COMPREHENSIVE WEALTH REPORT

Ethiopia

Accounting for sustainable development (1992–2020)

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Comprehensive Wealth Report — Ethiopia Accounting for sustainable development (1992–2020)

April 2024

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Photo: iStock

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Dedication

The authors dedicate this report to the memory of Kirk E. Hamilton, whose untimely passing on February 6, 2024, left the world without one of its pioneers in the conceptual and practical development of comprehensive wealth accounts. Hamilton authored or co-authored many of the seminal works in the field and devoted much of his professional career to establishing the Changing Wealth of Nations program at the World Bank. His sharp insights, lucid writing, and careful analysis have, fittingly, created a rich endowment to draw upon. It is up to those who remain to build on this and ensure that comprehensive wealth accounting features prominently in the measurement of progress beyond GDP.

Executive Summary

The core factors of economic progress are capital assets, which include human, natural, produced, financial, and social capital. These comprise an economy's comprehensive wealth. Comprehensive wealth focuses on the stocks of underlying assets that generate income flows, which determine society's well-being. Comprehensive wealth accounts can monitor the change in productive capital stocks over time. This is pertinent not only to a nation's sustainable development but also to ensuring the delivery of the United Nations Sustainable Development Goals (SDGs).

Although income can be temporarily boosted by drawing down capital, this reduces productive capacity in the longer term and compromises the well-being of future generations. Comprehensive wealth measures provide policy-makers the ability to monitor this stock of productive capacity, identify weaknesses and strengths, and ensure that short-term decisions are not harmful to the country's long-term prosperity. This is pertinent not only to a country's long-term development but also to the delivery of the SDGs over the next few years.

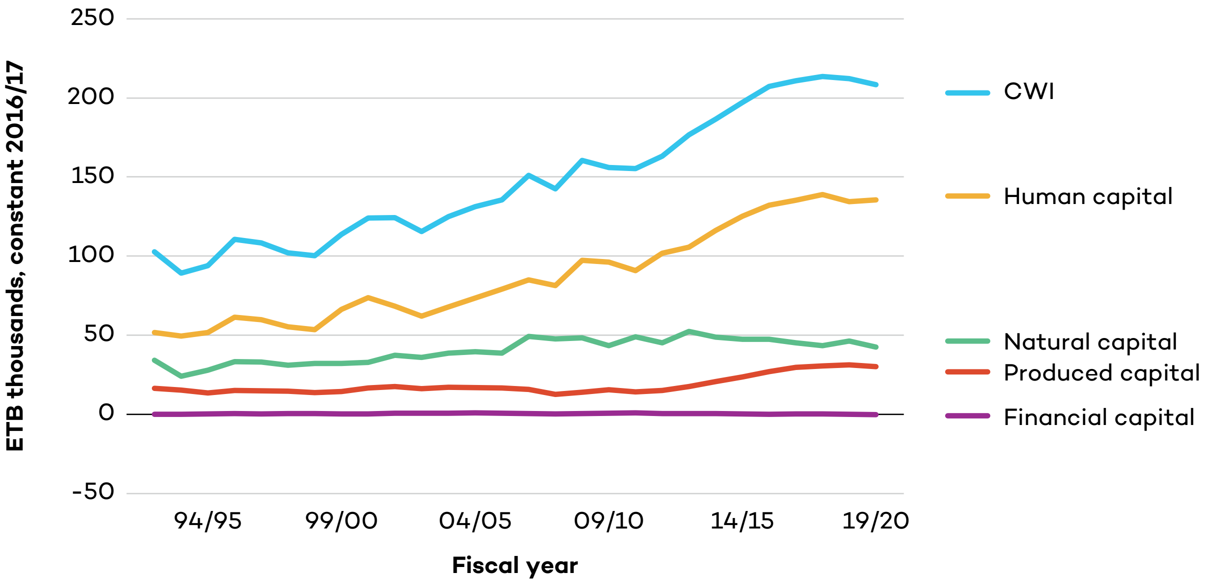
Ethiopia has made progress in expanding its comprehensive wealth despite social, economic, and environmental challenges (Figure ES1). The stock of real comprehensive wealth per capita doubled from 1992/93 to 2019/20, growing annually at 3%. Human capital—which represents between 50% and 65% of total wealth—was the main driver. In recent years, there has been a reversal of this generally positive trend. Comprehensive wealth declined in real per capita terms in 2018/19 and 2019/20. On top of this, indicators of land use, temperature, and precipitation all point to growing pressures on ecosystems and climate. If nothing is done to reverse these trends, future prosperity will be compromised. Reversing them will require that stocks of assets grow to reduce the pressure from an increasing population.

Most of Ethiopia's human capital is found in the agriculture, forestry, and retail trade sectors. Thus, the country's future efforts in increasing human capital stock should prioritize both enhancing the productivity of human capital in these sectors and growing it in other sectors where it will yield greater well-being gains.

Market natural capital is the second largest share of the country's comprehensive wealth index, accounting for 20% to 34% of total wealth. To grow this wealth, the government should target enhanced productivity in agriculture and forestry through investment in sustainable land management and/or nature-based solutions. Investment in sustainable land management and/or nature-based solutions for increasing natural capital requires a mechanism for financing such investments. As part of the financing mechanisms, the country should explore possible financing mechanisms, including schemes for "payments for ecosystem services."

Regarding non-market natural capital, the study found that land area per capita fell by more than half over the period due to rapid population growth. Again, investments in productivity will be required to offset the decline in available land resources per capita. The country has made significant efforts to expand the total forest land, which increased from 18.3% to 21.5% of the total land area. This presents an essential step toward reinforcing the country's carbon storage capacity and developing other forest ecosystem services. Climate system indicators show an upward temperature trend and high precipitation variability. The country is highly vulnerable to climate change and needs to invest more in adaptation and mitigation measures that complement the sustainable management of its natural capital.

Figure ES1. Overall trend, comprehensive wealth index in Ethiopia, per capita



Source: Authors' calculations based on data from Central Statistical Agency, Ministry of Finance, National Bank of Ethiopia, Natural Gum Production and Marketing Enterprise, Economy Watch, the World Bank, and Food and Agriculture Organization of the United Nations.

Produced capital is concentrated in four sectors: manufacturing, real estate, construction, and agriculture. Although the agricultural sector is the dominant sector in terms of its contribution to the country's GDP, investment in produced capital in the agriculture industry grew at a relatively low rate compared to other sectors (like manufacturing, real estate, and construction) that contribute less to real GDP. The agricultural sector remains dominated by traditional farming technologies (such as ox-powered plows). The country needs to focus on increasing investment in fixed capital in the agricultural sector to increase the productivity of the sector and its contribution to the economy. The service, education, and health sectors account for a small percentage of the stock of produced capital, and this low level of investment constrains the future development of the country's human capital.

Financial capital, traditionally a strength of the country, has become a drag on its well-being. In 2019/20, the financial capital index moved into negative territory after being positive for the rest of the study period. High levels of net foreign debt are a burden in terms of both debt servicing (paying interest on debts) and repayment of the principal. They limit Ethiopia's ability to invest in inclusive economic growth and sustainable natural resource management. Thus, managing Ethiopia's debt through policies such as debt for nature/climate swaps could provide inclusive investment in nature protection and climate change mitigation and adaptation as a bridge to greater debt sustainability and address the three crises of debt, climate, and nature.

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1.0 Introduction

The world is facing global environmental changes ranging from loss of biodiversity to changes in climate patterns that are severely affecting human well-being through their negative impacts on nations' produced, natural, human, financial, and social capital. The speed, scale, and extent of these changes are beyond previous human experience. Thus, for a prosperous and sustainable future, policy supports from the scientific community is becoming crucial. A future is sustainable if the current society is able meet its needs without compromising the ability of future generations to meet their own needs (Halvorsen et al., 2019), which is the essence of the term "sustainable development" as coined in the Brundtland Report (World Commission on Environment and Development, 1987). Sustainable development requires that, relative to their respective demographic bases, "each generation should bequeath to its successor a productive base at least as large as it inherited from its predecessor" (Dasgupta, 2014, p. 19).

How to measure social welfare in a way that addresses sustainable development is an ongoing debate among ecologists, environmental economists, and mainstream economists. Despite the debate and the developments in search of a measure of social welfare, nations continue to rely mostly on GDP and its annual change as their central measure of economic progress and as a proxy for social welfare. Recent developments in search of a better indicator and/or measure of social welfare include four global reports on the Inclusive Wealth Index (United Nations University International Human Dimensions Programme on Global Environmental Change & UN Environment Programme [UNU–IHDP & UNEP], 2012, 2014; Managi & Kumar, 2018; United Nations Environment Programme [UNEP], 2023) and two major reports on comprehensive wealth in Canada (Smith, Bizikova et al., 2016; Smith et al., 2018). Unlike GDP, the inclusive or comprehensive wealth index considers not only the welfare change the current generation is experiencing but also intergenerational welfare changes by revealing how the basis of welfare, which is capital stocks (produced, natural, human, financial, and social capital), changes over time.

Over the last decade, Ethiopia has been praised as one of the fastest-growing economies in the world as well as for implementing a green economy strategy (Federal Democratic Republic of Ethiopia [FDRE], 2011) and a growth and transformation plan (FDRE, 2016). Ethiopia aspires to become a middle-income country by 2025. The current government has a reform agenda that identifies job creation, inclusive economic growth, and poverty reduction as its primary goals on the pathway to prosperity (Office of The Prime Minister of the FDRE, 2019). However, the country remains one of the poorest in the world and has a rapidly growing population. Moreover, natural resource degradation in Ethiopia has been going on for centuries. Declining land resource productivity is a severe problem in the country and, given continued population growth, one that is likely to be even more pressing in the future (Berry, 2003; Gebreselassie et al., 2016; Tilahun, 2020). Land degradation affects agricultural productivity, with negative consequences for food security (Muluneh et al., 2017) and the well-being of future generations.

Given the above, this study aims to develop comprehensive wealth estimates for Ethiopia and identify their relevance to policy-making. Such an endeavour aligns with SDG 17.9, which calls for developing measurements of progress toward sustainable development that complement GDP and support statistical capacity building in developing countries (United Nations Statistical Commission, 2017). The study has been undertaken in the context of the Measuring Comprehensive Wealth to Promote Inclusive and Sustainable Development project hosted and carried out by the International Institute for Sustainable Development.

Based on available national and international data, the comprehensive wealth of Ethiopia has been calculated using a methodology developed by IISD in previous studies for Canada (IISD, 2016 and 2018), as well on the work by the UN Environment Programme in its global Inclusive Wealth reports (UNU–IHDP & UNEP, 2012, 2014; Managi & Kumar, 2018; UNEP, 2023) and by the World Bank in its *Changing Wealth of Nations* reports (World Bank, 2006, 2011, 2018). Both the Canadian and international approaches suggest using a "bottom-up" approach to calculate comprehensive wealth.

2.0 Key Findings

2.1 National Comprehensive Wealth Index of Ethiopia

The national comprehensive wealth index (CWI) measures the real (inflation-adjusted) per capita value of Ethiopia's aggregate produced, natural, human, and financial capital. It is constructed as the sum of several sub-indexes: the fixed capital index; the market natural capital index; the human capital index, and the net foreign assets (international investment position index) (see indicators on produced [PC], natural capital [NC], human capital [HC], and financial capital [FC] in Section 2.2 for further details). Ideally, it would have been possible to include social capital in the CWI. However, the concepts, methods, and data required to place a monetary value on social capital have not yet been fully developed. However, work in that direction is progressing (Hamilton et al., 2016; Smith et al., 2018), so future versions of the CWI may incorporate social capital. For now, social capital is assessed here based on non-monetary indicators.

The CWI, which is measured both in terms of per capita constant ETB[1] and constant USD[2] for a period of 28 years from 1992/93 to 2019/20, is the most comprehensive measure of wealth that can be compiled for Ethiopia today. The CWI measured in constant ETB per capita grew from ETB 102,853 in 1992/93 to ETB 208,522 in 2019/20 (Figure 1 and Table 1). Over the 28 years, it grew by 103% with an average annual growth rate of 3%. When expressed in constant USD per capita, the index grew from USD 12,071 to USD 24,472 (Figure 1 and Table 1).

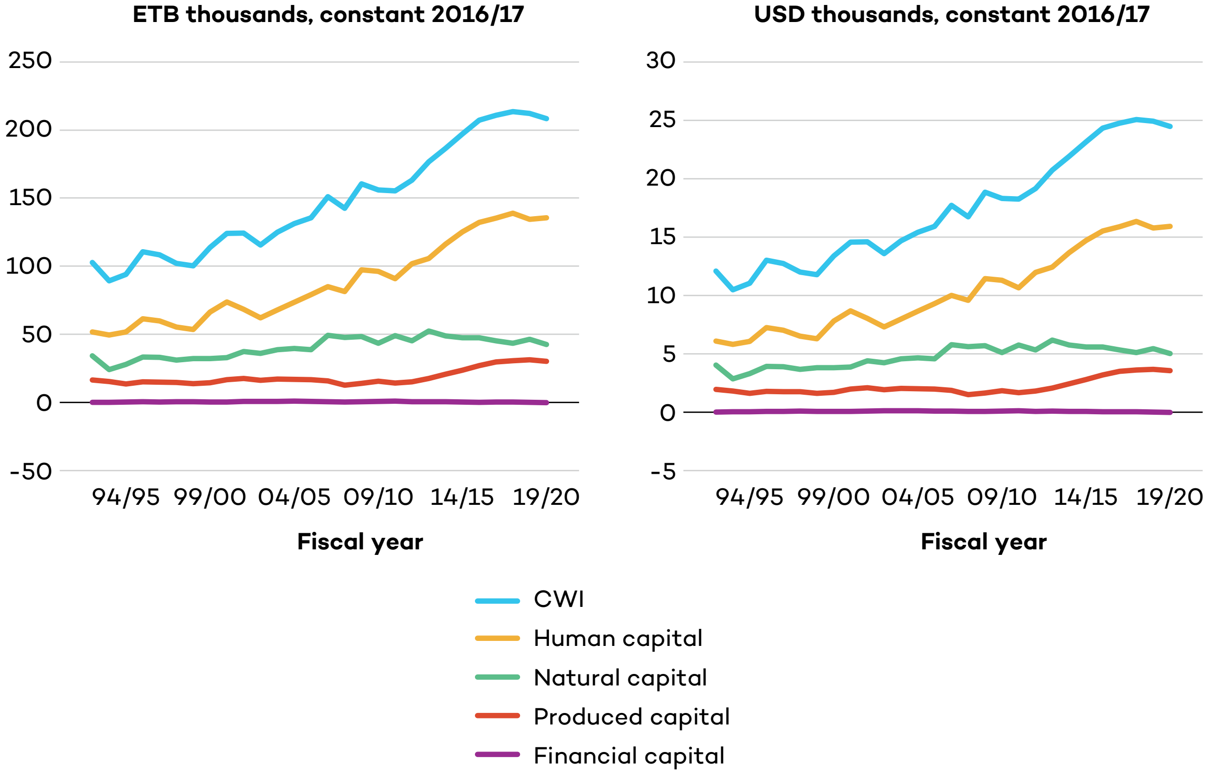
Despite this progress, the figures from recent years present a warning sign regarding the possible future path of wealth. The CWI peaked in 2017/18 at ETB 213,539 (USD 25,061) per capita. Following that, it declined by 0.6% and 1.8% in 2018/19 and 2019/20 respectively. Declines in the CWI are a sign of unsustainability. If these declines continue, the average Ethiopian's well-being will also begin to decline.

Looking at the individual elements of the CWI, human capital accounts for the largest of Ethiopia's assets by far. It accounted for 50 to 65 of the CWI over the period. Human capital measured in constant ETB per capita grew from 51,809 ETB to 135,659 ETB, for total growth of 162% and an average annual growth rate of 4% (Figure 1 and Table 1). In per capita USD, human capital increased from 6,080 USD to 15,921 USD.

[1] All values in constant ETB in this report use 2016/17 as the base year.

