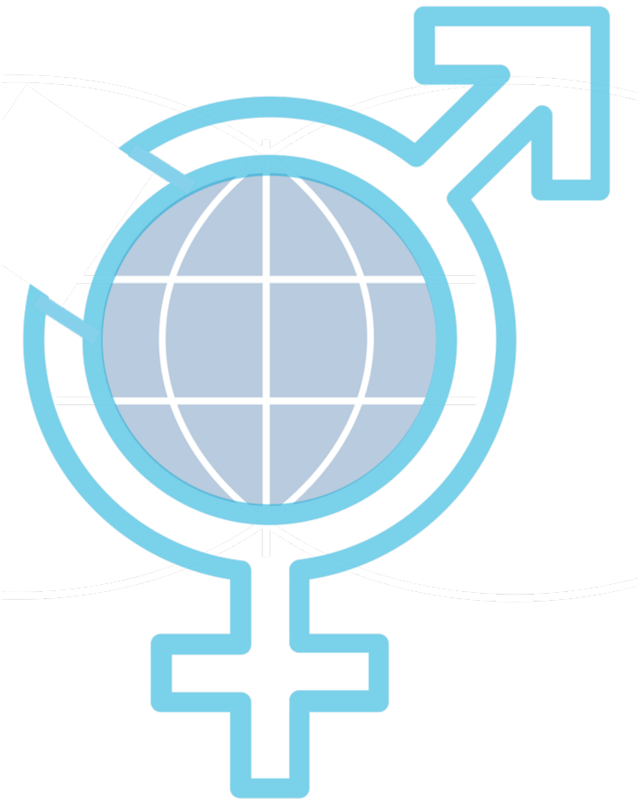
GENDERED IMPACTS OF GLOBAL ECONOMIC CHANGES



Ralf Schramm

Master Thesis | Industrial Ecology

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TU Delft

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Ralf Schramm
University of Leiden: 3502422
Technical University Delft: 5225027
Master of Science: Industrial Ecology

1. Supervisor: Rutger Hoekstra
2. Supervisor: Nthabi Mohlakoana

Additional Supervision: Ranran Wang

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Executive Summary

Over the last three decades, global economic structures have undergone massive transformations, with the gender aspect of these developments often being overlooked. This study addresses this research gap by exploring how these economic changes have affected men and women differently in terms of hours worked, and identifying the key drivers behind these trends.

From 1995 to 2019, global working hours for men increased by 907 billion hours (30% rise), while women's working hours increased by 606 billion hours (33% rise). Nevertheless, the total hours gap between men and women has increased, though both genders experienced a decrease in weekly hours per employment, with men reducing their hours slightly more than women. Women's participation rates increased slowly from 57% in 1995 to 64% in 2019, while men's participation rates remained constant at 80%, significantly contributing to the observed trends. Regional disparities revealed that the Global North and China saw minimal increases in total working hours, with a narrowing weekly hours gap for women, while the Global South, especially India, experienced major gains in male working hours with very little change in female working hours, reflecting lower participation rates for women. A sectoral analysis shows that agriculture experienced a decline of 25% for both genders, mainly in China. This decline in agricultural hours was offset globally for men primarily in Construction, Retail, Manufacturing, and Transportation, and for women in Retail, Service, Education, and Manufacturing, with increases mostly occurring in sectors where each gender was already predominant. The decomposition analysis showed that technological advances in agriculture, the most dominant sector, offset rising consumption levels for both genders, leading to a decrease in hours worked, while no other industrial sector experienced the same offsetting effect. Furthermore, it indicates that efficiencies in technology saved hours worked for both genders in all regions, but these savings were consumed by rising final demand. The primary drivers influencing changes in working hours have been similar for both men and women, with men slightly benefiting more from production technology advances

This research provides a comprehensive understanding of regional disparities and gender inequalities in the context of global economic development over the last three decades for various industry sectors and countries. By bridging the research gap and offering detailed insights into the differential impacts of global economic changes on men and women, this study contributes to a more nuanced understanding of labor developments.

1. Introduction

In the past three decades, humanity has witnessed profound global transformations that have reshaped economies, societies, and individual livelihoods. Technological advances have significantly increased production efficiency, with notable improvements in food production yielding major increases in goods per output (Reza Anik et al., 2020). Various financial crises, such as the Asian crisis in 1997 and the global financial crisis in 2008, have shocked economies and connected structures, often leading to recessions, unemployment, and increased governmental debt (Barthélémy et al., 2020; Reinhart & Rogoff, 2009). Trade agreements and market-oriented reforms, like the Washington Consensus, have been recognized for both their stabilizing growth and destabilizing inequality creation (Feenstra & Hanson, 1997; Stiglitz, 1998; Beramendi & Anderson, 2008; Zameer et al., 2020; Zhang et al., 2020). International trade has also seen substantial changes, with historically low costs for exchanging goods and ideas facilitated by advancements in information and communication technology (Baldwin, 2017). This has not only enhanced global connectivity but also intensified competition in the global market (Ethier, 2005; Dahlman, 2007). The term globalization, despite its varying interpretations, generally refers to this broad development of increasing international trade and exchange (Kıvılcım, 2018). The extent and impact of globalization are subjects of scholarly debate. Some experts argue that the period from 1970 to 2000 represents the peak era of globalization, while others consider the year 2008 as a critical turning point in the evolution of global interconnections (Miskiewicz & Ausloos, 2010; Wang & Sun, 2021). In either case, the last three decades have been heavily influenced by it.

Research has extensively examined the consequences of globalization, uncovering stark global and national imbalances, creating winners and losers (Kapstein, 2000; Teney et al., 2014; McMichael, 2013; Jakob, 2022). To examine international trade input-output (IO) data is commonly used, it quantifies the amount of exchange between various industries and regions in monetary terms. Global input-output data has been used to shed light on intricate relationships between different regions and their intersectoral connectivity (Wiedmann & Lenzen, 2018). Applications beyond the monetary realm of IO data scrutinized the outsourcing of emissions (Minx et al., 2011; Hoekstra et al., 2016), material footprints (Simas et al., 2015), biodiversity loss (Sun et al., 2022) and land-use changes (Wiedmann & Lenzen, 2018). Additionally, social divides have been studied using IO-data. The empirical results show that these inequalities have deepened, with phenomena like poverty (Sullivan & Hickel, 2023), imperial appropriations (Hickel et al., 2022), and slavery becoming intertwined with global trade (Alsamawi, Murray, Lenzen, et al., 2014; Simas et al., 2014; Alsamawi et al., 2017). Generally speaking, minority countries (Global North) are living on the shoulders of majority ones (Global South) (Alsamawi, Murray, Lenzen, et al., 2014; Cherniwchan et al., 2017; Wiedmann & Lenzen, 2018; Shilling et al., 2021; Hickel et al., 2022).

Despite the wealth of studies on the environmental and social developments, the specific impacts of globalization on gender have been underexplored. Relevant literature using IO data to analyze gender and economic changes entails:

- Simas et al. (2014) quantified ‘bad labor’ for individual years, incorporating a gender inequality indicator based on the share of female employment in total labor. The study confirms a global trade imbalance with net flows to the North, highlighting Asia's significant share in regional trade and the pivotal role of food production in sectoral analysis.
- Hickel et al. (2022) advanced the understanding of the total labor drain from the Global South to the North from 1990 to 2015. They estimated the net appropriation by the North to be 392 billion hours of work but noted that the gender differences within this dynamic remain unexplored.
- Barba & Iraizoz (2020) analyzed female employment in European countries from 2008 to 2018 using Structural Decomposition Analysis (SDA) for various industry sectors. They found that while final demand drives employment, technological advances reduce labor

opportunities for women. The study emphasizes that hours worked is a more appropriate indicator than employment, as it more accurately reflects part-time work.

While these studies provide valuable insights into labor dynamics, they leave significant gaps in understanding how globalization has differently impacted men and women globally in the last three decades. The gender-specific effects of economic changes, particularly in terms of working hours, remain underexplored. Therefore, this research seeks to answer the following questions:

Main Research Question:
How have global economic changes affected the working hours of men and women differently in the last three decades?

