

and employers are often unenthusiastic. Qualifications are often a confidence trick: employers need to trust that credentials impart (or signal) skills, students need to feel they are worthwhile, and parents need to trust educational institutions as destinations for their children. In countries such as the United Kingdom, vocational education is often seen as a second-class choice, and this problem becomes self-reinforcing. (There are some significant exceptions, of course: apprenticeships at major engineering companies and defense contractors can be very competitive.)

By contrast, in the Swiss system, apprenticeships are common. Around 38 percent of Swiss young people go into vocational education, compared with the OECD average of 32 percent.⁴² The success of the Swiss model depends in part on the strong involvement and influence of employers. Apprenticeship places are, by definition, available only when employers offer them, and this ensures a strong link with labor demand. Second, there are no dead ends in the system. Learners do not complete an apprenticeship and then stop learning; the system is designed to allow them to pursue higher education if they want to.⁴³ A high share of workers participate in adult learning. Forty percent of Swiss aged 25–34 and 24 percent of those aged 55–64 take part in adult learning, compared to 18 percent and 6 percent in the European Union.⁴⁴ These figures are high even relative to countries with strong vocational education systems: the figures for Germany are only 19 percent and 3 percent. Vocational education in Switzerland is not a period of learning followed by employment but emphasizes lifelong learning.

Uschi Backes-Gellner, a professor at the University of Zurich, and colleagues identify three main features of the Swiss vocational system that makes it so strong. First, the curricula are advanced, linked to business needs, and flexible: they are redrafted every five years in consultation with businesses, ensuring that they stay fresh and focused on the skills businesses need. Second, apprenticeships can exist only if businesses provide them, the result being a system driven by business needs rather than those of the educational

provider. Finally, Swiss vocational education combines occupational and general skill training. Vocational education systems do more than teach learners to do a job: they give them the skills to learn throughout their lives. The system produces better labor outcomes for some than others—incomes are higher for men who go through the system than women—but the labor market prospects for students in vocational relative to general education have deteriorated little over time.⁴⁵

The Swiss system balances high-quality university education with high-quality vocational education. Switzerland spends more on education per student than any other country in the OECD except Luxembourg.⁴⁶ It has more elite universities per capita (defined as among the world's top one hundred) than any other country in the world.⁴⁷ But it also has a vocational system that companies, learners, and their parents see as a route to both a good job and personal respect. It is adaptive, meaning students can start at a low level and progress. The result is a system that gives workers the skills to ensure the diffusion and adaptation of innovation.

There's a virtuous circle in Swiss skill adoption: the acquisition of skills may provide incentives to develop new skills.

Technical skills → diffusion of new innovations → incentive for skill creation → higher wages

The supply of skills can create its own demand, in a variation of Say's law that production can lead to demand for that product. Swiss firms operate in a niche production mode, and they are enabled to do so by the availability of skilled workers.

In addition, when workers gain high skills, these skills let them benefit from innovation. The supporting infrastructure of the labor market rests on a characteristically Swiss combination of minimum wages in some cantons and a mixed economy of institutions. Around half of Swiss employees are covered by collective bargaining, much higher than the proportion in the United States (12 percent) or the

United Kingdom (27 percent) but well below the level of Austria (98 percent) or Sweden (90 percent).⁴⁸ Labor markets are regulated through wage bargaining, rather than union-employer conflict, there are very few strikes, and it is relatively easy for firms to hire and fire staff.⁴⁹ The result of this situation is relatively high wages for many workers.

CELLULAR GEOGRAPHY

It is hard to measure spatial inequality in income, but the best guesses suggest that Swiss regional inequality is low.⁵⁰ This is partly because of the country's urban structure, with major cities serving different external markets. But it is also due to the legacy of powerful decentralized institutions. The result can be perverse. Some of the twenty-six cantons are smaller than the major corporations located in them. (Zug, with a population of around 130,000, is host to the cryptocurrency platform Ethereum, which had, at one point, a US \$1.2 trillion value). At one company, a representative told me that their headquarters might be located in low-tax Zug, but if they needed to scale up their R&D activities they would be able to do so only in Zurich.

Swiss policy has tried to encourage nationwide innovation. One example of this effort is the Swiss universities of applied science. Policymakers had long been concerned about bridging the gap between the apprentice system and higher education, enabling students on the vocational track to jump to the academic track. Between 1997 and 2003 the Swiss government established nine universities of applied science, carefully located so as to be accessible to students everywhere in the country. Based on the model of the German *Fachhochschulen*, teaching the applied knowledge of technical and engineering disciplines, these universities had a legal mandate to focus on applied research and to collaborate with firms and other research institutions.⁵¹

These institutions are not Stanford or Cambridge; they rank nowhere on international league tables. But they train workers whose skills are tailored to local business needs. They also provide local firms with opportunities for collaborative research, reducing the barriers to innovation. Throughout the country they produce highly skilled graduates with both practical and scientific knowledge, thereby fostering the direct transfer of knowledge and technology between research institutions and the firms that can profit from that knowledge and technology. They help new technologies to be adapted and to diffuse through the economy.

Economic studies show a 7 percent increase in the number of patents and a 10 percent increase in the quality of patents filed by firms near these institutions a decade later.⁵² Over the long term, local economies become more focused on innovation-led industries that benefit from this proximity. Institutions that focus on the modest diffusion and adaptation of technology can have a powerful local impact, benefiting local workers.

EQUITY THROUGH DIFFUSION IN SWITZERLAND

Switzerland is full of paradoxes. Despite its mountainous terrain, it is highly accessible. It has a reputation (undeserved) as unwelcoming to foreigners, but it has one of Europe's highest shares of foreign-born residents. It is traditional, with an economy based on old-school industries such as watchmaking, yet it is also hypermodern, leading in niche technological fields and home to some of Europe's best universities. The Swiss model of innovation melds niche production on the German model with a US focus on disruptive, radical tech. Switzerland is also unusual in its mixture of historical, family-owned multinationals and SMEs that coexist with startups founded by migrants and funded by venture capital.

But the key strength of the Swiss model is diffusion. Vocational education gives Swiss businesses the skilled workers they need; it

gives workers the ability to earn high wages; and it allows diffusion of innovation into other parts of the economy. Its multiple population hubs exist for historic reasons. But policy has reinforced this situation with new institutions that facilitate innovation, built to evolve with local economies over the long term.

Switzerland's political economy is dominated by slow-moving institutions, but it encourages a long-term perspective. I was struck by the honesty of the firms and policymakers I spoke to. There was no wishful thinking about the future. Innovation policymakers were resistant to fads of innovation policy. The vocational education system was designed to give a realistic view of the labor market, and where the jobs are, rather than offering learners false hope. Firms were clear about their comparative advantages, rather than boosterist about the next phase of growth. This approach sometimes felt dour, but it has created a system which—for now—means that many people can benefit from Switzerland's success in innovation.⁵³