[2] All values in constant USD in this report use 2016/17 as the base year and the 2017 purchasing power parity (PPP) conversion rate from ETB to USD as reported by the World Bank's PPP conversion factor (8.52 ETB/USD). The application of the 2017 PPP conversion rate to the entire time series results in identical growth trends over time regardless of whether the results are presented in constant ETB or constant USD.

Figure 1. Trends in the comprehensive wealth index of Ethiopia and its components (1992/93-2019/20)



Source: Authors' calculations based on data from Central Statistical Agency, Ministry of Finance, National Bank of Ethiopia, Natural Gum Production and Marketing Enterprise (NGPME), Economy Watch, the World Bank, and Food and Agriculture Organization of the United Nations.

Market natural capital, the second most significant component of Ethiopia's wealth, accounted for 20%–36% of the CWI. Market natural capita measured in constant ETB per capita grew from ETB 34,344 (USD 4,031) to ETB 42,654 (USD 5,006), for total growth of 24% over the period, with an average annual growth rate of 1.4 (Figure 1 and Table 1).

Produced capital accounted for 9% to 17% of the country's CWI over the period. The value of produced capital nearly doubled in constant per capita terms, increasing from ETB 16,576 (USD 1,945) to ETB 30,331 (USD 3,560), for a total growth of 83% and an average annual growth rate of 2.7% (Figure 1 and Table 1).

Financial capital, the smallest element of Ethiopia's comprehensive wealth portfolio, accounted for 0.8% or less of the CWI. It declined from ETB 124 (USD 15) per capita to ETB -122 (USD -14) per capita, for a total decline of 198% over the period, with an average annual decrease of 1.3%, respectively (Figure 1 and Table 1). The negative financial capital per capita in 2019/20 implies that the country's net foreign assets were lower than its net foreign liabilities in that year.

Table 1. CWI of Ethiopia and its components (1992/93–2019/20) in constant 2016/17 prices, per capita

	CWI (in 1,000s)		Produced capital (in 1,000s)		Natural capital (in 1,000s)		Human capital (in 1,000s)		Financial capital	
Year	**ETB**	**USD**	**ETB**	**USD**	**ETB**	**USD**	**ETB**	**USD**	**ETB**	**USD**
1992/93	102.85	12.07	16.58	1.95	34.34	4.03	51.81	6.08	124.30	14.59
1993/94	89.31	10.48	15.34	1.80	24.19	2.84	49.52	5.81	258.38	30.32
1994/95	94.00	11.03	13.75	1.61	28.09	3.30	51.75	6.07	412.36	48.39
1995/96	110.77	13.00	15.28	1.79	33.38	3.92	61.59	7.23	517.29	60.71
1996/97	108.39	12.72	14.90	1.75	33.21	3.90	59.85	7.02	424.35	49.80
1997/98	102.20	11.99	14.81	1.74	31.17	3.66	55.55	6.52	662.59	77.76
1998/99	100.36	11.78	13.81	1.62	32.34	3.80	53.59	6.29	619.99	72.76
1999/00	113.90	13.37	14.55	1.71	32.37	3.80	66.51	7.81	468.93	55.03
2000/01	124.17	14.57	16.81	1.97	32.95	3.87	73.91	8.67	499.59	58.63
2001/02	124.37	14.60	17.71	2.08	37.45	4.39	68.42	8.03	785.85	92.23
2002/03	115.69	13.58	16.40	1.92	36.12	4.24	62.22	7.30	949.04	111.38
2003/04	125.11	14.68	17.25	2.02	38.85	4.56	68.06	7.99	950.87	111.59
2004/05	131.39	15.42	17.02	2.00	39.66	4.65	73.73	8.65	990.94	116.30
2005/06	135.69	15.92	16.83	1.98	38.84	4.56	79.27	9.30	749.49	87.96
2006/07	151.07	17.73	15.96	1.87	49.28	5.78	85.11	9.99	715.32	83.95
2007/08	142.51	16.73	12.82	1.50	47.74	5.60	81.54	9.57	420.27	49.32

	CWI (in 1,000s)		Produced capital (in 1,000s)		Natural capital (in 1,000s)		Human capital (in 1,000s)		Financial capital	
Year	**ETB**	**USD**	**ETB**	**USD**	**ETB**	**USD**	**ETB**	**USD**	**ETB**	**USD**
2008/09	160.49	18.84	14.09	1.65	48.43	5.68	97.42	11.43	558.04	65.49
2009/10	156.03	18.31	15.57	1.83	43.45	5.10	96.26	11.30	759.01	89.08
2010/11	155.39	18.24	14.33	1.68	49.10	5.76	90.84	10.66	1131.16	132.75
2011/12	163.23	19.16	15.31	1.80	45.30	5.32	101.99	11.97	637.38	74.80
2012/13	176.73	20.74	17.64	2.07	52.56	6.17	105.88	12.43	661.51	77.63
2013/14	186.75	21.92	20.79	2.44	49.04	5.76	116.31	13.65	606.05	71.13
2014/15	197.23	23.15	23.79	2.79	47.60	5.59	125.40	14.72	439.75	51.61
2015/16	207.30	24.33	27.24	3.20	47.50	5.57	132.33	15.53	229.96	26.99
2016/17	210.93	24.75	29.78	3.49	45.44	5.33	135.36	15.89	357.47	41.95
2017/18	213.54	25.06	30.67	3.60	43.47	5.10	139.09	16.32	316.70	37.17
2018/19	212.34	24.92	31.36	3.68	46.39	5.44	134.49	15.78	98.17	11.52
2019/20	208.52	24.47	30.33	3.56	42.65	5.01	135.66	15.92	-121.56	-14.27

Source: Authors' calculations based on data from Central Statistical Agency, Ministry of Finance, National Bank of Ethiopia, Natural Gum Production and Marketing Enterprise (NGPME), Economy Watch, the World Bank, and FAO.

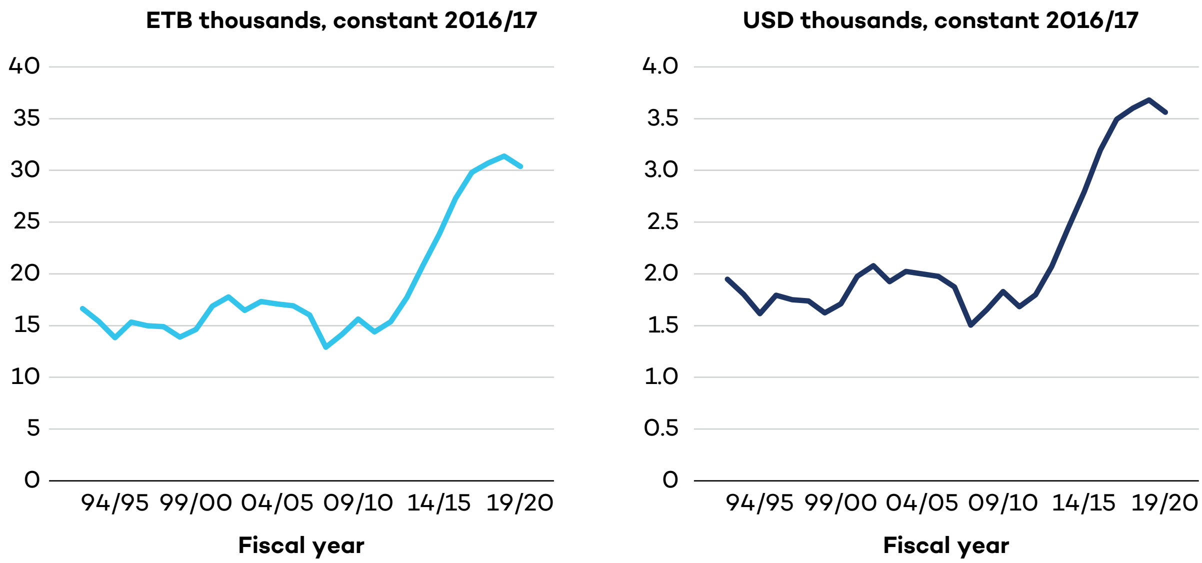
2.2 Components of the Comprehensive Wealth Index

2.2.1 Produced Capital Index

The produced capital index is the sum of the fixed capital index (FCI) and the inventory index. The FCI measures the real per capita value of fixed capital stocks owned by households, businesses, and governments and includes residential and non-residential buildings, roads, dams, machinery and equipment, and other fixed assets. The Inventory Index measures the real per capita value of the inventories of goods held by the business sector. Due to data constraints, the Inventory Index could not be compiled for this study, so produced capital is assessed using the FCI only.[3] The trends in the Fixed Capital Index (hereafter, the produced capital index, or PCI) and the factors driving the trends are discussed in the remainder of this section. Technical details of the indicator are presented in the Appendix B.

The PCI for the year 1992/93 was ETB 16,576, increasing to ETB 30,331 in 2019/20 (Figure 2), for an average annual growth rate of 2.7% over the study period. However, this growth was not steady throughout the period. From 1992/93 to 2007/08, the PCI declined at an average rate of 1%, from ETB 16,576 (USD 1,945) to ETB 12,817 (USD 1,504). Before 1992, Ethiopia had been in a continuous and protracted civil war for close to two decades. The years after the end of the civil war and separation of Eritrea to become an independent country saw little progress on the economy. Instead, this was a period of transition and reorganization of the state apparatus. The government again had a border war with Eritrea from May 1998 to June 2000. These periods had a negative impact on the country's capacity to attract investors and limited public sector investment in produced capital, which shows in the flat PCI until 2010/11.

Figure 2. PCI Ethiopia, (1992/93-2019/20)

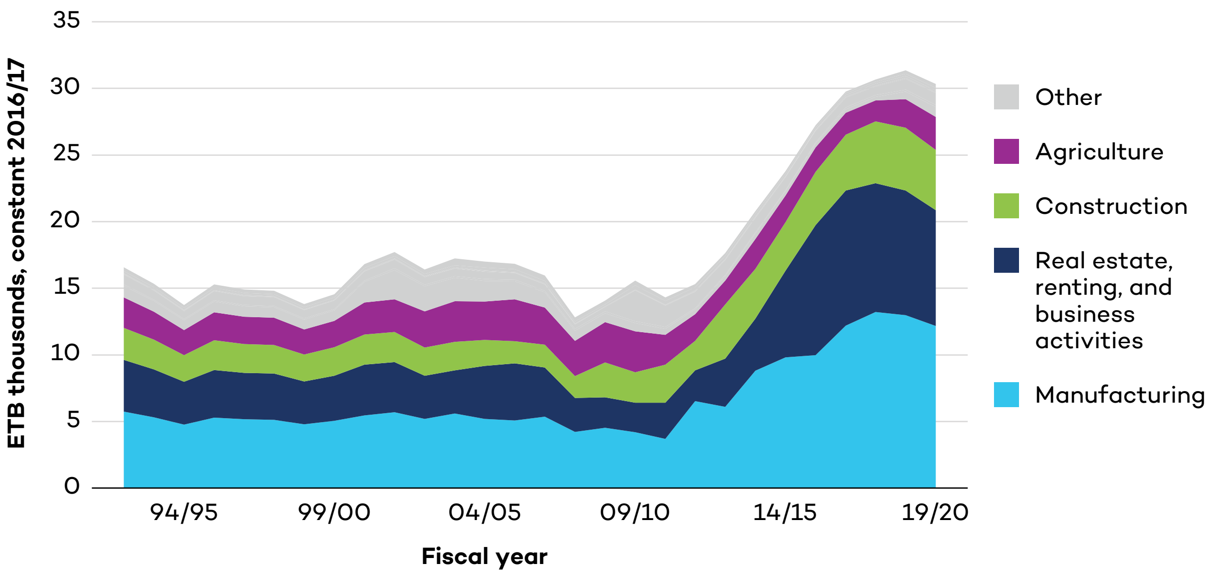


Source: Author's calculations based on data from Economy Watch, Central Statistical Authority, National Bank of Ethiopia, and the World Bank.

[3] This data gap is unlikely to have a significant impact on our results, since inventories are generally a small share of produced capital.

In the period after 2007/08, the PCI grew steadily at an average growth rate of 8%, increasing from ETB 12,817 (USD 1,504) to ETB 30,331 (USD 3,560). The peace and internal security of the country were relatively stable from 2000/01 onward, though conflict began growing again in 2017/18. The country was able to focus on economic development during this period through several short- and medium-term development plans. Since 1993, Ethiopia has followed an Agricultural Development-Led Development Strategy, Growth and Transformation Plan (GTP) I (2010/11–2014/15) (FDRE, 2010) and GTP II (2015/16–2019/20) (FDRE, 2016) and Green Growth Strategy (FDRE, 2011). These have provided incentives for private sector investment coupled with public investments in energy, road transport, and infrastructure.

Figure 3. Produced capital index per capita by sector, Ethiopia (1992/93–2019/20)



Source: Author's calculations based on data from Economy Watch, Central Statistical Authority, National Bank of Ethiopia, and the World Bank.

Ethiopia's PCI was concentrated mainly in four sectors of the economy (manufacturing, real estate and rentals, construction, and agriculture [which includes crop and livestock, forestry, hunting, and fishing sub-sectors]). These four sectors accounted for 86%–95% of the PCI over the period (Figure 3).

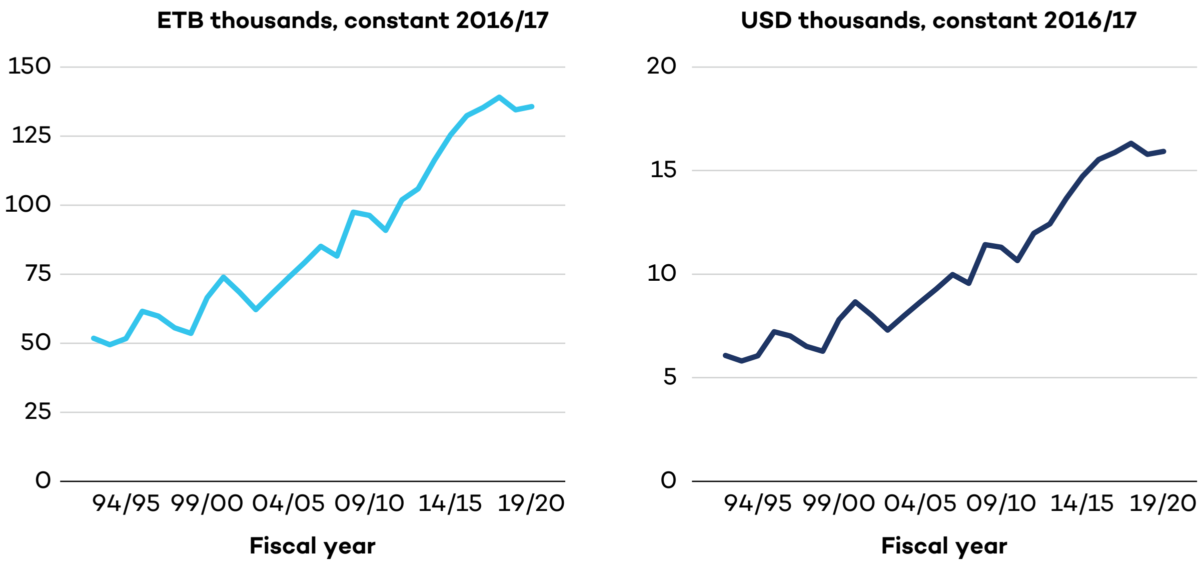
2.2.2 Human Capital

The concept of human capital goes back to the work of Adam Smith in the 18th century. In his book *An Inquiry Into the Nature and Causes of the Wealth of Nations*, Adam Smith defines human capital as "the acquired and useful abilities of all the inhabitants or members of the society" (Smith, 1776). Many definitions of human capital have been suggested in the literature since Smith's seminal work. These definitions generally focus on economic returns. Consequently, human capital has long been seen as the capacity embodied in individuals to contribute to production. Human capital covers both cognitive and non-cognitive skills, such as intra- and interpersonal abilities, that contribute to prosperous societies. One of the most all-encompassing definitions of human capital was proposed by the Organisation for Economic Co-operation and Development (OECD) two decades ago: "the skills, competencies, and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being" (OECD, 2001, p. 18).