Sub-Questions:
1. ***How much have working hours changed for women and men in which sectors and regions?***
2. ***What were the economic drivers behind these changes?***

By investigating these questions, this study aims to provide a nuanced understanding of gender disparities in the context of global economic transformations. The structure of this thesis is designed to guide the reader through a comprehensive analysis, beginning with the methodology. The next section delves into suitable input-output (IO) data, detailing the creation of a novel database to address the research questions and explaining the Structural Decomposition Analysis (SDA) accessably. Chapter three presents the outcomes, starting with a global overview and then breaking down the data into regional and sectoral levels. The Discussion chapter contextualizes these results, highlighting key insights and acknowledging limitations. Finally, the thesis concludes with answers to the research questions and final remarks.

2. Methods

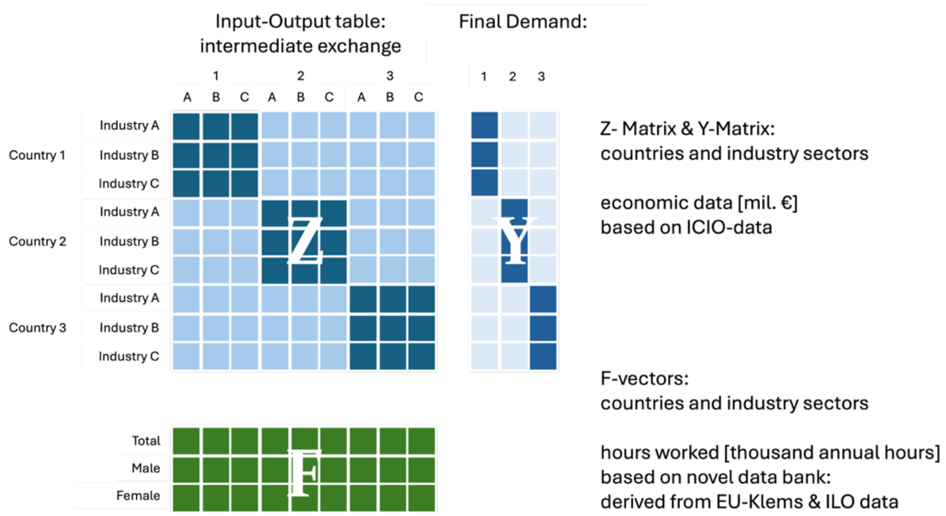
<u>Methodology for the quantification of hours worked</u>

Choice for Multi-Regional Input-Output data

To analyze global economic trends and answer the research question, the most suitable data source is input-output (IO) data. Commonly used, IO data serves as the foundation for understanding exchanges between economic sectors and regions. Prominently, the indicator of Gross Domestic Product is derived from IO data, highlighting its importance in today's society (Bergh, 2009).

The long history of IO-matrices advanced with the research of economist Wassily Leontief. He explored mathematical ways to calculate the indirect linkages between actors. Thereby, hidden costs and unexpected connections throughout the economy were unveiled (Miller & Blair, 2009). The importance of such high level data led to harmonization rules in the System of National Accounts (United Nations et al., 2009). Additionally data banks to the commonly used economic tables have enriched the field with social (e.g. Richter et al., 2019; Zamani et al., 2018) and environmental research (Minx et al., 2009). Figure 1 shows an overview of an IO-table for one year, with the extension for this research that will be further explained in the following.

Figure 1: Abstracted Data Overview for one year

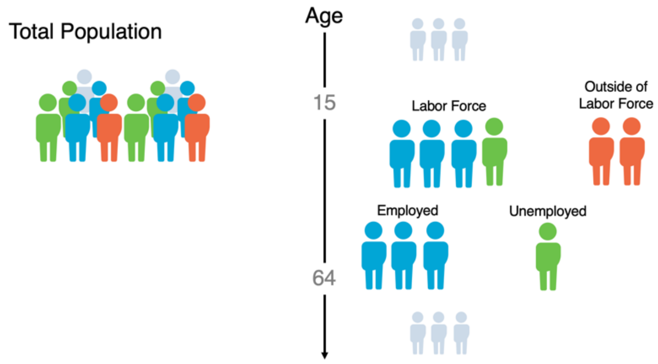


Choice for Employment data

To apply IO data to the gendered lens of hours worked, we first need to understand the development of employment data. Main categories are defined by the International Labour Organisation (ILO) as an agency of the United Nations. They gather regulary in International Conferences of Labour Statisticans to redefine and further clarify common concepts.

The economic perspective on a population includes people who could potentially work (the labor force), typically aged 15 to 64, and people outside this labor force, referring to those not actively seeking employment or incapable of working. Large surveys are conducted to collect data about these groups, as depicted in Figure 2 (Office for National Statistics, 2020).

Figure 2: Population divided into Categories of Labor Force



The employed part of a population is further disaggregated into six sub-categories (Appendix A), distinguishing between those employed by another entity and the self-employed or others (ILO, 2018). This research primarily discusses employed people as a whole, without further disaggregating the data due to the scarcity and inconsistency of subcategory data throughout the analysis period. Therefore, when referring to 'hours worked,' we mean 'hours worked' by employees and employers alike. While their average working hours usually differ, as discussed in the limitations section.

Development of novel data bank

A comprehensive analysis of global economic trends and gender differences in working hours required a novel data bank that extends the current state-of-the-art in Input-Output (IO) data. Existing IO and employment data banks were thoroughly scanned to assess their suitability regarding indicators, time frame, and regional detail level (Appendix B).

Exiobase initially appeared to be a promising candidate due to its detailed gender and skill-level breakdowns (Stadler et al., 2018). However, it lacked further developed regional details, particularly for the Global South. Additionally, a review of its supplementary material revealed that to disaggregate statistical data into 200 product categories, Exiobase made numerous assumptions (Simas et al., 2018). Notably, it assumed that wages within certain industry subsectors were put equivalent to hours worked. This assumption posed a significant problem for studying gender differences, as it would obscure results due to the gender pay gap (Karamessini & Ioakimoglou, 2007; Terada-Hagiwara et al., 2018).

Consequently, the need for a novel data bank emerged. The foundation was the economic data bank of the Inter-Country Input-Output (ICIO), which covers more than 66 countries with high industrial-sector resolution. Furthermore, ICIO's constant price version was crucial for performing Structural Decomposition Analysis (SDA).

To extend this with employment data, the high-quality data banks of EU Klems (Bontadini et al., 2023) and the ILO (EU-LFS documentation, 2023) were integrated. While the Klems databank originally stems from European funding, it has extended its coverage, and covers 30 countries with robust official statistics on employment and hours worked for various industry sectors. To cover the remaining 36 countries of ICIO, the ILO databank was used. The combination of both resulted in the final frame to create hours worked, split by two genders, for 19 industry sectors, for 66 countries and one 'Rest-of-World' region. Based on the supplementary material from Exiobase (Simas et al., 2018), Gloria (Lenzen & Li, 2022), EU Klems (Bontadini et al., 2023) & ILO-databank (EU-LFS documentation, 2023), the main approach became to collect 'employment' data and multiply it with 'average hours worked per week'.

$$Employment\ [thousand\ jobs] * \emptyset\ weekly\ actual\ hours\ worked * 52\ [weeks]$$

$$= Total\ \boldsymbol{hours\ worked}\ per\ \boldsymbol{industry}\ \&\ \boldsymbol{gender}\ [thousand\ annual\ hours]$$

1. EU KLEMS Countries:

For the 30 countries covered by the EU KLEMS database, the calculation of hours worked was conducted using a combination of ILO data and KLEMS data. The process involved the following steps:

- The primary approach relied on ILO data to calculate the total hours worked split by gender (based on the approach above).
- EU-Klems had only a gendersplit of hours available from the year 2008 onwards. Hence, the amount of hours worked was taken from the EU KLEMS database, and then split into percentages based on the calculated results from the ILO data.

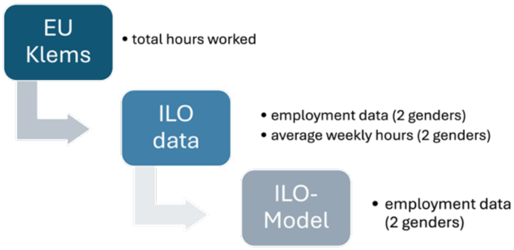
2. Remaining Countries:

For the remaining 36 countries not covered by EU KLEMS, more assumptions due to less detailed data were required. The methodology involved several steps to ensure accuracy:

- The availability of employment data and average hours worked was thoroughly scanned. Every country apart from China had at least some years of employment and average working hours available.
- If detailed sectoral data was unavailable, it was assumed that these sectors developed similarly to the aggregations of these sectors from the same country.
- For missing years, data gaps were bridged by averaging neighboring years or assuming the development trends of aggregate sectors. Extrapolation of 'hours worked' was applied if within reasonable changes, for 'employment' this was not suitable.
- In cases where specific data were unavailable, changes per year were assumed to be the same as countries with comparable economies.
- If none of the above approaches were applicable, ILO-modeled employment data was used. This model is available for every country but shows high variances compared to surveyed data. Then the employment data was multiplied by the average weekly hours from a comparable country.