The Human Capital Index (HCI) measures the aggregate value of real (inflation-adjusted) per capita human capital, which represents the skills, experiences and competencies embodied in the population (United Nations Economic Commission for Europe, 2016). These can be thought of as stocks of capital that provide economic returns in the form of higher incomes and greater productivity. Human capital is developed through formal learning (such as the education system and on-the-job training) and informal learning (such as interaction with friends and family). The development of human capital takes place over a person's whole lifetime. Therefore, human capital accumulation is said to be lifelong and "life-wide" (UNU–IHDP & UNEP, 2014).

The HCI increased from ETB 51,809 (USD 6,080) in 1992/93 to ETB 135,659 (USD 15,921) over the period, for a total increase of 162% and an average annual growth rate of 4% per year. The expansion of human capital was not continuous over time, and the country experienced several periods of declines (1995/96–1998/99, 2000/01–2002/03 and 2008/09–2010/11 and after 2017/18).

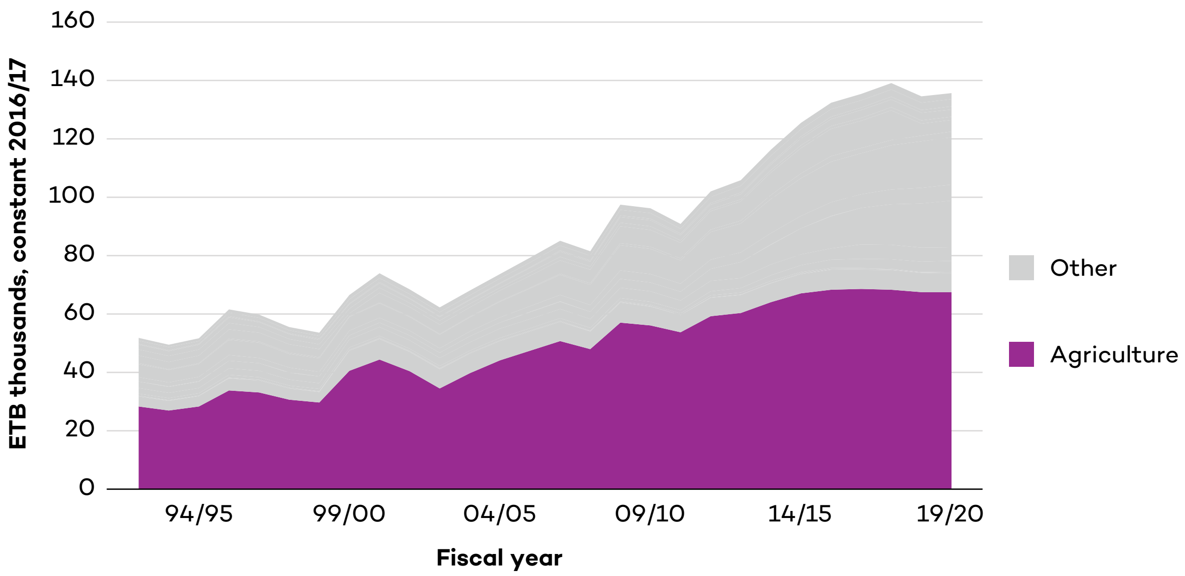
Figure 4. Present value of Ethiopia's human capital per capita (1992/93–2019/20)



Source: Authors' calculations based on data from Ministry of Finance, National Bank of Ethiopia, Central Statistical Agency, and the World Bank.

Most of Ethiopia's human capital is employed in agriculture (50% in 2019/20). Nine sectors (agriculture, retail trade, construction, forestry, wholesale trade, small-scale and cottage industries, transport and communication, large and medium-scale manufacturing, and education) accounted for 90% to 94% of human capital over the period.

Figure 5. Real human capital per capita by sector of employment



Source: Authors' calculations based on data from Ministry of Finance, National Bank of Ethiopia, Central Statistical Agency, and the World Bank.

2.2.3 Natural Capital

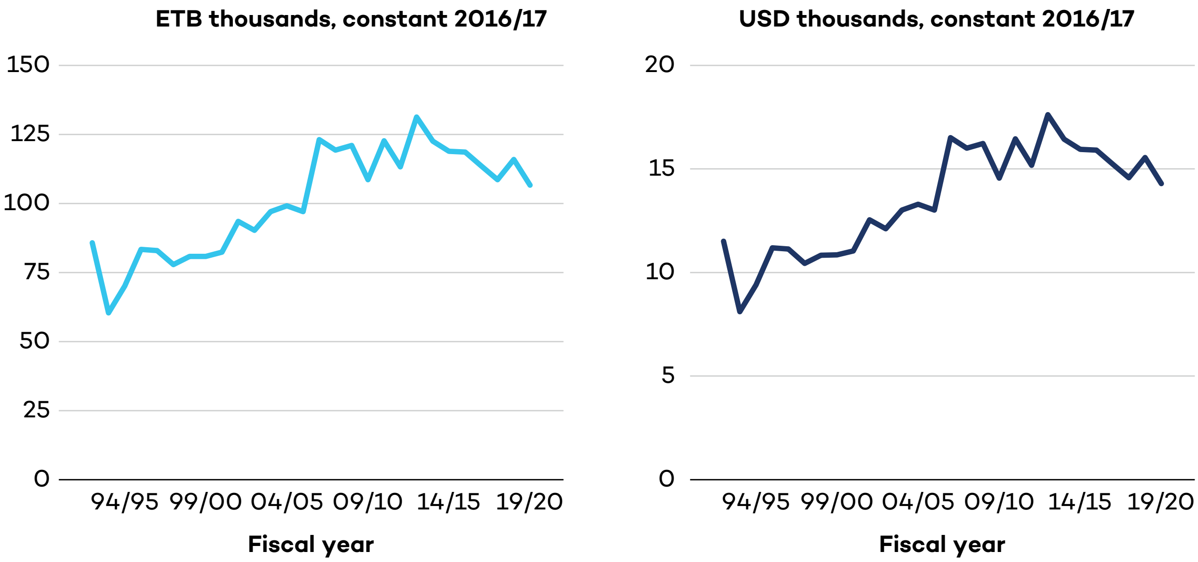
Natural capital consists of market natural capital and non-market natural capital. The market natural capital index (NCI) in this study measures the sum of the present values of the expected future rents generated from four broad categories of natural resources. These natural resources are agricultural products and services, forest products and services, water (hydropower), and mineral resource extraction. The NCI measures the aggregate value of real (inflation-adjusted) market natural capital in ETB and PPP (purchasing power parity) USD per capita.

Non-market natural capital is composed of terrestrial ecosystem services and atmospheric conditions. The indices for terrestrial ecosystem services measure the extent of each terrestrial ecosystem, in hectares and per capita. At the same time, the two non-market natural capital indices for atmospheric conditions (temperature and precipitation) are measured in terms of annual temperature departure in degrees Celsius from normal long-term average temperature and annual precipitation departure in percent from normal long-term average precipitation.

Results: Market Natural Capital (NCI)

The NCI fluctuated over the period (Figure 6), growing from ETB 34,344 (USD 4,031) in 1992/93 to ETB 42,654 (USD 5,006) in 2019/20, for a total increase of 24% and an average growth of 1.4% per year. However, since 2012/13 there is noticeable decline in the value of the asset.

Figure 6. NCI, Ethiopia, (1992/93–2019/20)

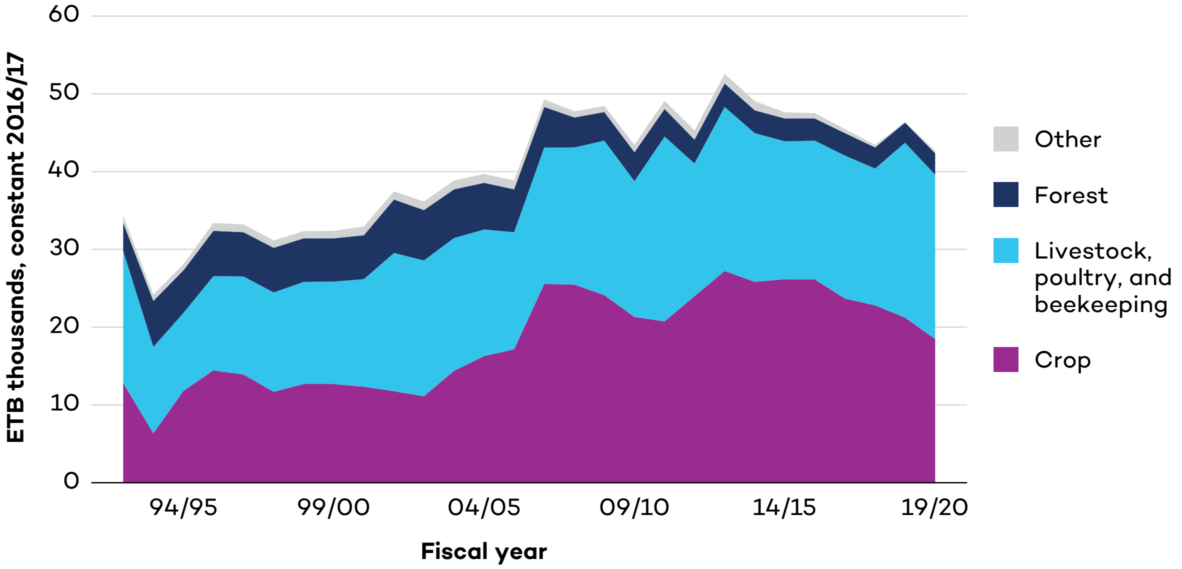


Source: Authors' calculation based on data from the Ethiopian Central Statistical Agency, National Bank of Ethiopia, NGPME, and FAO.

Figure 7 shows that agriculture (crops, livestock, poultry, and beekeeping) accounts for the largest share of the NCI, followed by forestry. In 1992/93, the NCI from livestock, poultry and beekeeping had a total value of ETB 16,987 (USD 1,994) and a total share of 49% of the index. The value of crops was ETB 12,797 (USD 1,502), or 37% of the NCI. Agriculture accounted for 87% of the NCI in 1992/93. The value of forests in the same year was ETB 3,653 (USD 429), accounting for 11% of the NCI. Thus, forests and agriculture together represented 97% of the NCI in 1992/93. Hydroelectric power and minerals together accounted for the remaining 3%.

The rank of each asset's contribution to the NCI did not change from 1992/93 to 2019/20 – that is, agriculture still contributed the most, followed by forests, hydropower, and minerals. However, there were changes in the proportion of each asset's contribution. The share of crops increased from 37% to 43%, while that of livestock, poultry and beekeeping increased from 49% to 50%. On the other hand, the value of forests declined from 11% to 6%. For other assets, we found a declining contribution of hydropower (2% to 0.1%) and a stable share of mining and quarrying (around 1%).

Figure 7. Market natural capital' contribution to market natural capital index, Ethiopia (1992/93–2019/20)

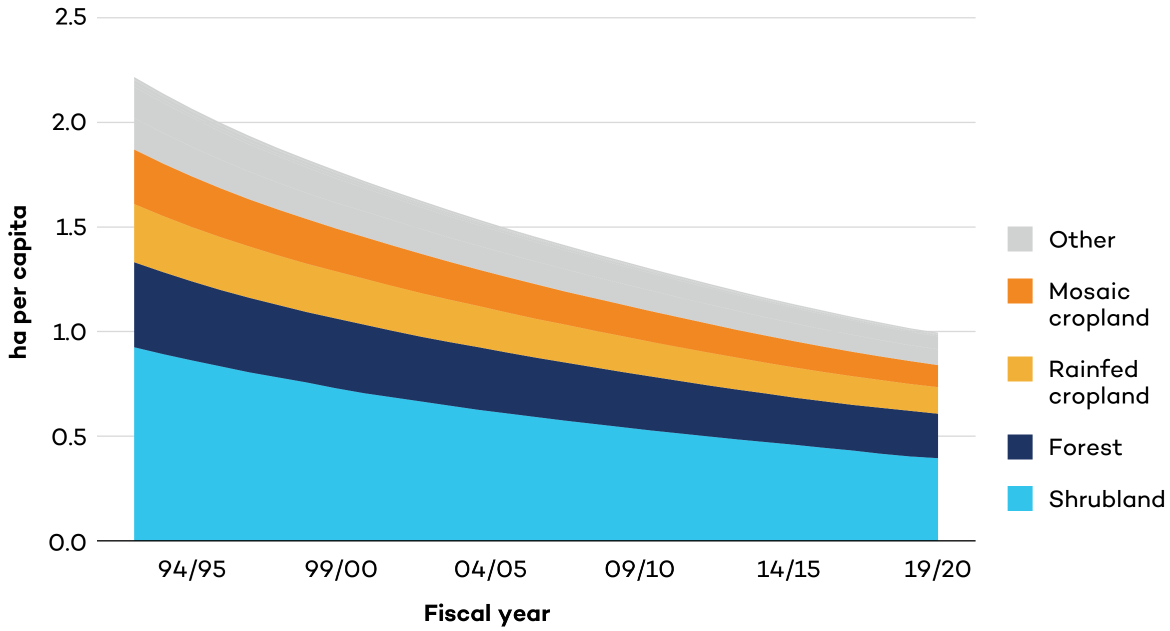


Source: Authors' calculation based on data from the Ethiopian Central Statistical Agency, National Bank of Ethiopia, NGPME, and FAO.

Results: Non-Market Natural Capital

Non-market natural capital is measured through ecosystem extent (Figure 8, Table 2) and climate system (Figures 9 and 10; Table 2). We find that the extent of ecosystems declined on a per capita basis (Table 2); and both temperature and precipitation increased over time.

Figure 8. Land per capita by land cover type, Ethiopia (1992/93–2019/20)



Source: Authors' calculations based on data from AidData and the World Bank.

Table 2. Summary of trends in non-market natural capital

Ecosystem extent	Unit	1992/93	2019/20	Annual growth rate (1992/93–2019/20)
Total land	Ha per capita	2.217	0.995	-1.97%
Mosaic cropland	Ha per capita	0.260	0.107	-2.11%
Rainfed cropland	Ha per capita	0.278	0.126	-1.96%
Irrigated cropland	Ha per capita	0.011	0.005	-1.85%
Forest	Ha per capita	0.406	0.214	-1.69%
Shrub land	Ha per capita	0.925	0.395	-2.05%
Sparse vegetation	Ha per capita	0.017	0.003	-2.93%
Grassland	Ha per capita	0.151	0.075	-1.81%
Bare areas	Ha per capita	0.150	0.062	-2.08%
Waterbodies	Ha per capita	0.015	0.007	-1.97%
Wetland	Ha per capita	0.003	0.001	-2.01%
Built-up land	Ha per capita	0.001	0.001	1.70%

Climate system	Unit	1981	2019/20	Annual change (1981-2020)
Temperature departure from normal	°C	-0.54	0.16	0.14
Precipitation departure from normal	%	-14.89	7.24	4.21

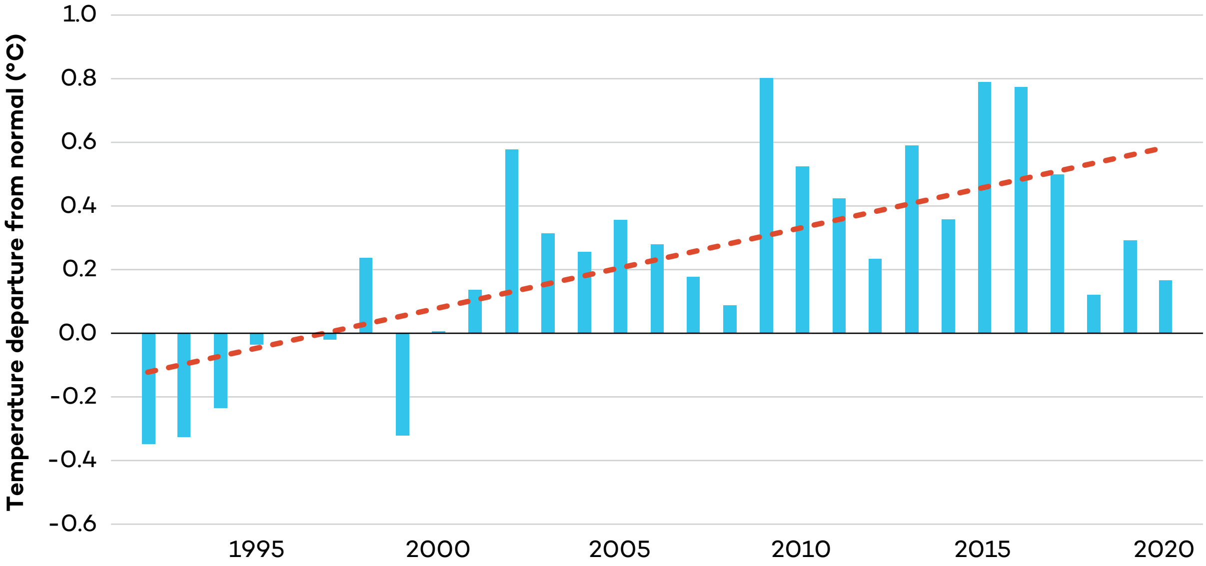
Source: Authors' calculations based on data from AidData and the World Bank.

Temperature

The result shows an upward trend in temperature at the national level over the period 1992 to 2020.[4] The average temperature across Ethiopia over the period was 0.23°C above the 1981–2010 normal (Figure 9). The coldest year was 1992 (0.35°C below the normal), and the warmest year was 2009 (0.8°C above the normal). The temperature departure was 0.16°C above average in 2020.

[4] Temperature and precipitation data are presented on a calendar-year basis rather than a fiscal year basis.

Figure 9. Temperature departure from 1981–2010 normal (°C), Ethiopia, 1992–2020

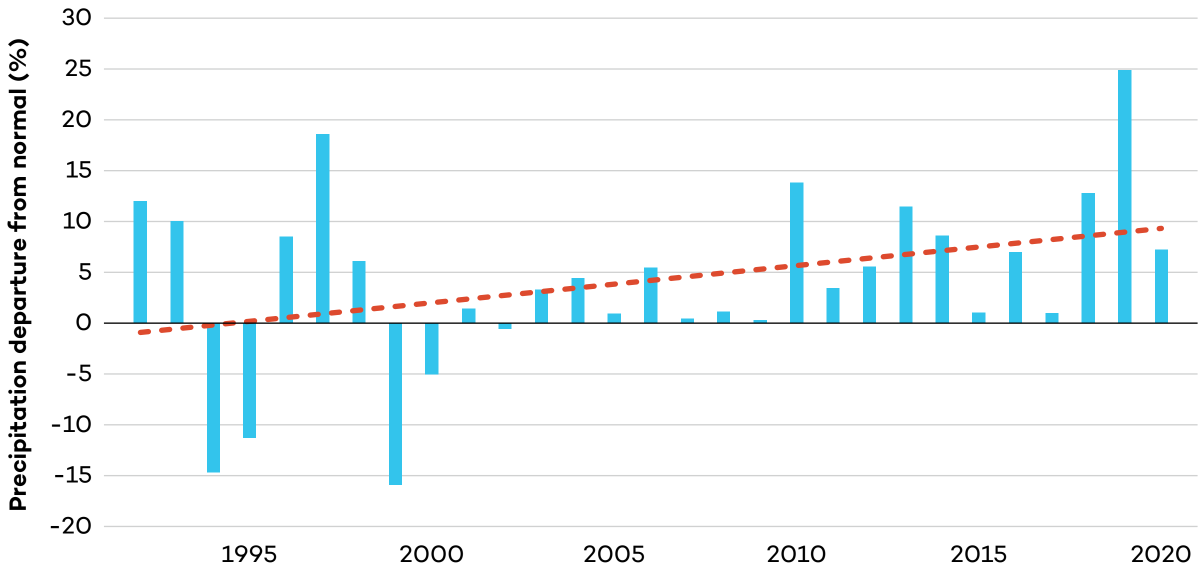


Source: Authors' calculations based on data from AidData.

Precipitation

The average precipitation across Ethiopia over the period was 4.2% above the 1981–2010 normal (Figure 10). The driest year was 1999 (15.9% below the normal), and the wettest year was 2019 (24.9% above normal). In 2020, precipitation departure was 7.24% above average.

Figure 10. Precipitation departure from 1981–2010 normal (%), Ethiopia, 1992–2020



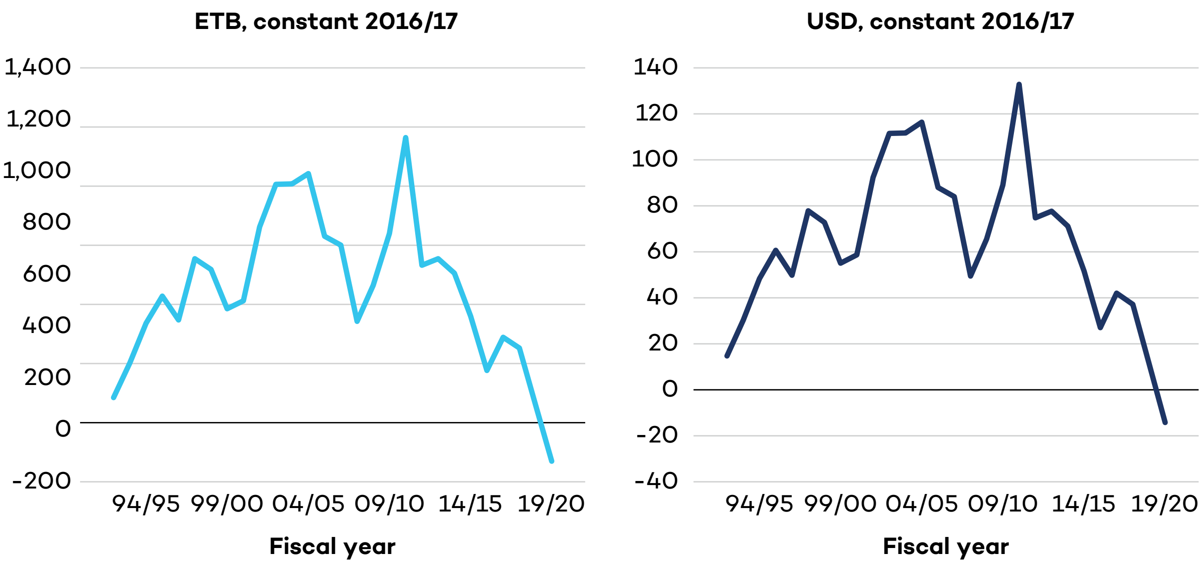
Source: Authors' calculations based on data from AidData.

2.2.4 Financial Capital

The financial capital index (FCI) measures the real per capita value of the difference between the value of foreign financial assets owned by Ethiopians and the value of domestic financial assets owned by non-residents—also known as the international investment position (IIP). As a low-income developing country with low savings and investment rates but high population growth, assessing the level and trends of the FCI is an important step toward monitoring the changes in the country's productive base.

The FCI showed a fluctuating trend over the period (Figure 11). In 1992/93, the value of the index was ETB 124 (USD 15). It peaked at ETB 1,131 (USD 133) in 2010/11 before declining to ETB -122 (USD -14) in 2019/20. The negative FCI in 2019/20 indicates that the country ended the period with foreign financial assets lower than its foreign financial liabilities. However, the government had been a net creditor for most of the period, only becoming a net debtor toward the end. Several reasons explain this change in status, notably the accumulation of foreign debt and foreign direct investment flows. World Bank (2024d) data shows that in 2020, foreign debt was estimated at USD 30.36 billion and accounted for around 28.4% of the country's gross national income (World Bank, 2024c). Also, the year 2010/11, when the FCI began to decline, coincides with the expansion of foreign direct investment inflow to the country. According to the World Bank (2024e), the share of foreign direct investment to GDP more than doubled between 2010 and 2020, from 1% to 2.2%, mainly driven by China, Saudi Arabia and Turkey (United States Department of State, 2021).

Figure 11. Trends in Ethiopia's financial capital per capita (1992/93–2019/20)



Source: Authors' calculations based on data from National Bank of Ethiopia and the World Bank.

2.2.5 Social Capital

The concept of social capital originates from the realization that social connections, shared values, institutions, trust, and participation are vital components of a well-functioning society (Coleman, 1988). One way to explore the importance of social capital is to look at social bonds, such as those between colleagues, family, friends, and local, regional, cultural, and religious communities. For example, friends and families represent essential sources of support during emotional, social, and economic difficulties. Also, many people find jobs through personal contacts and networks rather than through advertisements.

Because social capital determines the quality of networks and relationships among people, it drives the level of well-being of the society. With the current configuration of the global economy, tracking social capital is critical. As people become wealthier and less dependent on one another for support, the sense of community can begin to wither. Due to the rapid expansion of technology and the internet, people are dedicating more time to screens and may spend less time in community activities and socializing with neighbours, friends, and family (Scrivens & Smith, 2013). The COVID-19 pandemic has recently demonstrated how much social capital matters in our daily lives. Participation in group activities tracks the share of people who participated in or were members of a group, organization, or association.

Civic Engagement in Ethiopia

Participation in Group Activities

Ethiopia has a long history of traditional community-based self-help organizations (see Text Box 1). In addition, formal civil society organizations (CSOs) began to emerge in the 1960s during the reign of Emperor Haile Selassie. Currently, there are nearly 3,000 registered CSOs in the country, of which 429 are internationally registered and the remaining are local.[5] It is difficult to get data on the percentage of the population engaged and participating in these CSOs. The same problem exists in the case of traditional self-help organizations.

According to the Federal Cooperative Agency (2021), there are nearly 93,000 cooperatives in Ethiopia, with more than 21 million members, of which 32% are female. There are also about 21,000 primary savings and credit cooperatives, with about 5.3 million members, of which nearly 58% are female. The cooperatives create employment opportunities for about 2 million people in Ethiopia. Text Box 2 provides further details.

[5] The Authority for Civil Society Organization (ACSO) (n.d). *List of civil society organizations.* https://acso.gov.et/wp-content/uploads/2021/04/Local.pdf

Box 1. Traditional forms of social capital in Ethiopia

There are several kinds of social networks in Ethiopia. These networks use traditional coping strategies to address crises, including drought-induced problems, such as the death of animals, crop failure and food scarcities (Mogues, 2006). Mutual support is very common in rural communities. People in those communities depend on relatives and friends for their needs, which range from money, grains, crop harvesting, to housing construction. Traditional systems, such as iddir, equb, debo, and wonfel, are well-known as the common mechanisms through which individuals gain supports from neighbours, friends, and relatives during social or financial challenges.

Iddir are informal financial and social institutions that are nearly ubiquitous in Ethiopia (Aredo, 2010). Iddir are traditional insurance arrangements characterized by payments of a fixed amount of money to a shared pool set up by members with symmetric information about each other (Dejene, 2003). Women-only iddir provide solutions to the social and economic challenges Ethiopian women are facing (Teshome et al., 2014).

Equb are rotating savings associations in which members pay fixed amounts each week or month into a fund and then cast lots to decide who should take the collected money (Caudell et al., 2015; Kebede & Butterfield, 2009; Kebede, 2018). The system operates based on mutual trust, and members are primarily of family and friends with strong social networks and confidence in each other. Equb provide a platform for saving money within the security of family and ethnic networks (Kedir & Ibrahim, 2011).

Debo is a labour-sharing arrangement in which individuals can draw labour from other households in the vicinity to obtain assistance in carrying out time-sensitive tasks in agriculture and other activities. In return, the individual hosting the debo provides food and drink for the participants. A similar arrangement is a wonfel. Rather than providing immediate recompense in the form of food and drink, participants in wonfel are provided with a promise of future reciprocity among the participating members (Ayalew, 2003; Tabirat, 2021).

Box 2. The history of cooperatives in Ethiopia

The modern cooperative movement started in Ethiopia in the 1950s and was formalized following the Farm Workers' Cooperatives Decree in 1960, which was meant primarily to aid retired farm workers (Emana, 2009; Ahmed & Mesfin, 2017). The voluntary and open membership principle of the cooperatives was not fully practised during the early years of the movement. The feudal land tenure system excluded peasant farmers from joining cooperatives because land ownership was a prerequisite for membership in cooperatives. During the military regime (1974–1991), the cooperative movement was used more actively to mobilize and distribute resources in the country (Emana, 2009). Mandatory membership and production quotas were among the features of the cooperatives during the military regime (Spielman, 2008).

Since 1994, the government has promoted a new generation of cooperatives with universally accepted principles. These new cooperatives are independent entities organized to promote the common socio-economic interests of their members (FDRE, 1994). In line with international conventions on cooperatives, a federal agency was established. The purpose of the agency is to manage more adequately the implementation of cooperative legislation. It also aims to better organize policies and legal measures for the interest of the society. These efforts led to an important expansion of both the number of agricultural cooperatives and the services they provided to their members (Abate et al., 2014).

Voter Turnout

Since 1995, Ethiopia has conducted six national elections (Table 4). The voting age population was about 26.4 million during the first election in 1995. Out of this voting age population, 21.3 million people registered to vote, and 94% of those actually turned out to vote. Over the subsequent elections, the country's population almost doubled, and the voting age population increased by 127% to close to 60 million. Voter turnout for the 2021 election remained near 94%, though votes cast as a share of the voting age population was considerably lower than in 1995 (63.4% versus 76.0%). In all six elections, voter turnout rates were high by international standards, with the exception of the election in 2000, which coincided with the end of the Ethiopian war with Eritrea.

Table 3. Voter turnout in the last six national elections

Year	Population	Voting age population	Registered voters	Total votes cast	Votes cast as a share of registered voters (%)	Votes cast as a share of the voting-age population (%)
1995	55,549,970	26,399,033	21,337,379	20,068,508	94.0%	76.0%
2000	61,679,843	30,386,448	33,963,430	18,226,800	53.7%	60.0%
2005	73,053,286	34,161,773	27,372,888	22,610,690	82.6%	66.2%
2010	88,013,491	41,919,571	31,926,520	29,832,190	93.4%	71.2%
2015	99,465,819	49,011,364	36,851,461	34,351,444	93.2%	70.1%
2021	110,871,031	59,878,624	40,525,964	37,946,992	93.6%	63.4%

Source: Authors, based on data from the International Institute for Democracy and Electoral Assistance, 2024.

Trust in Ethiopia

Data from the World Values Survey (Table 4) on trust shows that the proportion of respondents who think most people can be trusted completely or somewhat increased from the mid-2000s to the late 2010s (from 76.6% to 86.6%), perhaps as a result of the stabilization of the security situation in the country following the end of the conflict with Eritrea in the early 2000s. The same trend was apparent in terms of trust in strangers. Just 26% of respondents felt that strangers could be trusted completely or somewhat in the mid-2000s. By the late 2010s, 47.8% of respondents felt that way.

Table 4. Trust variables for Ethiopia, World Values Survey

Variable	Description/indicator variable	World Values Survey Wave 5 (2005–2009)	World Values Survey Wave 7 (2017–2022)
Generalized trust	Most people can be trusted	21.4	11.8
Trust in neighbours	Trust your neighbours completely or somewhat	76.6	86.6
Trust in strangers	Trust strangers completely or somewhat	26.0	47.8

Source: Authors, based on data from Inglehart et al., 2022.

3.0 Conclusion and Policy Implications

Comprehensive wealth focuses on the stocks of assets that generate income flows, which determine society's well-being. Although income can be temporarily boosted by drawing down capital, this reduces productive capacity in the longer term and compromises the well-being of future generations. Comprehensive wealth measures allow policy-makers to monitor this stock of productive capacity, identify weaknesses and strengths, and ensure that short-term decisions are not harmful to the country's long-term prosperity. This is pertinent not only to a country's long-term development but also to the delivery of the SDGs in the next few years.