By employing these methodologies, the novel data bank was able to provide a comprehensive and detailed analysis of hours worked over 25 years, ensuring robsut accuracy and relevance to the research questions. Figure 3 depicts the approach in an abstracted way and Appendix C lists detailed the assumptions for every country.

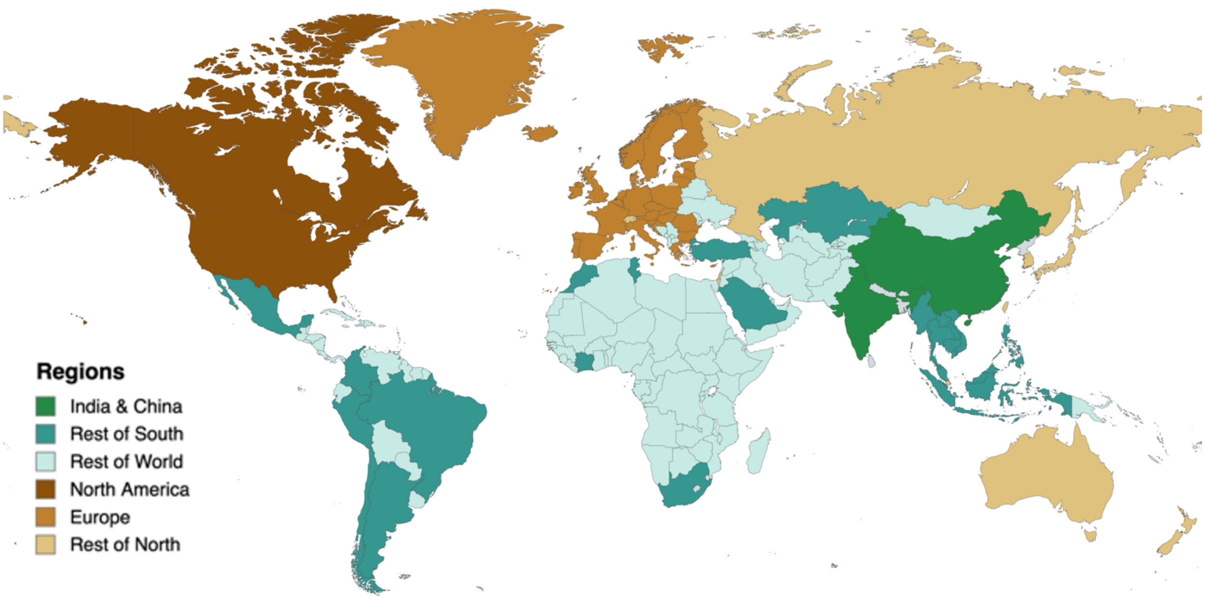
Figure 3: Abstracted Data Overview for one year



Furthermore, industrial sectors were reclassified in the year 2008 internationally. This required further assumptions to bridge these different categories. Appendix D explains this more in detail and shows the official concordance table from the ILO.

The analysis was conducted for 67 regions, and 19 sectors. However, in order to depict results in a meaningful way, the countries were aggregated into seven regions. The main differentiation was made between Global North & Global South (according to Sun et al., 2022), while China and India due to their sheer size were taken separate. Furthermore, the availability of data created the need to distinguish between 'Rest of South', referring to countries belonging to the Global South that did have 'hours worked' available, and 'Rest of World', which refers to any country that did not have an empirical working hours data set. These countries were aggregated and 'hours worked' were derived from the ILO employment-model. The list of every country can be found in Appendix E, while Figure 4 depicts them in a graphical way.

Figure 4: Regional aggregates



Methodology for quantification of economic drivers

A deep understanding of the global interconnectedness will not solely be accomplished by looking at this new total hours worked but also by decomposing the constituent parts of it. Structural Decomposition Analysis (SDA) is an elaborated approach that uses IO data to quantify the impact that economic changes have on a variable, commonly used for environmental emissions (Miller & Blair, 2009; Arto & Dietzenbacher, 2014; Hoekstra et al., 2016). Here, we expand applications so far, by using it for the first time on hours worked with more than 66 countries.

By calculating two footprints for consecutive years and keeping one variable equal while the remainders change, the effect of each component on the change can be studied. The calculations are then done year by year to reduce the variance of the non-uniqueness issue for this SDA (Hoekstra et al., 2016). Hours-worked footprint is expressed as (u) and calculated by the multiplication of the intensity vector (f = F / output x), the Leontief matrix ($L = I – A^{-1}$) with A representing the multi-regional technical coefficient matrix (with A = Z / x, where x = Z + y), and the final demand (y). The main principles of these calculations are based on (Miller & Blair, 2009). The difference of two observation years is expressed in Δu.

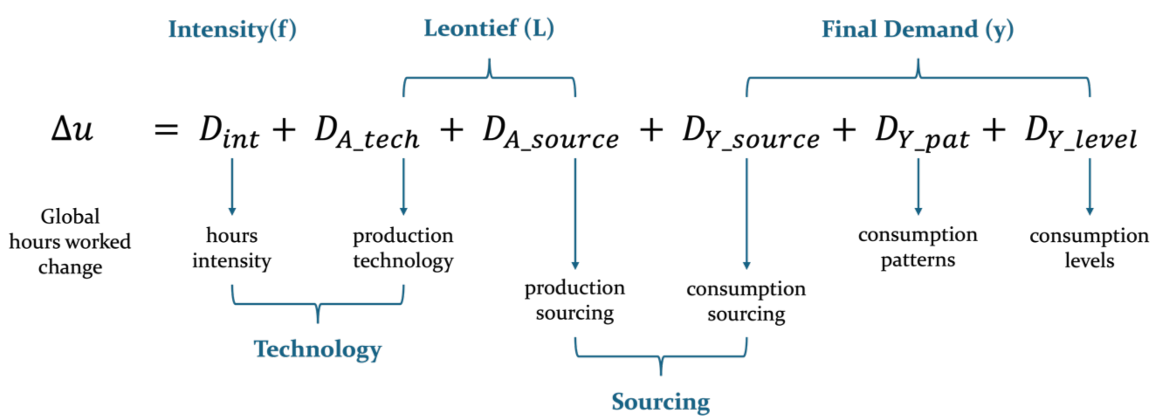
$$\boldsymbol{\Delta u} = \boldsymbol{u} - \boldsymbol{u^{t-1}} \qquad (1)$$

Deconstructing this equation into its parts, leads us to the possibility to quantify the impact of each component on the total change with:

$$\boldsymbol{\Delta u} = \boldsymbol{f\, L\, y} - \boldsymbol{f^{t-1}\, L^{t-1}\, y^{t-1}} \qquad (2)$$

To gain further insights, this basic decomposition is split into various changes composed of technology, sourcing, and consumption effects, based on Hoekstra et al. (2016), described in Appendix F and Figure 5. For the interpretation of the results it is important to know, how each component is actually, Appendix F describes that in detail. The hours intensity or labor productivity, refers to the hours worked per output. The production technology is derived from the global inputs per output of an industry irrespective of the origin. Production sourcing considers the origin, and is used to analyze the share of a country contributing to the global output. The same applies to consumption levels and consumption sourcing, respectively. Lastly, consumption patterns is a result of the change of consumption shares each industry has within a region. With these methodological tools the outcomes were calculated and are described in the next chapter.