The results here show that Ethiopia has made progress in expanding its comprehensive wealth despite social, economic, and environmental challenges. The stock of real comprehensive wealth per capita doubled over the study period, growing annually at 3%. Human capital—which represents between 50% and 65% of total wealth—was the main driver. However, recent years have seen a reversal of this generally positive trend, with comprehensive wealth declining in real per capita terms in 2018/19 and 2019/20. On top of this, indicators of land use, temperature, and precipitation all point to growing pressures on ecosystems and climate. If nothing is done to reverse these trends, future prosperity will be compromised. Reversing them will require that stocks of assets grow to reduce the pressure from an increasing population.

Most of Ethiopia's human capital is found in the agriculture, forestry, and retail trade sectors. Thus, the country's future efforts in increasing human capital stock should both prioritize enhancing the productivity of human capital in these sectors and growing it in other sectors where it will yield greater well-being gains.

Market natural capital is the second largest share of the CWI of the country, accounting for 20% to 34% of total wealth. To grow this wealth, the government should target enhanced productivity in agriculture and forestry through investment in sustainable land management and/or nature-based solutions. Investment in sustainable land management and/or nature-based solutions for increasing natural capital requires a mechanism for financing such investments. As part of the financing mechanisms, the country should explore possible financing mechanisms, including schemes for "payments for ecosystem services."

Regarding non-market natural capital, the study found that land area per capita fell by more than half over the period due to rapid population growth. Again, investments in productivity will be required to offset the decline in available land resources per capita. The country has made significant efforts to expand its total forested land, which increased from 18.3% to 21.5% of the total land area over the period. This presents an essential step toward the reinforcement of the country's carbon storage capacity and the development of other forest ecosystem services. Climate system indicators show an upward temperature trend and high precipitation variability. The country is highly vulnerable to climate change and needs to invest more in adaptation and mitigation measures that complement the sustainable management of its natural capital.

Produced capital is concentrated in four sectors: manufacturing, real estate, construction, and agriculture. Although the agricultural sector is the dominant sector in terms of its contribution to the country's GDP, investment in produced capital in the agriculture industry grew at a relatively low rate compared to other sectors (like manufacturing, real estate, and construction) that contribute less to real GDP. The agricultural sector remains dominated by traditional farming technologies (such as ox-powered plows). The country needs to focus on increasing investment in fixed capital in the agricultural sector to increase its productivity and contribution to the economy. The service, education, and health sectors account for a small percentage of the stock of produced capital, and this low level of investment constrains the future development of the country's human capital.

Financial capital, traditionally a strength of the country, has become a drag on well-being. In 2019/20, the FCI moved into negative territory after being positive for the rest of the study period. High levels of net foreign debt are a burden in terms of debt servicing (paying interest on debts) and repayment of the principal amount of debt, limiting Ethiopia's ability to invest in inclusive economic growth and sustainable natural resource management. Thus, managing Ethiopia's debt through policies such as debt for nature/climate swap could provide inclusive investment in nature protection and climate change mitigation and adaptation as a bridge to greater debt sustainability and address the three crises of debt, climate, and nature.

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Appendix A. Methods and Data Sources

Table A1. Data used in the calculation of produced capital index

Data sources:

- Central Statistical Authority of Federal Democratic Republic of Ethiopia and National Bank of Ethiopia
- International Monetary Fund (IMF) and EconomyWatch.org
- World Bank

Fiscal year GC	Nominal GDP (GDP at current market prices) in ETB billion	Real GDP (GDP at constant market prices) in ETB billion	Real GDP growth (%)	Consumer Price Index (2016/17 =100)	Nominal gross fixed capital formation (billions of ETB)	Gross fixed capital formation (% of GDP)	Implied exchange rate (ETB/ USD)	Population in million, WB data	Population growth rate (%)
1992/93	390	273	13.36	13	6.40	16.39	1.88	53.30	3.6
1993/94	414	283	3.49	14	7.24	17.47	1.89	55.18	3.5
1994/95	496	300	6.12	15	6.12	12.35	2.09	57.05	3.4
1995/96	559	340	13.53	14	9.79	17.52	2.05	58.88	3.2
1996/97	579	350	2.84	14	7.75	13.39	2.02	60.70	3.1
1997/98	557	335	-4.19	14	8.46	15.19	2.00	62.51	3.0
1998/99	598	357	6.29	15	9.09	15.20	2.01	64.34	2.9
1999/00	689	392	9.84	15	17.04	24.73	2.10	66.22	2.9
2000/01	703	424	8.30	14	18.47	26.25	1.94	68.16	2.9
2001/02	688	431	1.51	14	20.24	29.41	1.84	70.14	2.9
2002/03	759	421	-2.16	16	20.56	27.08	2.03	72.17	2.9

Fiscal year GC	**Nominal GDP (GDP at current market prices)** in ETB billion	**Real GDP (GDP at constant market prices)** in ETB billion	**Real GDP growth** (%)	**Consumer Price Index** (2016/17 =100)	**Nominal gross fixed capital formation** (billions of ETB)	**Gross fixed capital formation** (% of GDP)	**Implied exchange rate** (ETB/ USD)	**Population in million, WB data**	**Population growth rate** (%)
2003/04	896	478	13.57	17	28.98	32.34	2.06	74.24	2.9
2004/05	1,101	535	11.82	18	31.90	28.97	2.19	76.35	2.8
2005/06	1,361	593	10.83	21	41.84	30.73	2.37	78.49	2.8
2006/07	1,779	661	11.46	24	47.98	26.98	2.71	80.67	2.8
2007/08	2,568	732	10.79	35	70.00	27.26	3.46	82.92	2.8
2008/09	3,468	797	8.80	38	96.07	27.70	4.27	85.23	2.8
2009/10	3,960	897	12.55	41	119.17	30.09	4.28	87.64	2.8
2010/11	5,286	997	11.18	54	164.53	31.13	5.04	90.14	2.9
2011/12	7,669	1,083	8.65	67	275.81	35.96	6.64	92.73	2.9
2012/13	8,896	1,198	10.58	72	293.93	33.04	7.08	95.39	2.9
2013/14	10,886	1,321	10.26	77	400.84	36.82	7.14	98.09	2.8
2014/15	13,320	1,458	10.39	85	508.98	38.21	7.77	100.84	2.8
2015/16	15,681	1568	7.56	90	585.67	37.35	8.06	103.60	2.7
2016/17	18,326	1,717	9.50	100	704.60	38.45	8.52	106.40	2.7
2017/18	22,024	1,834	6.81	114	751.63	34.13	9.35	109.22	2.7
2018/19	26,962	1987	8.35	132	948.87	35.19	10.37	112.08	2.6
2019/20	33,743	2,109	6.14	159	1,037.69	30.75	12.10	114.59	2.2

Appendix B. Methods of Calculating Produced Capital

There is a large body of work on the data and method needed to measure produced capital (Böhm et al., 2002; Feenstra et al., 2015; Lange et al., 2018; Organisation for Economic Co-operation and Development [OECD], 2009). At a minimum, it requires data on the value of annual investments in fixed assets, inventories, and valuables. Produced capital represents the value of the stock of all human-made assets used to produce goods and services in the economy. The United Nations System of National Accounts (European Commission et al., 2009) defines produced capital as "produced assets that are used repeatedly or continuously in production processes for more than one year." These include assets such as structures, machinery, and equipment, cultivated trees or animals that are used repeatedly or continuously to produce other products, such as fruit or dairy products, and intellectual property products, such as software or artistic originals used in production. Produced capital stocks may also be classified by economic sector. In Ethiopia, sectoral data on produced capital is unavailable from the Central Statistical Agency (CSA), the National Bank, or the National Income Accounts section of the National Planning Commission. However, the Ethiopian Investment Commission, CSA, and National Bank report investment by sector.[6] These investment data were used to compile the estimated produced capital stocks required for the study.

In addition to data on investments in produced capital, information is required on the expected service lives and annual depreciation rates of the assets to compile produced capital stocks. All produced assets have a limited but varying useful lifetime in production due to their tendency to deteriorate from use over time. Due to a lack of observed estimates of depreciation rates for produced assets in Ethiopia, we applied an annual depreciation rate of 3.38%, which is an average value of the depreciation rates for public (2.5%) and private (4.25%) produced assets in low-income countries suggested by Gupta et al. (2014).

With investment data and information on service lives/depreciation rates in hand, it was possible to estimate produced capital stocks. Among the various methods available for doing so, the most widely applied by statistical agencies—the so-called perpetual inventory method (PIM)—was chosen. The idea of the PIM is that produced capital stocks may be estimated as the cumulated flows of annual investments in produced assets corrected for depreciation of those assets.

To measure produced capital stocks using the PIM, an opening capital stock estimate for the first year of the time series is required. To estimate this opening stock, we used a simplified approach adapted from the OECD *Measuring Capital* handbook (OECD, 2009). Starting from this opening stock estimate, we compiled a time series of produced capital stocks from 1992/93 to 2019/20 in nominal prices by accumulating gross fixed capital formation (GFCF)

[6] Sectors include agriculture (agriculture, hunting, fishing, and forestry), construction, education, health and social works, hotels and restaurants, manufacturing, mining, and quarrying, other community, social and personal service activities, real estate, renting and business activities, transport, storage and communication, wholesale, retail trade and repair services.

and depreciating the stock of capital existing at the beginning of each year using a depreciation rate of 3.38% stated above. Next, we deflated the time series of produced capital stocks using the consumer price index (CPI) with 2016/17 as the base year. Then, we divided the result by population to derive the real per capita measure of produced capital required for the CWI. Finally, to convert the real per capita figures from Ethiopian Birr to United States dollars, we applied the 2017 purchasing power parity (PPP) exchange rate from the World Bank to all years. The steps are laid out in more detail below.

Step 1 – Estimating the opening value of produced capital stocks for 1992/93

We estimated the 1992/93 capital stock value using a simplified approach outlined by the OECD (2009) handbook and based on data in Table A1. According to this approach, a reasonable estimate of the produced capital stock in any year may be derived by dividing the value of gross fixed capital formation in that year by the sum of the depreciation rate of fixed capital plus the long-term growth rate of real GDP. Equation A1 expresses this approach in algebraic notation:

$$K_0^T = \frac{I_0^T}{(\delta^s + \theta)} \qquad \textbf{A1}$$

where

- K_0^T is the total nominal value of the produced capital stock in the base year (1992/93)
- I_0^T is the total nominal value of gross fixed capital formation in the base year (1992/93)
- δ is the annual rate of depreciation of fixed capital (a constant); we used a 3.38% depreciation rate as stated above (Gupta et al., 2014).
- θ is the long-term annual growth of real GDP in the economy (a constant). We used a real GDP growth rate of 1.34% calculated as a geometric mean of the annual growth rates of real GDP of Ethiopia for the period 1980 to 1993 for which data is available.[7]

In implementing Eq. 1, we want to avoid situations in which an outlier GFCF value for 1992/93 would unduly influence the value of I_0^T. To avoid this, we took the average GFCF from 1990/91 to 1994/95 to estimate the value of I_0^T.[8] Equation A2 expresses this in algebraic terms:

$$I_0^T = \frac{\sum_{t=1990/91}^{FY\ 1994/95} I_t^T}{5} \qquad \textbf{A2}$$

where I_t^T is the total nominal value of gross fixed capital formation in year t (t $\in \{FY$ 1990/91, 1991/92,1992/93,1993/94 *and* 1994/95$\}$).

[7] Real GDP growth rate for the period 1980-1993 from IMF as reported in Economy Watch database is used for calculating the average long term real GDP growth rate using geometric mean (Economy Watch, n.d.).

[8] If the base year for a country is not 1992/93, then GFCF will be averaged for whatever 5-year period is centred around the chosen base year.

Step 2 – Compiling the time series of capital stock estimates.

After estimating the nominal value of capital stock for 1992/93, we constructed a time series of nominal capital stock estimates for 1992/93 to 2019/20. This was done using a simple approach of accumulating nominal GFCF each year and depreciating the capital stock of the previous year. This is shown algebraically in Equation A3:

$$K_t^T = K_{t-1}^T + I_t^T - (\delta^s \times K_{t-1}^T) \quad \textbf{A3}$$

where

- K_t^T is the total nominal value of the produced capital stock in year t
- K_{t-1}^T is the total nominal value of the total produced capital stock in year $t-1$; at $t = 1$, $K_{t-1}^T = K_0^T = I_0^T$
- $GFCF_t^T$ is the total nominal value of gross fixed capital formation of produced capital in year t
- and other variables are as previously defined.[9]

Because of constraint on availability of disaggregated data of GFCF by type of asset and sectors, we used the ratio[10] of planned investments as reported by the Ethiopian Investment Commission[11] in each sector to total planned investment flows in all sectors to disaggregate GFCF and produced capital stock by sectors. We applied the following equations to disaggregate the GFCF and produced capital stock by sector:

$$a_t^j = \frac{V_{tp}^j}{V_{tp}^T} \quad \textbf{A4}$$

$$I_t^j = a_t^j \times I_t^T \quad \textbf{A5}$$

$$K_t^j = K_{t-1}^j + I_t^j - (\delta^s \times K_{t-1}^j) = K_t^j = a_t^j \times K_t^T \quad \textbf{A6}$$

where

- a_t^j is the ratio of planned investment in sector j in year t to total planned investment in all sectors in the same year based on data from the Ethiopian Investment Commission
- V_{tp}^j is the nominal value of planned investment of sector j in year t

[9] Note that Equation A3 assumes that produced capital of all types in all industries depreciates at a constant annual rate. This is not likely true, as capital will have different depreciation profiles depending on its type and how it is used. Some assets will depreciate evenly over time while others may depreciate more quickly earlier or later in their lives. For the purposes of this study, we assumed linear depreciation rate of 3.38% based on Gupta et al. (2014).

[10] The ratio of investment in each sector to total annual investment was calculated based available data (2001/02 to 2018/19) from National Bank of Ethiopia and Ethiopia's Investment Commission and for the remaining years for which data was not available, we imputed the 18 years averages of the investment ratios for each sector.

[11] The Ethiopian Investment Commission reports data on the annual approved plans for investment in each sector of the economy. Though such investments are not always executed as planned, they nonetheless may be taken as a reasonable indicator of the split of total actual gross fixed capital formation by sector.

- V_{tp}^{T} is the nominal value of total planned investment of all sectors in year t
- I_t^j is the nominal value of gross fixed capital formation of sector j in year t
- K_t^j is the nominal value of the produced capital stock of sector j in year t
- K_t^T is the nominal value of the total produced capital stock of all sectors in year t (from Eq. A3)

Step 3 – Deflation and normalization by population

Since C/IW is measured in real (or inflation-adjusted) and not nominal values, to deflate the estimated total nominal value of produced capital (K_t^T) and each K_t^j, we used the CPI, base 2016/17 using the following equations for the aggregate real capital stock and sector wise real capital stocks respectively.

$$\overline{K}_t^T = \frac{K_t^T}{CPI_t} \quad \text{A7}$$

$$\overline{K}_t^j = \frac{K_t^j}{CPI_t} \quad \text{A8}$$

where $\overline{K}_t^T$ is the total real value of produced capital in the economy in year t.

Finally, to normalize the results in equations A7 and A8 by population, in other words to calculate the produced capital index on real per capita basis, we divided the results by total population[12] sizes of the country for the corresponding years covered in the study using the following equations.

$$PCI_t = \frac{\overline{K}_t^T}{P_t} \quad \text{A9}$$

$$PCI_t^j = \frac{\overline{K}_t^j}{P_t} \quad \text{A10}$$

where

- PCI_t is the real produced capital index for the country in ETB per capita at time t
- PCI_t^j is the real produced capital index of sector j in ETB per capita at time t
- P_t is total population size of the country at time t.

Finally, the estimates in ETB were converted into constant 2017 USD using the IMF implied conversion rate, base 2017 which equals 8.52 (Table A1). The choice of 2016/17 as base year for the constant ETB estimates allowed direct conversions to USD without further adjustments of bases.

[12] Ethiopia did the last population census in 2007. National and international data on population are therefore based on projections. The national level projections show relatively lower population figures for the country compared to the international projections for example for the year 2018/19 are lower by 13.4 million (112.08 million versus 98.66 million). Therefore, we used population projection data from the World Bank Database.

Appendix C. Human Capital

Human capital is most commonly measured using either a cost-based approach or a lifetime income approach. In the cost-based approach, the value of the human capital stock is calculated as the depreciated value of the stream of past investments, including investments coming from the individual, the family, employers, and governments (Eisner, 1985; Kendrick, 1976; Schultz, 1961). The lifetime income approach, which was favoured for this study, measures human capital by summing the discounted values of all future income streams that all individuals in the population expect to earn throughout their lifetime (e.g., Jorgenson & Fraumeni, 1989, 1992a, 1992b; UNU–IHDP & UNEP, 2012, 2014). The approach is data intensive, however, so a simplified method following Macklem (1994) was adopted.

The formula for HC calculation used in this study is:

$$HC_t = \sum_{n=1}^{\infty} LC_t \frac{(1+g)^n}{(1+r)^n} \qquad \textbf{A11}$$

where HC_t is the human capital in year t, LC_t is the total market labour compensation in year t, g is the expected real annual growth rate of labour compensation, and r is the discount rate. Note that, in keeping with the approach to estimating the value of other assets, we're not taking wage growth into consideration in this study, unlike the approach used by Macklem (1994). The reason for this is simply for consistency of methods across assets. Also, since we assume that human capital will last forever, we can use the simplified formula for calculating wealth, where the asset value in year t is simply the rent in year t (total labour compensation in this case) divided by the discount rate.

We estimated labour **market compensation for self-employment** as follows:

- For labour market compensation in the agricultural sector, which includes labour in crop production, animal farming, forestry and fishing sub-sectors, we used the agricultural GDP multiplied by a wage factor of 0.9 as labour market compensation for labour engaged in the sector, which accounts for 64% of the total employment in the country in 2021 (World Bank, 2024a).
- For labour market compensation in small-scale and cottage industries, retail trade, private households with employed persons, and labour in other community, social, and personal activities, for which GDP contributions are reported in the country's system of national accounts (SNA), we considered the same wage factor of 0.9. This means total labour market compensation for people employed in these sectors equals 0.9 times the GDP of each sector.
- For labour market compensation in the mining and quarrying sector, for which GDP contribution is reported in the country's SNA, we considered a wage factor of 0.5. This means total labour market compensation for people employed in this sector equals 0.5 times the GDP of the sector.
- For labour market compensation in transport and communication, construction, wholesale trade, hotel and restaurant, and health and social work sectors, for which

GDP contributions are reported in the country's SNA, we considered a wage factor of 0.3. This means total labour market compensation for people employed in these sectors equals 0.3 times the GDP of each of these sectors.

- For labour market compensation in large and medium manufacturing industries and education sectors, for which GDP contributions are reported in the country's SNA, we considered a wage factor of 0.2. This means total labour market compensation for people employed in these sectors equals 0.2 times the GDP of each sector.

We calculated **labour market compensation from employment** as follows:

- Data on the "compensation of employees" variable from the SNA that we compiled from the World Bank (2024b) is not disaggregated by sector. We obtained data on recurrent expenditure in three broad sectors (public administration and general services, economic services, and social services)[13] from the National Bank of Ethiopia under its reports on public finance for the period 2003/04–2019/20 (National Bank of Ethiopia, n.d.). These expenditures include salaries, periderms, and other recurrent expenditures. We used these data to construct ratios of recurrent expenditures in each broad sector to total recurrent expenditures of the three broad sectors for the period 2003/04 to 2019/20. For the remaining years (1992/93 to 2002/03), we assumed the ratios for 2003/04. We multiplied the compensation of employees' data from the World Bank by these ratios to get the disaggregated compensation of employees in the three broad sectors (public administration and general services, economic services, and social services). Furthermore, we obtained detailed data on the recurrent expenditure of 2019/20 with the sectors included under the broad sectors. Public administration and general service includes organs of the state, justice and security, general services, and national defence. In the SNA, these are all reported as public administration and national defence, and the GDP contribution of the sector is reported. Thus, the compensation of employees multiplied by the ratio of public administration and general services expenses to total recurrent expenses in the three broad sectors gives us compensation of employees in the public administration and national defence sectors.
- The compensation of employees in the economic services sector has been further disaggregated into seven sectors (agriculture, electricity and water, wholesale trade, large and medium-scale manufacturing industries, mining and quarrying, transport and communication, and construction sectors) based on 2019/20 data from the Ministry of Finance on recurrent expenditure in economic services that reported recurrent expenditures in the above-listed sectors. We first calculated the ratio of recurrent expenditures in each sector to the total recurrent expenditure of economic services. We multiplied the compensation of employees in the economic services by each of these ratios to further disaggregate the compensation of employees in each of the seven sectors listed above.

[13] Public Administration and General Services covers activities and services that are key for the functioning of the state such as legislative activities, tax collection, security, external affairs, and general administrative services. Economic Services are activities directly contributing to the development of the country. They include core sectors such as agriculture, trade, and industry. Social Services are related to welfare and quality of life of citizens. They include sectors such as education, housing, and health.

- The disaggregated compensation of employees in social services has been further disaggregated into the compensation of employees in three sectors (education, health and social work, and other community, social, and personal activities). Based on similar data from 2019/20 on the recurrent expenditure[14] of social services and the sectors it includes, we first calculated the ratio of recurrent expenditures in each sector to the total recurrent expenditure of social services. We multiplied the compensation of employees in the social services by each ratio to further disaggregate the compensation of employees in the three sectors listed above.
- Finally, for each sector, we sum the labour market compensation from self-employment with labour market compensation from employment to get the total labour market compensation by sector.
- We divided the total labour market compensation by the real discount rate to get the discounted value of human capital in each sector. We used the average real discount rate of 6.964[15] to calculate the discount in accounting for the natural capital.

[14] https://www.mofed.gov.et/media/filer_public/3c/11/3c11e7d1-d342-413f-ac2d-ba3dd733878c/2012_ec_budget_year_goe_federal_budget_proclamation_part_two.xlsx

[15] Based on data from National Bank of Ethiopia and the World Bank on interest rate on lending and inflation rate for the period 1992/93 to 2019/20, we calculated the real interest rate for each year using the formula: $r = (i - \pi)/(1 + \pi)$ where r is real interest rate, i is nominal interest rate on lending, and π is inflation rate. Then we calculated the geometric mean of the real interest rates of 17 years in the period 1992/93-2019/20 for which real interest rates are positive and used the result as long-term average real discount rate. We selected the 17 years for which real interest rates were positive, because during these years price levels were relatively stable and rates of inflation are lower than nominal interest rates and indicate stable economic condition. Using the other years has the risk of understating the discount rate. Average real interest rate for the period 1992/3 to 2019/20 is 0.554 and it does not reflect the real time preference of people or decision makers in the Ethiopian context.

Appendix D. Natural Capital

D1. Market Natural Capital

The estimation of the value of market natural capital is based on the concept of resource rent. Resource rent is calculated as the difference between the revenues earned in a resource extraction activity in a given year and the costs of that extraction, including materials, energy, labour and produced capital inputs (opportunity cost plus depreciation). The estimation was as follows for each type of marketable resource or market natural asset, such as agricultural products (crops, livestock, poultry, and beekeeping products), forest products, hydroelectric power, and minerals. We estimated the annual rents of each resource starting from 1992/1993. Next, we calculated the present value of the expected future rent generated from its use using a real discount rate of 6.964, which corresponds to the average over the expected productive lifetime of the asset. This gave us the value of natural capital in current (or nominal) terms for the asset under consideration. Next, for each year of the study period (1992/93–2019/20), we applied the CPI as a deflator, taking 2016/17 as the base year to convert the nominal values of natural capital to real ones. Next, we estimated each year's total real value of natural capital by summing all individual estimates. Next, we divided the aggregate value of real natural capital by the population to obtain the real per capita estimates of natural capital. Details on data and methodology for each natural asset are provided below. Finally, the real per capita estimates were converted to USD using the 2017 PPP exchange rate.

The general approach to measuring market natural capital in this study is as follows:

1. We estimated the annual resource rent for each market natural asset, starting from the base year 1992/1993.

$$RR_t^i = TR_t^i - C_t^i - (r_K K_t^i + \partial^i) \qquad \textbf{A12}$$

where

- RR_t^i = rent of market natural asset i in year t
- TR_t^i = total revenue from resource extraction (net of subsidies) of market natural asset i in year t
- C_t^i = total extraction costs (materials, energy, and labour) of the market natural asset i in year t
- r_K = rate of return to capital (market interest rate on savings)
- K_t^i = the value of the produced capital stock used in the extraction process of market natural asset i in year t
- ∂^i = depreciation of produced assets used in the production of market natural capital asset i, assumed constant

2. We calculated the present value of the expected future rent generated from its use using an average real discount rate of 6.964 over the expected productive lifetime of the asset.

$$V_t^i = \sum_{t=1}^{T} \frac{RR_t^i}{(1 + r_d)^t} \quad \textbf{A13}$$

where

- V_t^i = in situ value of the market natural asset i in year t
- T = the expected remaining asset life (For renewable resources we assumed infinite productive lifetime). For minerals, because they are non-renewable resources, T is finite and equals the lifetime of the mineral ores, which is a function of the reserve in the ores and the annual extraction rate (see details below on how we determined T for non-renewables).
- r_d = long-term average real discount rate = 6.964
- RRt = annual resource rent (in equation A12).

3. We applied the CPI as a deflator, taking 2016/17 as the base year (2016/17 CPI = 100) to convert the nominal values of the present value of rents to real ones for the period 1992/93 to 2019/20.
4. We estimated the total real value of all natural assets in year t in by summing all individual V_t^i calculated in equation A13:

$$V_t^T = \sum_{i=1}^{N} V_t^i \quad \textbf{A14}$$

where

- V_t^T is the total value of natural capital in real prices in year t and N is the number of individual natural assets.

5. We divided the real present value of resource rent by population to get the real per capita measure of market natural capital from each asset for the period 1992/93 to 2019/20.

D.1.1 Present Value of Rent Per Capita From Crops

To calculate revenue from each the over 60 crop types (which include cereals,[16] pulses,[17] oilseeds,[18] vegetables,[19] root crops,[20] fruits,[21] plantations [including coffee],[22] and spices[23]), we used data on harvested area, production, and producers' prices of crops from the CSA

[16] Cereals: teff, barley, wheat, maize, sorghum, figure millet, oats, rice

[17] Pulses: fava bean, field peas, haircoat beans, chickpeas, lentils, grass peas, soya beans, gibto

[18] Oil seeds: neug, linseed, ground nuts, safflower, sesame, rapeseed.

[19] Vegetables: lettuce, head cabbage, tomatoes, green pepper, red pepper, Swiss chard

[20] Root crops: carrot, onion, potatoes, yam, garlic, sweet potato

[21] Fruits: avocado, banana, lemon, orange, mango, papaya, pineapple

[22] Plantations: coffee, khat, hopes, sugar cane, cotton, tea, tobacco, sisal, bast fibres

[23] Spices: nutmeg, mace, cardamoms, anise, badian, fennel, coriander, ginger, other spices

for the period 1992/93 to 2019/20. To calculate the cost of crop production, we used data on input (seed and fertilizer) from the CSA, and we value the seed cost by the producer price of crops with data from the CSA and farm gate price of fertilizers from literature (Cedrez et al., 2020). International Fertilizer Development Center, 2012; Rashid et al., 2013); We estimated the prices of seeds and farm gate prices of fertilizers for the period 1992/93 to 20219/20 and used them to calculate the costs of seeds and fertilizer inputs used in the production of each crop type for the indicated period. To calculate the cost of labour, as rural labour markets in Ethiopia are imperfect and share-cropping arrangements in the land and labour markets are common (Deininger et al., 2008; Gebru et al., 2019; Gebrehiwot & Holden, 2020; Holden & Tilahun, 2021), we assumed 50% of the revenue from crop production goes to the landowner as rent. In other words, the 50% of the revenue as share to the tenant includes the cost of seed, fertilizer, and depreciation of fixed inputs as wage for labour used in crop production. To disaggregate these costs, we considered traditional farm implements and two oxen per hectare as fixed capital in crop production of smallholder rural farmers and got the prices of these inputs from CSA. We estimated the prices of farm implements and two oxen for the period 1992/93 to 2019/20 on per-hectare basis. We assumed five years of productive lifetime of both farm implements and two oxen and salvage value of 50% of the prices of these fixed factors in calculating the depreciation costs per hectare. By multiplying the costs per hectare with the total cultivated land in hectare per crop type we got the costs of depreciation. To calculate the cost of capital, we used the market interest rate on savings and multiplied this by the total nominal value of the fixed factors (farm implements and oxen). Finally, we deducted these costs (input, labour, depreciation, and cost of capital from the total revenue of a crop to get the annual rent for the period 1992/93 to 2019/20, which is the same as 50% of the revenue from harvest that goes to the landowner as rent.

D.1.2 Present Value of Rent Per Capital From Livestock, Poultry, & Beekeeping

Livestock Products and Services

To calculate revenue from **livestock products** (milk, meat, hides and skins, greasy wool), we used data on quantities of these products of different livestock types (cattle, goat, sheep, and camel) and producers' prices of these products from the CSA for the period 1992/93 to 2019/20. For some of the products like pig meat, hides, skins and greasy wool and their producer prices, we rely on data from FAOSTAT. We used the prices to calculate the revenue from each of these livestock products for the period 1992/93 to 2019/20. We also considered revenues from **livestock services** because in Ethiopia livestock (mainly oxen, horses, mules, donkeys, and camels) provide services for traction in farming and for transport. The authors assumed that equines (horses, mules and donkeys) and oxen serve to transport harvests from farm to homestead for at least 25 days (2 rounds of trips per day) during the peak season (December to February), equines and camels serve as local transport for transporting people and goods from home to local market by owners for at least 1 day (2 trips) per week (104 trips per year) as rural open markets in Ethiopia are commonly held one day per week. In addition, donkeys are key animals used for transporting drinking water from water points to homes and transporting fuel wood from forest/woodlands to home in rural areas. We assumed that donkeys provide service to their owners for at least 1 day (2 trips) per week for fetching water and 1 day (2 trips) per week for transporting fuel wood. We considered only equines, camels, and oxen 3 years old and above used for such services, and data from the CSA on the population of livestock provides this age distribution. We also considered that only 50 female donkeys and female horses aged 3 and above are providing services because in rural areas, if a horse and donkey get pregnant, farmers do not use these animals frequently for transporting goods and people. In the lowland areas of Ethiopia, where camels are common, female camels are mostly used for breeding, and thus we only considered male camels as means of transport services.

We compiled data for animal transport fairs in rural Ethiopia from the CSA for the year 2015/16 and the cost was ETB 58.2 per trip. We used the prices and multiplied by the number of transport and traction providing livestock (i.e., male donkeys, horses, and oxen aged 3 and above and 50% female donkeys and horses, all male and female mules aged 3 and above, and male camels aged 3 and above) to calculate the revenue from livestock services.

To calculate the cost of producing livestock products and services, which include labour, animal feed, and other intermediate inputs (animal health, breading, and miscellaneous costs), we rely on literature (Yimer et al., 2016;[24] Meskel & Gemechu, 2017;[25] Miklyaev & Jenkins, 2013[26]). We multiplied each of these unit costs by the number of each type of livestock population to get the total costs of labour, animal feed and intermediate inputs for the period 1992/93 to 2019/20.

To calculate depreciation of the stock of livestock population, we assumed 90% of the original value as salvage value for all livestock types and a productive lifetime of 10 years for cattle, equines, and camels and 4 years for sheep, goats, and pigs. We calculated the annual cost of depreciation as 10 of the total value of each of each of the livestock population (which is the product of total number of the livestock population and producer price per unit of livestock) divided by the lifetime of the livestock type. To calculate the cost of livestock capital

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[24] Yimer (2016) reported 3.35 tonnes of dry matter with a value of ETB 1,292 /tonne in 2014/15 prices is required for 12.3 heads of livestock of various sorts herded by a household; we used this and generated inflation-adjusted feed cost per animal (352 ETB/head/year) and real prices for period 1992/93 to 2019/20 (Yimer, 2016).