Figure 5: Decomposition elements



3. Results

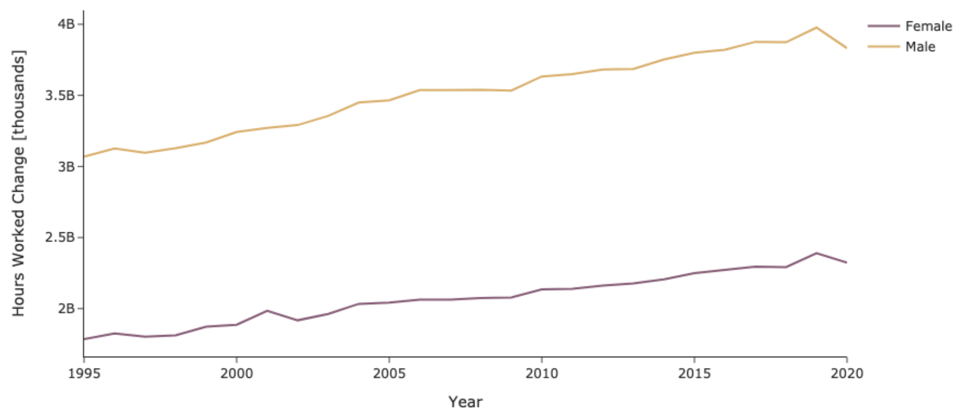
Results of the quantification of hours worked

Due to the global pandemic of Covid, the results for 2020 show opposite trends to the remaining time period. Therefore, 2020 is addressed in a separate paragraph in the discussion section, the main analysis focuses on the data up to 2019. It reveals several key trends and disparities between men and women:

Global Analysis

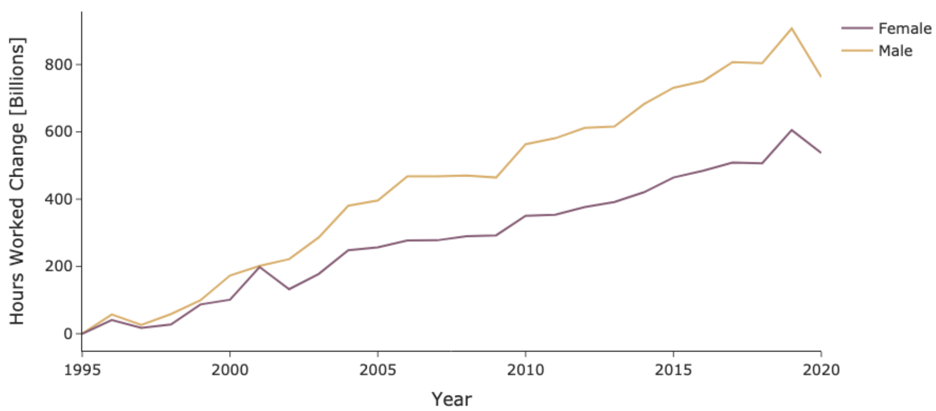
Absolute Increase in Working Hours**:** From 1995 to 2019, global working hours for men increased by 907 billion hours, representing a 30% rise compared to 1995. In contrast, women's working hours increased by 606 billion hours, marking a 33% rise. Despite the higher relative increase for women, the absolute hours worked by men remain significantly higher, maintaining a substantial gap between the genders (Figure 6).

Figure 6: Change of Global hours worked



Growing Gap in Relative Increase**:** Although the relative increase in working hours is higher for women (33% vs. 30%), the absolute difference between the total hours worked by men and women continues to grow. This suggests that the changes in gender employment dynamics are not sufficient to achieve equilibrium in total global hours worked (Figure 7).

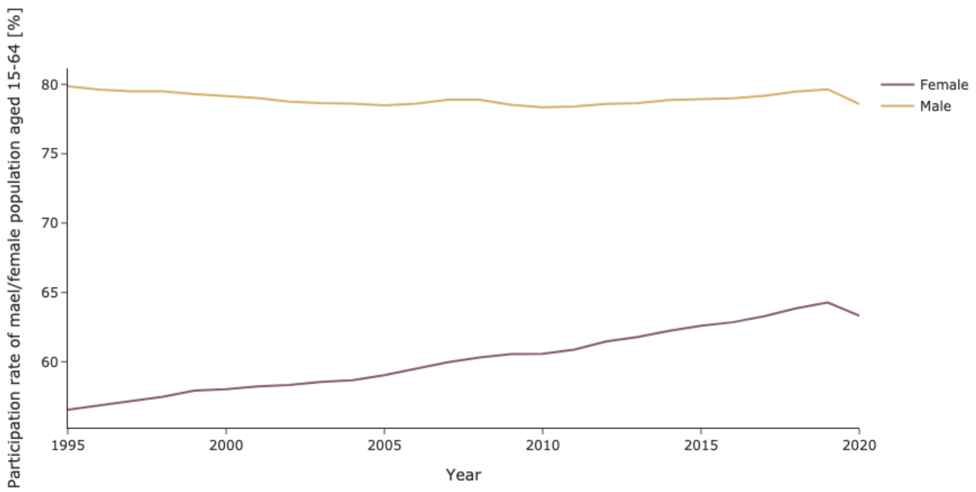
Figure 7: Relative Change of Global hours worked



Population Growth as a Non-Factor**:** The population growth rates for both genders have remained constant throughout the period, indicating that population growth alone does not account for the observed changes in working hours (Appendix G.1-3).

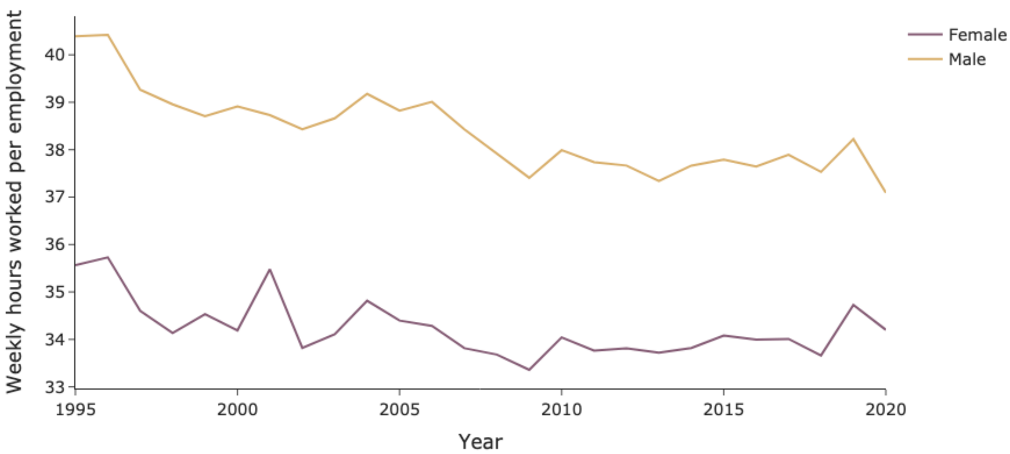
Participation Rates: Men's participation rate in the labor force has remained consistently high at 80%. Women's participation rate, however, has increased gradually from 57% in 1995 to 64% in 2019. This slow increase in women's participation rates partially explains the persistent gap in total hours worked (Figure 8). Appendix G4 & 5 shows the variance for each region.

Figure 8: Global Change of Participation rate [%]



Narrowing gap in Hours Worked per Employment: The analysis reveals a decrease in the average weekly hours worked per employment for both genders. Notably, men have experienced a greater reduction in hours per job compared to women (Appendix G.6). This trend indicates a convergence in the weekly hours worked per employment between men and women, despite the persistent divergence in weekly hours worked (Figure 9).

Figure 9: Absolute Change of weekly hours worked



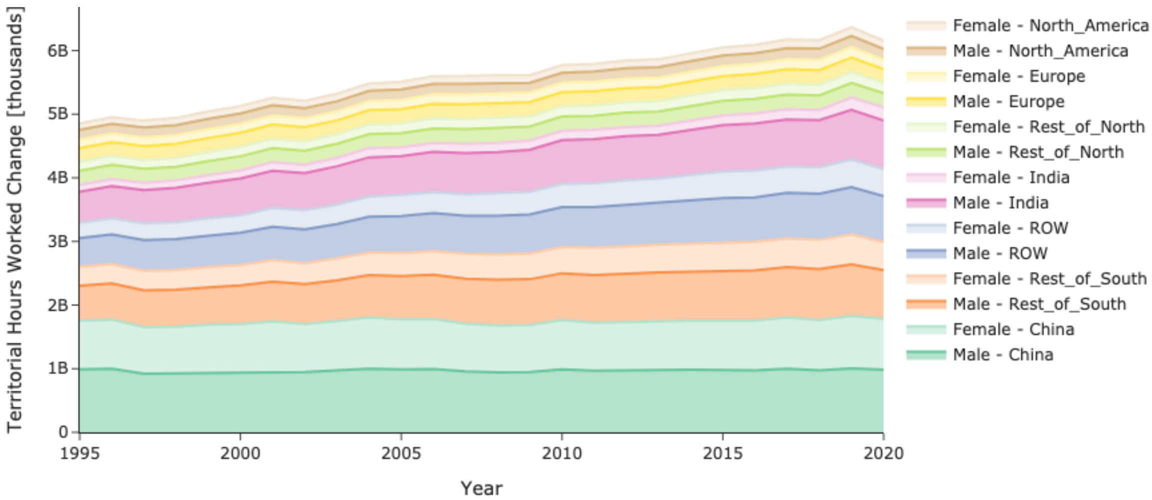
Overall, the data selection indicates that while men continue to work more than women globally, the gap in weekly hours per employment is narrowing. This is connected to the slowly increasing participation rates of women compared to constantly high ones of men.

Regional Analysis

The regional analysis reveals distinct patterns in the changes of working hours for men and women, highlighting significant regional disparities:

Gender-Consistent Regional Development: Across various regions, changes in working hours exhibit a similar gender impact. Regions experiencing growth or decline in working hours tend to show this trend consistently for both men and women (Figure 10).

Figure 10: Absolute Change of territorial hours worked



China's Dominance: A comparison of global hours worked to population share underscores China's significant contribution. Despite its population share, China exhibits a disproportionately higher share of global working hours (Appendix G.7).

Regional Groupings:

1. **Female Hours Increase Higher than Male:** In the Global North and China, the increase in working hours for women surpasses that of men. Both regions also display relatively low increases in total hours worked for both genders (Figure 11).
2. **Male Hours Increase Higher than Female:** In the Global South, particularly in India, the increase in working hours for men significantly exceeds that of women. Both genders in these regions exhibit substantial increases in hours worked compared to the Global North and China. India, in particular, shows a pronounced gender gap (Figure 12).

Figure 11: Relative Change of territorial hours worked (North & China)

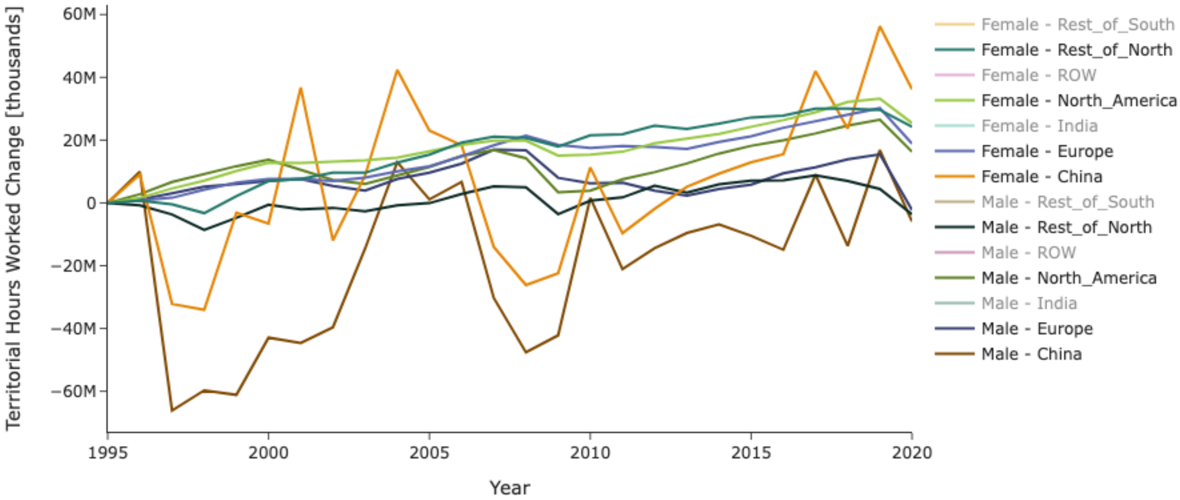
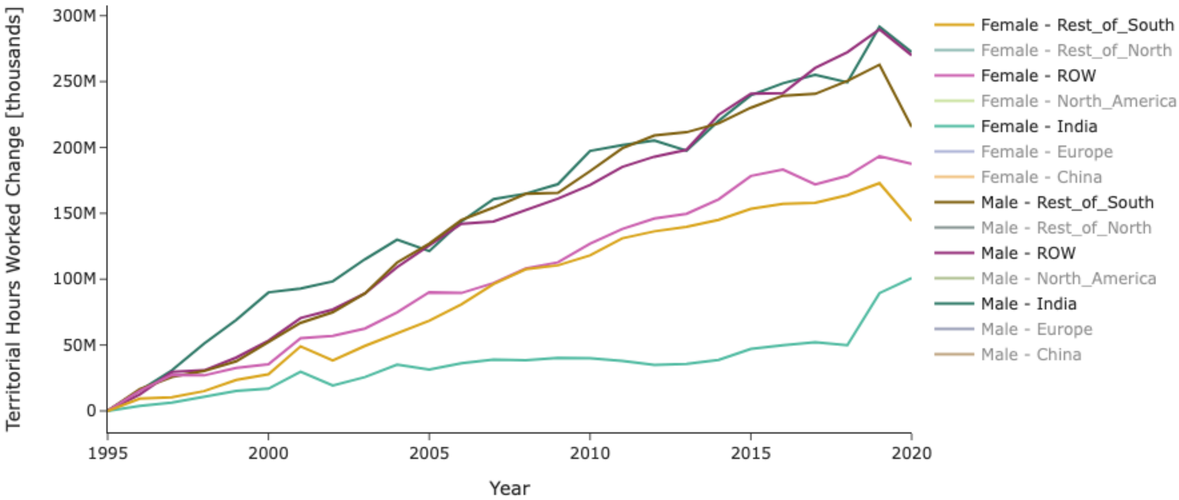


Figure 12: Relative Change of territorial hours worked (South)



Year 2001 Peak for Female Hours: There is a notable peak in female working hours in the year 2001, particularly in the Global South and China. This sharp increase is followed by stark decrease in 2002. This development is less observable in the Global North.

Year 2008 Decline in the North: It is to be observed that Northern regions experienced in 2008 and afterwards a more signficant decline in total working hours than Southern ones, which kept on rising.

Weekly Hours Observations: The trend of narrowing gender gaps in weekly hours worked is confirmed in the Global North and China. Conversely, in the Global South, the gender gap in weekly hours remains significant. In some cases, such as the 'Rest of South,' this gap has even widened (Figure 13 & 14).

Figure 13: Absolute Change of weekly hours worked (North & China)

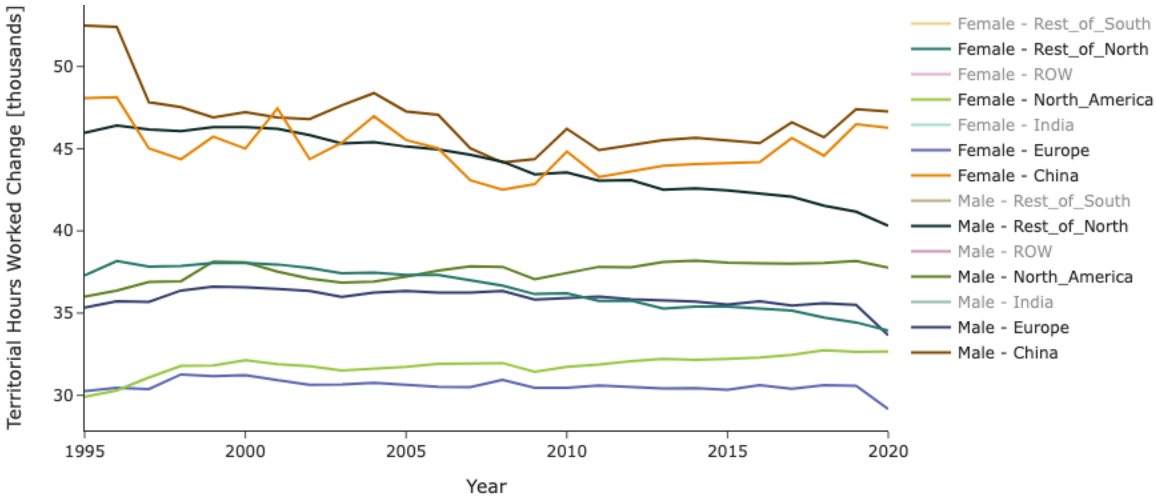
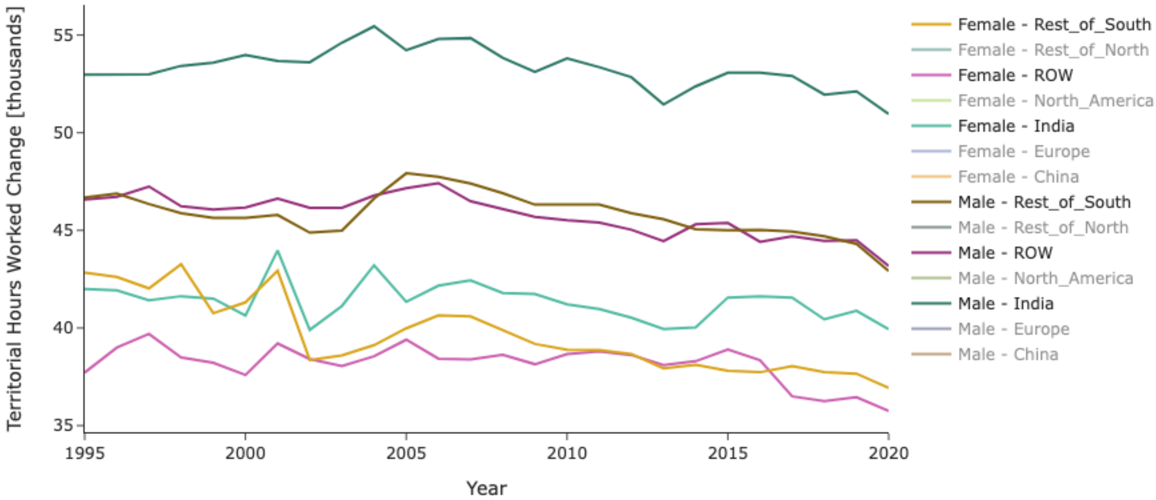