[25] Meskel and Gamechu (2017) reported labour cost of ETB 2529, cost of medications of ETB 254.4, and miscellaneous costs of ETB 194.4 per animal for smallholder cross-bred dairy production in Ethiopia for the survey year 2013/14. The costs reported by Meskel and Gemechu (2017) are for cross-bred dairy farm smallholders and may not represent, particularly for the labour cost, the cost of the dominant livestock production system. Therefore, we assumed half of the labour cost (ETB 1,264.5 per animal for cattle and equines) and the other costs as reported by Meskel and Gemechu (2017). We adjusted these figures for inflation and estimated these costs in real prices for the period 1992/93 to 2019/20 and used that to estimate costs of livestock products and services from cattle, equines, and camels and products from pigs (Meskel & Gemechu, 2017).

[26] Miklyaev and Jenkins (2013) reported costs of labour (ETB 107.14 /animal/year), medical and breading (ETB 8 /animal/year), and other miscellaneous costs (2% of animal deaths and 1% of feed sunk costs, which together are about ETB 12.75 /animal per year, assuming ETB 500 as price per animal (Miklyaev & Jenkins, 2013) and feed cost of 352 ETB/animal/year (Yimer et al. (2016)) for fattening of goats and sheep in highlands of Ethiopia. The costs reported by Miklyaev and Jenkins (2013) are fattening of sheep and goats and may not represent, particularly for the labour, the cost of the dominant livestock production system. Therefore, we assumed half of the labour cost (ETB 53.57 per animal for sheep and goats) and the other costs as they are reported by Miklyaev and Jenkins (2013). We adjusted these costs for inflation and estimated the costs in real prices for the period 1992/93 to 2019/20 and used the estimated costs of producing livestock products from sheep and goats (Miklyaev & Jenkins, 2013).

we multiplied the value of the stock of livestock population by the interest rate on savings (data from National Bank of Ethiopia). We disaggregated the input costs (labour, feed, and intermediate) of depreciation and livestock capital to livestock products and services and finally deducted these costs from the total revenues of livestock products and services to get the annual nominal rents from livestock products and livestock services for the period 1992/93 to 2019/20. Finally, we followed steps 2 to 5 to calculate the rent per capita from livestock products and livestock services.

Poultry

To calculate revenue from poultry (eggs and meat), we used data on quantities of these products and producers' prices of these products from the CSA for the period 1992/93 to 2019/20. To calculate the costs of poultry production (input costs including labour, and depreciation and cost of capital), we relied on unit costs from literature (Gemechu & Abiy, 2017)[27] who reported costs of feed, labour, medicine and disinfectants, depreciation of fixed capital, and cost of capital for dual-purpose chicken farming enterprises in Ethiopia. Finally, we deducted these costs (cost of feed, labour, intermediate inputs, depreciation, and cost of capital) from the total revenues of poultry products to get the annual rents for the period 1992/93 to 2019/20. Finally, we followed steps 2 to 5 to calculate the rent per capita from poultry.

Beekeeping

To calculate revenue from beekeeping products (honey and beeswax), we used data on number of beehives, average annual yield per beehive, and production quantities of honey and its producer prices from the CSA for the period 1992/93 to 2019/20. For beeswax and its producer prices, we rely on data from FAOSTAT. We used the prices to calculate the revenue from poultry for the period 1992/93 to 2019/20. To calculate the costs of labour and depreciation and cost of capital, we rely on Jenkins & Miklyaev (2014)[28] who reported the costs of honey production in Ethiopia. Finally, we deducted these costs (for labour, depreciation, and cost of capital) from the total revenues of beekeeping and got the annual

[27] Gemechu and Abiy (2017) reported that the annual cost for chicken farming enterprise with ETB 425/year, and these include feed costs (including transport) of ETB 62,497.85 per year, labour cost of ETB 4,494.55 for repairs and maintenance as well as cleaning of poultry sheds, medicine, and disinfectant costs of ETB 2,448.20, and ETB 1,156.5 per year as depreciation on equipment and buildings, and ETB 1,903.5 as cost of capital (investment on capital at a rate of 12%). We divided these costs by 425 (total number of birds per enterprise as reported in Gemechu and Abiy, 2017) to get the cost for each item per head of bird. For the fact that poultry farming by smallholder farmers in rural areas is not like the poultry enterprises, assuming the enterprise cost will overestimate the actual cost of poultry farming in rural areas. Therefore, we assumed only 30% of this unit cost in our analysis. We adjusted these unit costs for inflation and estimated the real costs per unit for each cost item for the period 1992/93 to 2019/20 and used for calculating the costs of feed, labor, intermediate inputs (medicine and disinfectants) and the costs of capital and depreciation (Gemechu & Abiy, 2017).

[28] Jenkins & Miklyaev (2014) reported the costs for five traditional beehives were ETB 750 in Amhara region and ETB 1,250; the costs for five bee colonies were ETB 15,000 in Amhara and 2,750 ETB in Tigray; the labour cost for five traditional beehives were ETB 146.88 in Amhara and ETB 256.25 in Tigray for the year 2011/12. We divided each cost by 5 to get the costs per unit of beehives. We adjusted these costs for inflation and estimated the real costs per hive per year of each cost item for the period 1992/93 to 2019/20 and used to calculate the cost of labor, depreciation, and capital costs of beekeeping. We considered bee colonies and beehives as capital with lifetime of 5 years in calculating depreciation. We used market interest rate for calculating cost of capital after adjusting for inflation (Jenkins & Miklyaev, 2014).

rents for the period 1992/93 to 2019/20. Finally, we followed steps 2 to 5 to calculate the rent per capita from beekeeping.

D.1.3 Present Value of Rent Per Capita From Forest Products

There are eight forest products covered in the study, including three wood products, namely fuel wood, charcoal, and timber (saw log, pulp wood, other industrial round wood) and five non-wood forest products (coffee, honey, beeswax, spices, and gums/resins). Data sources and specific notes on the calculation of rent from each forest product are described as follows. The data source for wood products (wood fuel, charcoal, saw log, pulp wood, other industrial round wood) was FAOSTAT data on Forestry Production and Trade.

In calculating the revenue from each of the wood products, we converted the physical quantities into a single unit of measurement (m^3). Some of the data, for example wood and charcoal, were in tonnes, and we converted these values into cubic metres using conversion factors[29] from literature. We used stumpage price[30] of wood for timber and wood for fuel and charcoal from FAO (2001) country report and Bekele (2011) for the period 1992 to 2010. These prices were nominal prices, and we estimated the nominal stumpage prices for 2011–2020 based on the data of 1992–2010 from the stated sources considering the annual average changes over the period 1992 to 2010. Then, all prices were used to calculate the revenue from wood products at real stumpage prices. Because we used stumpage prices, we did not deduct cost of labour and capital from the stumpage revenue in calculating the rent from wood products.

Non-Wood Forest Products

Gums and Resins

We used two data sources for determining the volume of natural gum and resin production. The first is data on volume of exports of natural gums and resins from the CSA. We got data on volume of exports for the period 1992/93 to 2019/20. However, this data does not show the total production, which is the sum of export plus domestic consumption of gums and resins. To solve this, we got data production, export, and domestic sales from Natural Gum Production and Marketing Enterprise (NGPME), which is a government owned enterprise operating in the sectors as major producer and exporter, accounting for close to 34% of the national level exports of gums and resins over the period 1999/00 to 2008/09. Based on these data, we calculated the ratio of exports to total production by the NGPME and used this ratio to estimate national level production of natural gums and resins for the period 1992/93 to 2019/20. We used the forest gate price of natural gums and resins, which is the price that tappers and collectors of natural gums and resins charge per 100 kg of gums and resins (Kassa et al., 2011; Tilahun et al., 2015). We adjusted these prices for calculating the total revenue from gums and resins production for the period 1992/93 to 2019/20.

29 *1,000 Kg of wood charcoal = 6.061 m^3 of wood* (Amous, 1999).

30 Stumpage prices are price charges for standing trees in monetary unit per m^3 of the volume of tree.

To calculate the costs, we used the ratio of opportunity cost of labour to total revenue of crop production and assumed zero capital cost and zero depreciation of capital in non-wood forest product extraction. We multiplied the total revenue of gums and resins by the ratio of opportunity cost of labour to total revenue of crop production to calculate the cost of labour from gums and resins extraction from forests. Following Yimer (2016) and Smith, McDougal et al. (2016), we assumed 3.4% of the revenue from gums and resins extraction as cost of intermediate inputs. We deducted these costs to get the annual rent for the period 1992/93 to 2019/20. Finally, we followed steps 2 to 5 to calculate the rent per capita from gums and resins extraction from forest.

Coffee and Spices

Based on crop production and input data from the CSA, we calculated the rent from coffee and spices for the period 1992/93 to 2019/20. Details on the methods used for rent calculation are presented in equations A12 and A13 above. Smith, McDougal et al. (2016), reported that 55% of coffee production in Ethiopia is derived from natural forests, 35% from plantation and 10% from garden coffee. About half of the garden coffee is also in forest areas and coffee plantations also need shade trees and are considered as forest. Therefore, it is possible to argue that 95% of coffee production in Ethiopia can be attributed to the forest sector rather than the conventional practice of attributing 100% of coffee outputs as part of agricultural output and GDP. Therefore, we considered 95% of the rent from coffee production as part of the rent from forests. Similarly, we assumed 4% of the rent from spices production as rent from wild spices derived from forest.[31] We deducted the rent from coffee and spices attributed to forests from the total rent from coffee and spices and take the difference as rents attributed to the agriculture.

Honey and Beeswax

Based on input and output data on beekeeping from the CSA of Ethiopia, we calculated the rent from honey and beeswax as described in equations A12 and A13. Following Nune et al. (2013) we assumed 70% of honey production is derived from forests; therefore, we take 70% of the calculated rent from honey and beeswax as rent derived from forests and 30% as rent attributed to agriculture.

[31] In Ethiopia, the four most important spices are ginger, turmeric, cumin, and korerima; respectively, these spices represent 65%, 15%, 8% and 3% of the national spice market (Meaton et al., 2015).
Spices of known forest origin are limited to korerima (also referred to as Ethiopian cardamom) and long pepper (piper capense; also known as timiz) (Avril, 2008; Smith, McDougal et al., 2016).
Chili pepper has spread to the wild and may be collected in some regions such as Gambella, though the extent to which this occurs is unknown (Avril, 2008; Smith, McDougal et al., 2016). Meaton et al. (2015) state that korerima represents 3% of the national spice market. No data on the share of long pepper production were found. Assuming that long pepper is less important that korerima, long pepper is assumed to account for 1% of the national spice market. Though the majority of korerima and long pepper are harvested from the forest, they are also cultivated in some areas (Avril, 2008; Gebreazgaabher et al. 2014). In the absence of other evidence, 90% of both korerima and long pepper are assumed to be derived from forests (Smith, McDougal et al., 2016).

D.1.4 Present Value of Rent Per Capita From Hydroelectric Power

To calculate the rents from hydroelectric power, we used the following formula:

$$hpR_t = TRhp_t - C_t - (r_K K_t + \partial) \quad \textbf{A15}$$

Where hpR_t is the rent from hydroelectric power at time t, $TRhp_t$ is the total revenue from sales of hydroelectric power generated at time t, C_t is the input costs including labour at time t used for production of hydroelectric power at time t, r_k is rate of return to capital (market interest rate on savings), K_t is the value of the produced capital stock used in the generation of hydroelectric power in year t, and ∂ is depreciation of produced assets used in the production of hydroelectric power, and assumed constant.

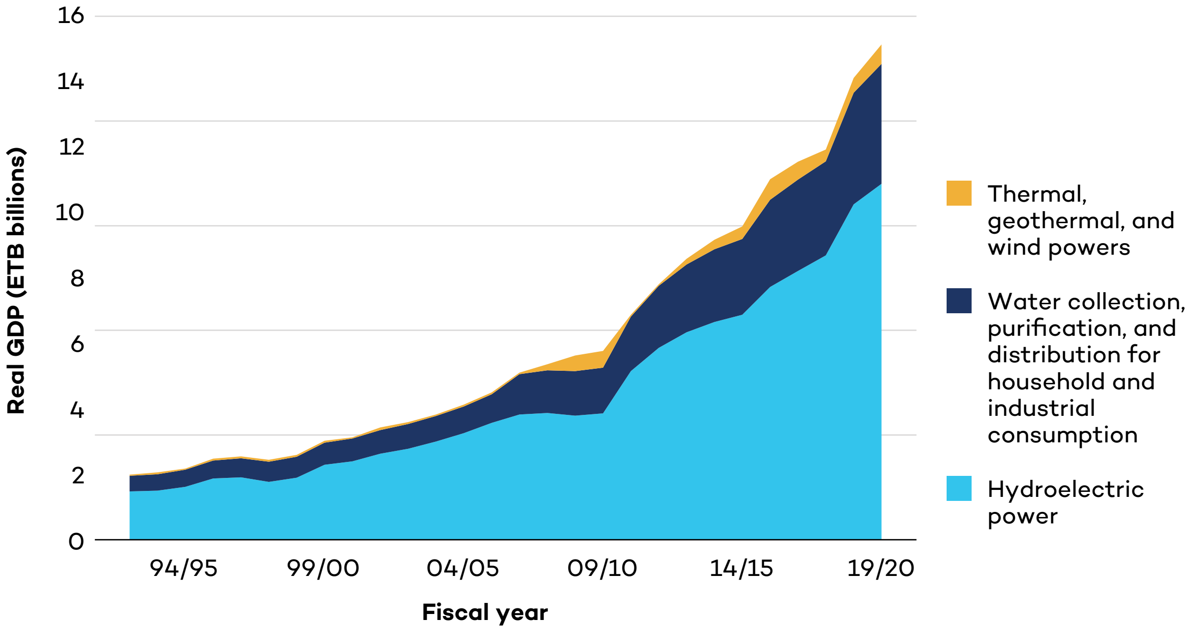
To calculate the revenue for sales of hydroelectric power, we got data on hydroelectric power production for the period 1992/93 to 2019/20 from the CSA and National Bank of Ethiopia. Whereas data on sales of electric power and cost of labour, and costs of other variable inputs are available from CSA for the period from 2014/14 to 2018/19. Therefore, we used the following method to estimate the revenues and costs for the years for which we could not get data.

1. Based on data from the CSA on production of electricity from hydropower and non-hydro sources, we determined the proportion of hydroelectric power to total electric power production for the period 1992/93 to 2019/20. The result shows that for the period 1992/93 to 2019/20, hydroelectric power production account on average 96.33% of the total electric power production, whereas electric power from non-hydro sources accounted for only 3.67% of the total annual electric power production over the indicated period.
2. We calculated the revenue from electric power sale per 100 KWH of electricity generated for the years that we have data on total sales of electricity. We used the average of these ratios and multiplied that total electric power generated to get the total revenue from sale of electric power for the years 1992/93 to 2019/20. We multiplied the result again by the ratio of electric production from hydro power to total electric production from all sources, which is on average 0.963. This gives the revenue from hydroelectric power for the period 1992/93 to 2019/20.
3. We applied similar method as stated in A and B above for estimating the cost of labour and other variable inputs.

Because of data constraints, we used the following method to estimate the cost of capital and depreciation. Data on GDP of the electricity and water sector for the period 1992/93 to 2019/20 has been collected from the CSA. The data is an aggregate of the value added from the production and distribution of hydroelectric power, the value added from the production and distribution of electric power from non-hydro sources (thermal, geothermal, and, recently, wind farms), and the value added from water collection, purification, and distribution for household and industrial consumption.