Figure 14: Absolute Change of weekly hours worked (South)



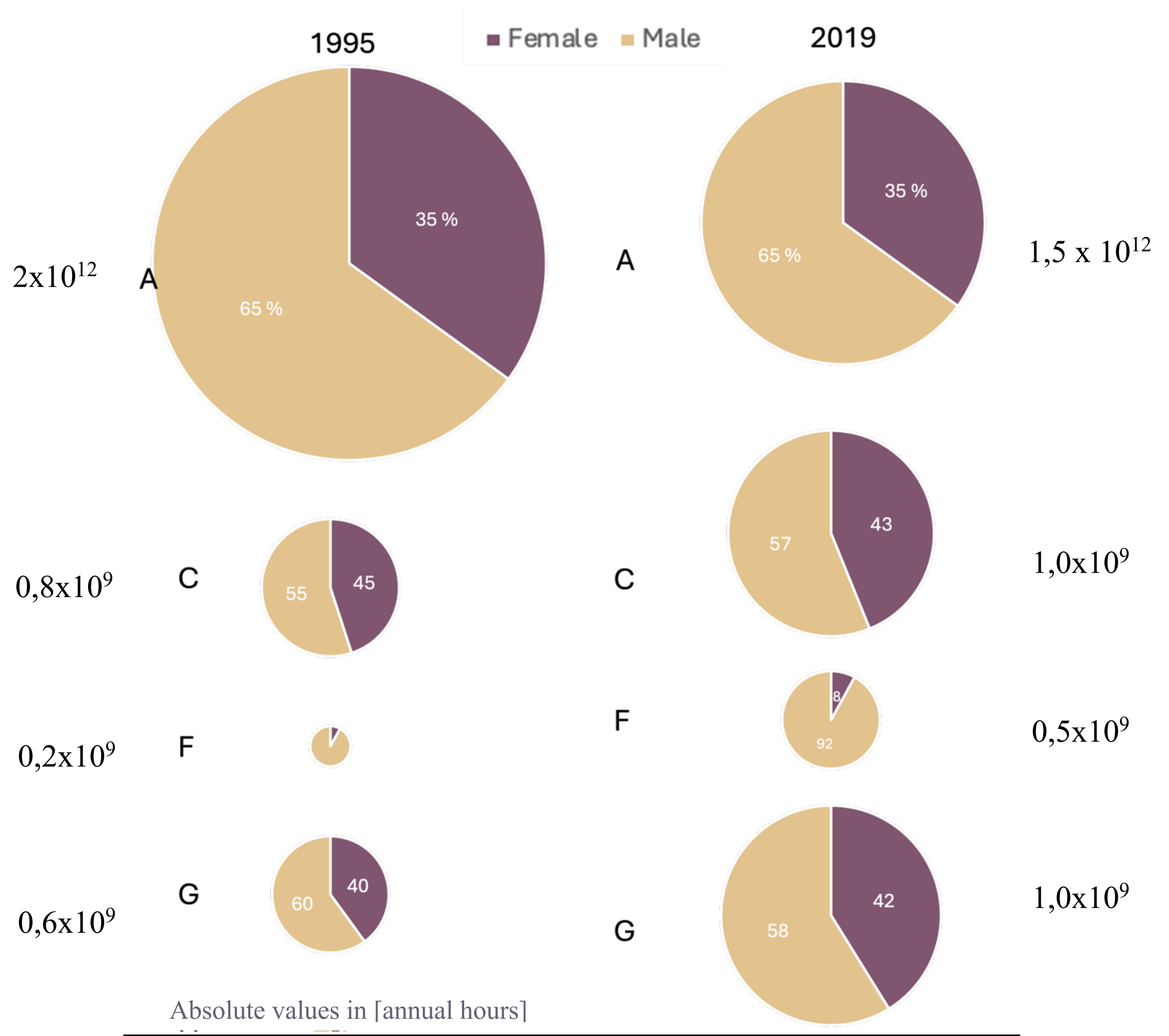
In summary, the regional analysis identifies China as having a disproportionately higher share of global working hours throughout the analyzed period. The global regions can be divided into two groups: the Global North and China, where women's working hours are catching up with men's, resulting in a narrowing gender gap; and the Global South, where the gender gap remains large or has even increased, especially in India.

Sectoral Analysis

Agriculture's Decline: Agriculture has played a major role in working hours for both genders, particularly in China, where the sector has experienced significant shrinkage up to 2019 (Figure 15). Table 1 below gives the names of each industry.

Sectoral Shifts: The decrease in agricultural (sector A) working hours has been largely compensated by increases in other sectors, notably Retail (G +73%), Manufacturing (C +36%), and Construction (F +130%) (Figure 15). Appendix G.8 shows the whole overview of all sectors and their changes with absolute values. Appendix G.9 & 10 show the absolute changes of hours per sector per gender.

Figure 15: Sector size change of relevant sectors



Stable Female Sector Shares: The female share of sectors has not seen major changes compared to the total industry sizes. The most notable increases of female hours worked up to 2019 has been in sectors such as Public Administration (+55% compared to 1995), Education (+93%), Health & Social Services (+79%), and Arts (+70%). These are generally sectors where the female share was already high (Table 1).

Table 1: Absolute Change of territorial hours worked

	(Industry)	Female Share 1995	Female Share 2019	Change
Agriculture, Forestry & Fishing	A	35%	35%	1%
Mining & Quarrying	B	14%	14%	0%
Manufacturing	C	45%	43%	-2%
Electricity, gas, steam & air conditioning supply	D	20%	19%	-1%
Water supply, Sewerage, Waste Management & remediation activities	E	20%	21%	2%
Construction	F	8%	8%	0%
Wholesale & Retail Trade, Repair of Motor Vehicles & Motorcycles	G	40%	42%	2%
Transportation & Storage	H	13%	10%	-3%
Accommodation & Food Service activities	I	52%	53%	1%
Information & Communication	J	27%	25%	-3%
Financial & Insurance activities	K	47%	46%	-1%
Real Estate activities	L	37%	36%	0%
Professional, Scientific & technical activities	M	38%	39%	2%
Administrative & support Service activities	N	33%	33%	0%
Public Administration & Defence, compulsory Social Security	O	30%	35%	5%
Education	P	58%	63%	5%
Human Health & Social Work activities	Q	67%	71%	4%
Arts, Entertainment & Recreation	R	45%	49%	5%
Other service & Household activities	ST	45%	49%	4%

In conclusion, the data indicates that while agriculture has declined significantly, particularly in China, this has been offset by growth in Retail, Manufacturing, and Construction sectors. The female share in various sectors has remained relatively stable, with notable increases in sectors that had a high female dominance already.

Results of the quantification of economic drivers (Q2)

The SDA quantifies key drivers behind the changes in working hours and reveals similar trends for both genders.

Global & Regional Analysis

- Table 2 shows the results for women, and Table 3 for men, indicating that hours intensity (hours worked per unit of output) has decreased significantly (female: -345%; male: -361%). However, these savings have been mainly offset by increases in consumption levels (female: +398%; male: + 447%). Figure 16 & 18 show these results in absolute values.
- A minor difference observed is that technological advancements have saved comparatively more hours for men (+8%) than for women (+23%).
- Annual analysis shows a peak in female hours worked in 2001 followed by a crash in 2002, apart from that both genders show similar trends in the remaining years (Figure 17 & Figure 19).
- Chinese women have a larger share of global female hours worked compared to their male counterparts (Table 2 & 3). This is connected to the above-average participation rate of Chinese women, averaging 73% from 1995 to 2019 (Appendix 5).

Table 2: Decomposition of changes for regions in female hours worked (in % of global change of female hours worked) between 1995 and 2019 with four major groups of effects.

Female (Region)	Technology		Sourcing		Final Demand		Total (%)
	Hours intensity	Production Technology	Production	Consumption	Consumption Pattern	Consumption Level	
Rest of World	-14	10	2	2	-3	31	27
Rest of South	-44	5	4	6	-2	58	27
India	-8	-9	0	1	-3	34	15
China	-230	16	-4	20	-21	229	10
Europe	-15	2	7	0	0	14	8
North America	-15	-1	10	-1	0	16	8
Rest of North	-18	1	8	0	-1	16	5
Total	-345	23	26	28	-31	398	100

Figure 16: Waterfall diagram for female hours worked (absolute values)

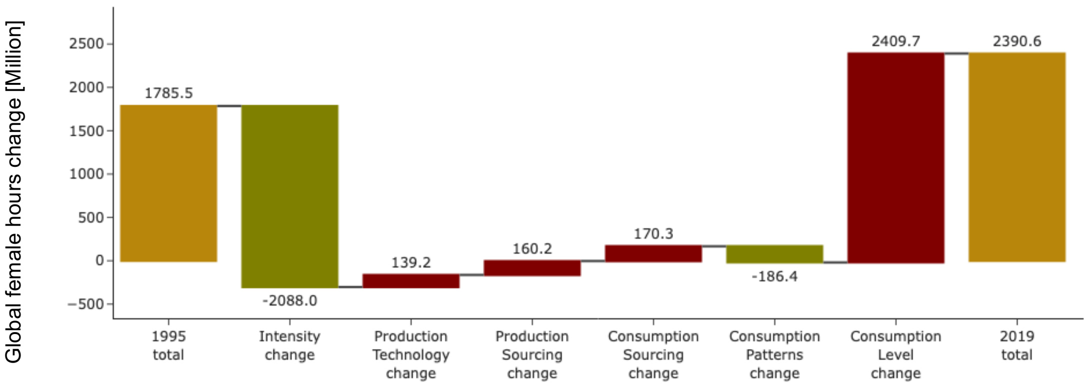


Figure 17: Annual effects of decomposition for female hours worked (absolute values)

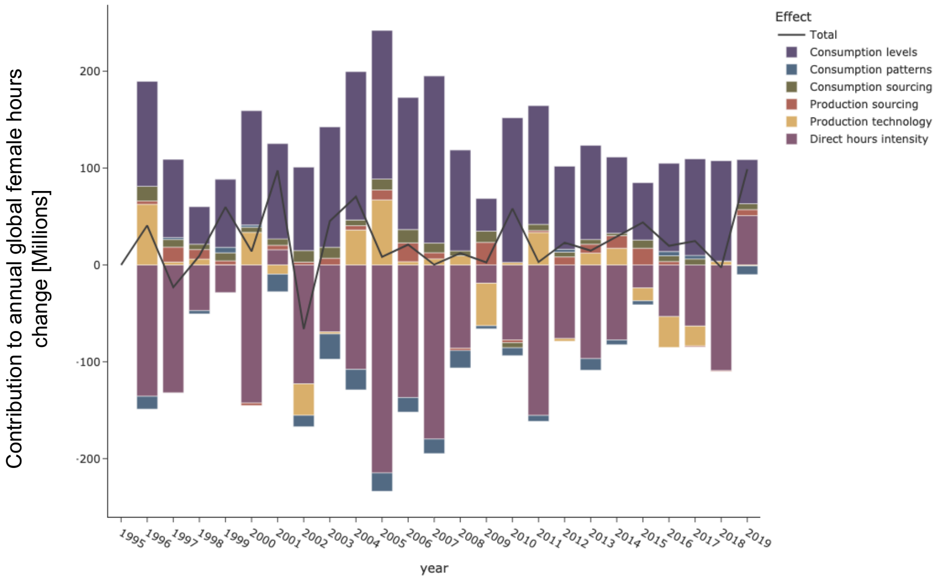


Table 3: Decomposition of changes for regions in male hours worked (in % of global change of male hours worked) between 1995 and 2019 with four major groups of effects.

Male (Region)	Technology		Sourcing		Final Demand		Total (%)
	Hours intensity	Production Technology	Production	Consumption	Consumption Pattern	Consumption Level	
Rest of World	-22	11	2	2	-3	36	27
Rest of South	-52	5	3	6	-3	68	27
India	-43	-21	-4	3	-5	100	30
China	-193	12	-3	15	-24	198	5
Europe	-18	2	7	-1	-1	15	5
North America	-15	-2	9	-1	-1	15	6
Rest of North	-20	0	6	0	-2	15	0
Total	-361	8	21	24	-38	447	100

Figure 18: Waterfall diagram for male hours worked (absolute values)

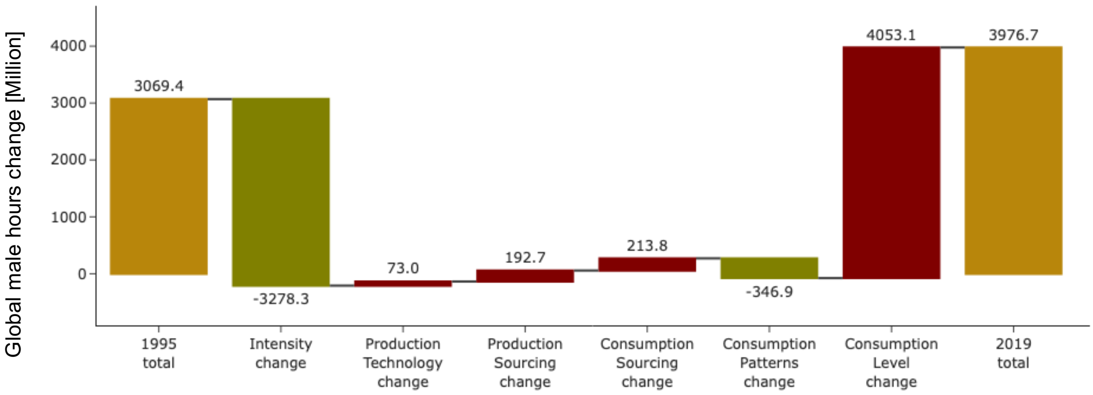
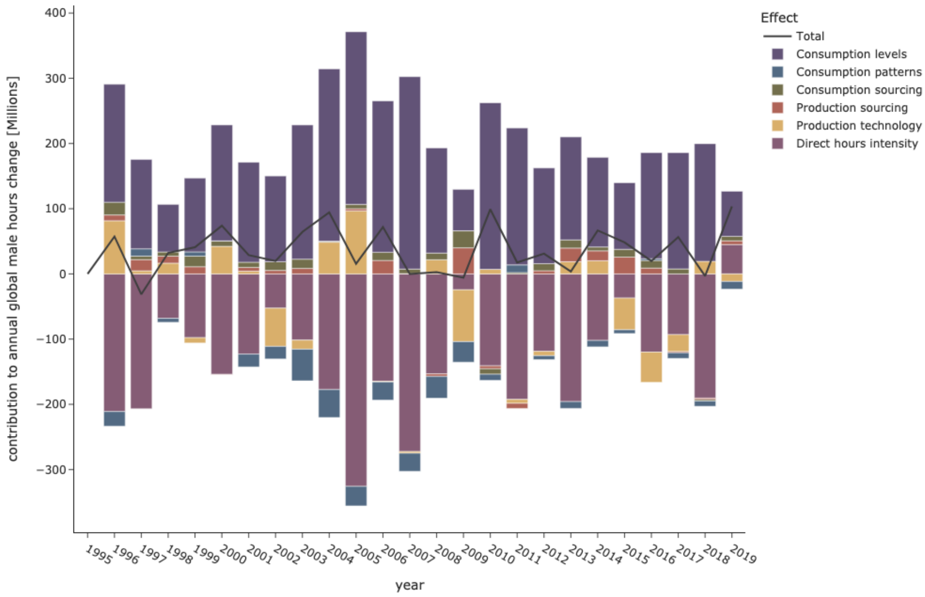


Figure 19: Annual effects of decomposition for male hours worked (absolute values)



Sectoral Insights:
Technological advances and consumption pattern changes have played a significant role in different sectors, as highlighted in Table 4 & 5.