Based on data from the CSA, we first disaggregated the GDP from electricity and water sectors into value added by the electricity subsector and value added by the water collection, purification, and distribution sub-sector. The result shows that for the period 1992/93 to 2019/20, value added by the electricity subsector on average accounted for 76.72% of the value added by the electricity and water sector. The water collection, purification, and distribution subsector accounted for the remaining 23.28%. The hydroelectric power production accounted on average for 96.33% of the total electric power production whereas electric power from non-water sources was accounting only 3.67% of the total annual electric power production over the indicated period. We used these ratios and multiplied each of them by the value added from the electricity sub-sector to get the value added by the hydroelectric power and value added by the non-water electric power generating sources. Figure D1 shows the disaggregated value added (real GDP) by the three subsectors of the electricity and water sector real GDP.

Figure D1. Value added by hydroelectric power, non-water (thermal, geothermal and wind) electric power, and water collection, purification, and distribution for household and industrial consumption



Source: Authors' calculations based on data from Central Statistical Authority.

To calculate the depreciation and cost of capital, we refer to the chapter on produced capital (Section 2.2.1). From our produced capital measure, we got data on the cost of produced capital and depreciation of produced capital at national level for the period 1992/93 to 2019/20. First, we determined the share or ratio of value added by the hydroelectric power, non-hydroelectric power, and water collection, purification, and distribution sub-sectors to real national GDP for the period 1992/93 to 2019/20. Then, we multiplied each of these ratios by the country-level depreciation of fixed capital and cost of capital to get the depreciation and cost of capital for the three sub-sectors of the electricity and water sector, respectively. Finally, we deducted the labour costs, depreciation, and cost of capital from the value added by the hydroelectric power subsector to get the rent from hydroelectric power for the period 1992/93 to 2019/20. Finally, we followed steps 2 to 5 to calculate the rent per capita from hydroelectric power.

D.1.5 Present Value of Rent Per Capita From Minerals

To calculate the rent from minerals we used the following formula:

$$MR_t^i = GDPm_t - C_t^i - (r_K K_t^i + \partial^i) \quad \textbf{A16}$$

where MR_t^i is the rent from minerals (i = 1) at time t, $GDPm_t$ is the GDP of the mining and quarrying sector at time t. Other variables and parameters are defined in equations A12 and A13. Data on GDP of the mining and quarrying sector for the period 1992/93 to 2019/20 has been collected from the CSA.

To calculate the cost of labour included in C_t^i, we relied on Household Income and Consumption Expenditure Survey (HICES) data from the CSA. HICES surveys are conducted, on average, every 5 years, and we rely on the 1995/96, 1999/2000, 2004/05, 2010/11, and 2015/16 HICES survey data. In these data sets, the number of household heads employed in the mining and quarrying sector and the average household expenditure by households employed in the sector are reported. We assumed income from employment by household heads in the sector is the only source of household expenditure and hence the product of the number of household heads in the sector by the average household expenditure equals the total wage for labour employed in the sector. Based on the five HICES survey data stated above, we estimated the total wage for the other years.

Table D1. Mineral reserves of Ethiopia

Minerals	Reserve in ton 1,000s of tones	Minerals	Reserve in ton 1,000s of tones
Gold	>0.2	Silica sand	34,000
Coal	>0.36	Feldspar	500
Tantalum	19.44	Quartz	400
Platinum	0.0125	Dolomite	2000
Iron	68,400	Kaolin	>120,000
Nickel	17,000	Datomite	172,000
Manganese	207.56	Bentonite	460,000
Limestone	>900,000	Soda ash	4,300,000
Gypsum	57,400	Sulphur	6000
Clay	21,600	Graphite	460
Potash	1,300,000	Kyanite	>10,000
Phosphate	181,000	Talc	118.18
Marble	100,000	Gemstones[32]	
Granite	70,000		

Source: Authors, based on data from Ministry of Mines and Petroleum, 2020.

[32] Ethiopia has become a significant producer of opal, sapphire, and emerald in recent years, bringing the total reported gems to over 40. However, there is no data on reserve level of gemstones. http://www.mom.gov.et/wp-content/uploads/2020/04/MoMP-Guide-APRIL-20202.pdf

To calculate the depreciation and cost of capital, we used the depreciation of fixed capital of the country and cost of capital data from the result of our study of the produced capital (See Section 2.2.1). First, we determined the share or ratio of value added by the mining and quarrying sector to real national GDP for the period 1992/93 to 2019/20. Then, we multiplied this ratio by the country-level depreciation of fixed capital and cost of capital to get the depreciation and cost of capital for the mining and quarrying sector. Finally, we deducted the labour costs, depreciation, and cost of capital from the value added by mining and quarrying sector to get the rent from minerals for the period 1992/93 to 2019/20. Finally, we followed steps 2 to 5 to calculate the rent per capita from minerals. Because minerals are non-renewable resources and mines have a finite lifespan, in calculating the present value of rent from minerals we used T=162 years based on data on reserves and average annual extraction for five minerals (gold, tantalum, kaolin, quartz, feldspar, and dolomite) (Table C2). We managed to collect data on the mineral reserves of the country (see Table C2 above). But we could only find CSA data for the years 2008–2011 and 2015–2018 on the annual extraction for five of the minerals: gold, tantalum, kaolin, quartz, feldspar, and dolomite. Based on this data, we calculated the average annual extraction for each of these five minerals. We found that the average annual extraction rates were 7,598.35 kg per year for gold, 164.58 ton per year for tantalum, 9,159.20 tons per year for kaolin, 1,939.95 tons per year for quartz, 408.75 tons per year or feldspar and 21,979 tons per year for dolomite. By dividing the reserve amounts for each of these five minerals (see Table C2) by the average annual extraction rates, we found lifetime of 26.32 years for gold, 118.12 years for tantalum, 13,101.58 years for kaolin, 206.19 years for quartz, 1,223.24 years for feldspar and 90.99 years for dolomite. Due to a lack of data on the rate of extraction for the other minerals listed in Table D2 and the fact that taking the average mine lifetime for the five minerals (which is 2,461.07 years) may overestimate the lifetime of other minerals, we chose to take the median lifetime, which is 162 years.

D.2 Non-Market Natural Capital

Data required to measure ecosystems as measures of non-market natural capital are reflected in two concepts: ecosystem extent and ecosystem condition. According to the System of Environmental-Economic Accounting (SEEA), "Ecosystem extent is the size of an ecosystem asset in terms of spatial area. Ecosystem condition is the quality of an ecosystem measured in terms of its abiotic and biotic characteristics" (2.13, p. 27). Ecosystem extent provides important information on the level of deforestation, desertification, the impact of agricultural conversion, urbanization, the location of ecosystem types or the fragmentation of landscape. Ecosystem extent is measured in physical terms (km^2, ha, m^3, etc.), and the unit of measure depends on the types of assets (forests, woodland, desert, freshwater, marine, etc.).

To measure non-market natural capital, we used a number of indices that measure the extent of **terrestrial ecosystems** agricultural land (mosaic, rainfed, and irrigated croplands), forest land (forest, shrub, and sparse vegetation areas), grassland, water bodies, wetland, bare land, and built-up land) and conditions of **atmospheric ecosystems** (temperature and precipitation). Temperature and precipitation are measured in terms of annual departure (in degree Celsius) from normal and annual precipitation in % departure from normal. The normals here represent the average temperature and precipitation over the period 1980–2010, as set by the World Meteorological Organization.

Ecosystem condition provides an analytical input for policy-making as it describes the characteristics of ecosystems and how they change over time. The types of conditions include biotic and abiotic components of ecosystems such as water, soil, biomass, vegetation, habitat, and species. SEEA Chapter 5 has extensive discussions of the topic. Because measuring ecosystem conditions in the country as a whole is still a challenge due to data availability, the estimation of non-market natural assets in this study is mainly focused on ecosystem extent. However, it is important to be aware of the necessity of measuring and tracking ecosystem conditions along with their extent since ecosystem condition is a critical determinant of the quality of natural assets.

D.2.1 Terrestrial Ecosystem Extent Per Capita

The estimates of ecosystem extent for the period 1992/93 to 2019/20 are derived from AidData, which uses land cover data based on European Space Agency land-cover class data products (Goodman et al., 2019). This is the most comprehensive, publicly available land-cover data set, and it provides complete coverage of Ethiopia. The data set provides 12 categories of land cover[33] for two city administrations and nine regional states of Ethiopia. The data provides 13 category columns[34] each with counts of pixels per unit of analysis for each year selected) and count (total count of pixels per unit of analysis that is equal to the sum of counts of pixels in the 13 categories of land cover; here, unit of analysis is city administration and regional states). First, we summed the number of pixels in each land cover category column of all the administrative units of analysis to get the total number of pixels in each land cover category, which is the national level number of pixels in the different land cover categories. We did the same summation for the total count of pixels for each administrative area (two city administrations and nine regions) for the period 1992/93 to 2019/20. Then we divided the sum of pixels in each land cover category by the sum of the total count pixels to get the proportion of land area of covered with each lad cover to the total land area of the country. The total land area of the country, as reported by the Central Statistical Authority, is 1,139,967.84 km^2 or 113,996,784 hectares. We multiplied the proportion of land area covered by each land cover type to total land area of the country for the period 1992/93 to 2019/20 by the total land area of the country (113.99 million hectares) to get the land area of each land-cover type in hectares for the period 1992/93 to 2019/20. Finally, we divided the land area of each land-cover type, say forest, of the period 1992/93 to 2019/20 by the corresponding year's population size to get the land area of each land-cover type in hectares per capita.

[33] Categories used are cropland (rainfed, irrigated, mosaic), forest, grassland, shrubland, sparse vegetation, wetland, urban land, bare areas, water bodies, and snow ice. UN Land Cover Classification System categories were grouped according to their IPCC classes, except for agriculture, which was broken into three different types of croplands. The original land-cover class names are modified in an export file for readability and ease of use. The full name of each class can be found in the land-cover map user guide: https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover. Version 2.0.7cds provides the LC maps for the years 1992-2015 and version 2.1.1 for the years after 2016 (both versions are produced with the same processing chain).

[34] The 13 categories of columns for each unit of analysis are cropland_rainfed, cropland_irrigated, cropland_mosaic, forest, grassland, shrubland, sparse vegetation, wetland, urban land, bare areas, water bodies, snow ice, and no_data. The number of pixels in the no_data column is zero.

D.2.2 Atmospheric Ecosystem

Temperature

The indicator is based on data on mean monthly temperature for the period 1992 to 2020 obtained from AidData, which provides monthly temperatures from the CRU[35] in degrees Celsius, Version 4.05. This data is the most comprehensive, publicly available monthly temperature dataset that provides complete coverage of Ethiopia. Temperature departures are calculated by subtracting the normal value for 1981 to 2010 from the annual value at each unit of analysis (two city administrations and nine regional states). To calculate the departures at the national level, we take the weighted average of the temperature departures of the two city administrations and the nine regional states. We used the ratios of the land area of each administrative unit to the total land area of the country as weights. We multiplied these ratios by the corresponding temperature departures of the administrative units and then took the summation of the results as national-level temperature departure from normal.

Precipitation

The indicator is based on data on mean monthly precipitation for the period 1992 to 2020 obtained from AidData, which provides monthly precipitation data from CRU in millimetres, Version 4.05. This data is the most comprehensive, publicly available monthly precipitation dataset that provides complete coverage of Ethiopia. Precipitation departures are calculated by subtracting the normal value for 1981 to 2010 from the annual value at each unit of analysis (two city administrations and nine regional states). To calculate the national-level departures, we take the weighted average of the precipitation departures of the two city administrations and the two regional states. We used the ratios of the land area of each administrative unit to the total land area of the country as weights. We multiplied these ratios by the corresponding precipitation departures of the administrative units and then took the summation of the results as national-level precipitation departure from normal.

D.3 Financial Capital

D.3.1 Measuring Financial Capital and Data Sources

Financial capital is captured by the international investment position (IIP), which is the difference between the value of foreign financial assets owned by residents and the value of financial assets owned by non-residents:

$$IIP = (FA) - Foreign\ Financial\ Liabilities\ (FL) \quad \textbf{A17}$$

Foreign financial assets (FA) can be decomposed as:

$$FA = Direct\ Investment_a + Portfolio\ Investment_a + Financial\ Derivatives_a + Other\ Investment_a + Reserve\ Assets_a \quad \textbf{A18}$$

[35] Harris et al., 2020; Climate Research Unit: https://crudata.uea.ac.uk/cru/data/hrg/

And foreign financial liabilities (FL) as:

$$FL = Direct\ Investment_l + Portfolio\ Investment_l + Financial\ Derivatives_l + Other\ Investment_l \quad \textbf{A19}$$

Note that reserve assets are not included in financial liabilities since they are the stock of assets owned by the country's central bank or monetary authority with no liability counterparts. The data covers the period 2001 to 2020 and was compiled from the Central Bank.

We obtained data on net foreign assets of Ethiopia from the National Bank of Ethiopia (n.d.) for the period 1992/93 to 2019/20. We calculated the financial capital index (FCI) in per capita terms by dividing net foreign assets by the total population using the following formula:

$$FC_t = \frac{NFA_t}{P_t} \quad \textbf{A20}$$

where FC_t is the financial capital index in constant 2016/17 ETB and USD per capita for year t, NFA_t is the net foreign assets of the country in ETB and USD in year t, and P_t is the total population of the country at time t.

Appendix E. Social Capital

Measuring social capital in monetary terms remains a challenge. The challenge arises from the complexity of human relationships and the abstract nature of social interactions. For example, how do we monetize trust? Also, some aspects of social interactions are irreplaceable and therefore, priceless.

Research on social capital valuation includes Helliwell et al. (2010), who focused on the effects of income change on differences in levels of life satisfaction associated with different levels of trust and social network size. The World Bank (2006) has estimated the value of social capital as residual value left over after subtracting the value of produced and natural capital from total wealth.[36] The shortcoming of this approach is that this residual value includes other forms of wealth, most notably human capital. The OECD (Scrivens & Smith, 2013) evaluates social capital at the individual and collective levels. The individual dimension sees social capital as an individual resource benefiting the members of the social network. It includes two aspects: personal relationships and social network support. The collective dimension, on the other hand, focuses on social capital as a feature of communities (Turcotte, 2015). This dimension takes into account civic engagements and trust and cooperative norms.

In the context of sustainability—one of the main purposes of valuing comprehensive wealth—civic engagement and trust and cooperative norms appear to be the most relevant indicators. As emphasized by Scrivens and Smith (2013) trust and cooperative norms are fundamental contributors to well-being at both the individual and collective levels. They are considered as public goods, in the sense that they can be used by anyone, unconditionally. In line with the idea of sustainability, they are also persistent over time and can be passed on to generations that follow. Moreover, when deteriorated, they can hardly be restored. For these reasons, the study focuses on a subset of indicators of civic engagement and trust and cooperative norms as described in the proposed suite of indicators in Table E1.

[36] Total wealth has been estimated as the present value of future consumption, rather than a summation of other capitals.

Table E1. Description of social capital indicators

Social capital	Indicator	Explanation
Civic engagement	Participation in Group Activities	The percentage of the population that participate in or are members of groups, organizations, or associations
	Volunteering	The percentage of population that volunteer their time and the hours spent doing so (along with their economic value)
	Diversity in Social Networks	The percentage of the population that meet people from different ethnic backgrounds through membership in groups, organizations, or associations.
	Engagement with Public Institutions	The extent to which people are involved in government decision making
	Control Over Public Decisions	The percentage of the population that feel they have control in the public decisions that affect their everyday lives
	Voter Turnout	The percentage of eligible voters that turns out in national & subnational elections
Trust and cooperative norms	Generalized Trust	The percentage of the population who believe that, generally speaking, most people can be trusted
	Trust in Neighbours and Strangers	The percentage of the population who believe that neighbours and strangers can be trusted a lot
	Trust that a Lost Wallet Will Be Returned	The percentage of the population who believe a lost wallet or purse would be returned with the money in it by someone who lives close by
	Trust in Institutions	The percentage of the population who have high confidence in national/provincial/municipal governments
	Belief in Helpfulness of Others	The percentage of the population who believe people try to be helpful most of the time
	Willingness to Help Others	The percentage of the population who have helped a stranger in the past month
	Acceptance of Others	The percentage of the population who would say that the country's cultural life is generally enriched by people coming to live from other countries.

Source: Smith et al., 2018.

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