1. Agriculture: Technological advances have offset consumption increases, leading to an overall decrease in hours worked.
2. Manufacturing: Similar to agriculture, technological advances have mitigated consumption increases but have still resulted in an overall increase in hours worked.
3. Retail, Construction, and Transportation: For men, these industries have not seen enough technological advances to offset the major increases in consumption levels, leading to a net increase in hours worked.
4. Retail, Service, Education, and Health Care: For women, these sectors have experienced similar trends, with technological advances failing to keep pace with rising consumption, resulting in a net increase in hours worked.

Table 4: Extract of Decomposition of changes for sectors in female hours worked (in % of global change of female hours worked) between 1995 and 2019 with four major groups of effects (Complete Table in Appendix G.11).

Female (Industry)	Technology (%)	Sourcing (%)	Consumption patterns (%)	Consumption level (%)	Total (%)
A	-142	17	-35	134	-27
C	-94	24	1	82	13
G	-33	9	1	56	33
I	-4	1	0	19	17
P	-11	0	-1	26	14
Q	-7	0	1	17	12
[...]	[...]	[...]	[...]	[...]	[...]
Total	-322	55	-31	398	100

Table 5: Extract of Decomposition of changes for sectors in male hours worked (in % of global change of male hours worked) between 1995 and 2019 with four major groups of effects (Complete Table in Appendix G.12).

Male (Industry)	Technology (%)	Sourcing (%)	Consumption patterns (%)	Consumption level (%)	Total (%)
A	-185	18	-41	171	-37
C	-57	12	2	60	17
F	-10	0	-3	43	30
G	-35	6	3	54	28
H	-16	4	1	26	15
I	-2	1	0	10	10
[...]	[...]	[...]	[...]	[...]	[...]
Total	-353	45	-38	447	100

4. Discussion & future research

This study aimed to fill the knowledge gap on gendered impacts of economic changes. To the best of the author's knowledge, this is the first time a Structural Decomposition Analysis has been applied to gendered hours worked on a global scale. The data work involved in creating this new database is valuable for understanding labor dynamics across different regions and industries offering insights that were previously underexplored.

The analysis reveals several key findings:

- Global Trends: There is a widening gap between men and women in total hours worked, attributed to women's slower increase in participation rates. However, in weekly hours worked, there is a noticeable convergence between genders.
- Regional Trends:
    - Global North and China: Female working hours have increased more than those of men, with female participation rates approaching those of men.
    - Global South, particularly India: Men's working hours have increased significantly more than women's, with a persistent participation rate gap and women not significantly entering the formal labor market.
- Industry Sectors:
    - Both genders have experienced a substantial decline in hours worked in the Agricultural sector, especially in China.
    - This decline has been offset for men primarily in Construction, Retail, Manufacturing, and Transportation sectors, and for women in Retail, Service, Education, and Manufacturing sectors. The increases have mainly occurred in sectors where each gender was already predominant.
- Structural Decomposition:
    - Both genders have experienced changes in working hours due to similar drivers with comparable intensities. However, men have seen slightly more advances in production technology.

Comparing these insights to the relevant literature mentioned in the introduction, gives directions for further investigations:

- Simas et al. (2014): While their study highlights the flow of labor from Southern regions to the North, including female work share, the relevance of gender in their study is questioned because the total female work share in the Global South does not compete with that of males. Their use of various indicators would require further cross-checking to validate findings. Additionally, their calculated indicators are embodied in trade, which was beyond the scope of this research. A similar scrutiny is needed for Hickel et al. (2022), who also used trade footprints. Considering their conclusions on the net drain to the South, it is likely that their findings would be confirmed when comparing the work share both regions hold relative to their population size (Appendix X), particularly when it comes to their quantification of China.
- The SDA in this study confirms the main drivers identified by Barba & Iraizoz (2020). The sectoral analysis largely overlaps, although slight differences occur in the ranking of important sectors for women. This can be explained by the different scales of the analyses, as they only examined Europe. The SDA in this thesis adds the aspect of outsourcing to the analysis of European female hours, indicating a positive effect in production.

Furthermore, some results can be contextualized within broader trends:

- Financial Crisis of 2008: Barba & Iraizoz (2020) stated that the 2008 financial crisis initially hit men harder in terms of employment, while female employment suffered in the long run. This thesis did not clearly observe this pattern. However, it was noted that the 2008 crisis had a more apparent impact on the Global North than on the Global South.
- The peak in female hours in the Global South in 2001 could be linked to China's entry into the World Trade Organization. While this is a global event, regional trade partners likely benefited even more from it (Singh, 2010). Additionally, global governance might have favored women's working rights, particularly in China (Shiwei, 2013). However, since such events typically have a gradual effect, they do not fully explain the massive drop in working hours the following year.
- Although the main analysis of this article set aside the impact of COVID-19, data from 2020 was included for longitudinal analysis. The primary observation is that China seemed less impacted initially, and overall, female hours dropped less than male hours in 2020. This might be due to the predominance of women in Education and Health Care sectors. However, this observation is not supported by existing literature (Alon et al., 2020).

These points highlight the need for further research to contextualize the data presented and to address other limitations of this study.

- Barba & Iraizoz (2020) stated that the financial crisis of 2008 hit men initially harder in terms of employment, while female employment suffered on the long run. From the research of this thesis, this observation did not become obvious. However, it was noted that 2008 had a more apparent impact on the Global North than on the Global South.
- The 2001 peak for female hours in the South could be connected to the entrance of China to the World Trade Organization. While is a global event, it most likely that regional partners of trade benefit even more from it (Singh, 2010). Furthermore, it could be that global governance would favor female's working rights, especially in the China (Shiwei, 2013). Since these events usually affect in a slow pace, this would not explain the massive drop of working hours in the year after.
- Covid-19 has disrupted the global structures massively. While it was put aside for the main analysis of this article, the data was included for the longitudinal analysis. From there main observations are that China seemed to be less impacted initially, and generally female hours dropped less than male ones in 2020. This could be explained by the predominantly share of women in Education, and Health Care sectors. However, this is not confirmed by literature (Alon et al., 2020).

These points highlight the need for further research to contextualize the data presented and to address other limitations of this study.

First and foremost, the novel databank requires a more thorough robustness check by comparing its results with those of other databanks, such as Exiobase. As discussed in the results section, our databank provides more realistic values for hours worked because it is not wage-dependent. However, it would be beneficial to assess the variances between our results and those of Exiobase, which covers the same time period. This comparison could lead to collaborative corrections and improvements for both databanks.

The hours worked data used in this study include hours actually worked by employees and employers, omitting differences between these groups (Park et al., 2012). The ILO databank provides hours differentiating these groups, but not for the whole time period of this analysis. Furthermore, a very important fact is that the employment data of this research covers solely formal employment. This excludes informal work, defined by the ILO as workers who contribute through (a) ownaccountant work in informal enterprises, (b) own final use procution, (c) family work, or (d) informal employment (17th ICLS, 2011). For some countries, especially in the South, this can mean the majority of an economy. Appendix H gives a broad overview of where informal occupations can be found within the definitions of employment (ILO, 2018). This is crucially important because research showed a welfare ranking for these categories with differences in formal and informal employment (Gindling, 2016). It was challenging to account for it due to limited data availability from the ILO, which only provided informal employment data from 2009 onwards, missing average hours and 14 years of the analysis. Including informal employment would hypothecitally increase the amount of hours for the Global South significantly, and could also narrow the gap for these regions, as women in Southern regions have a strong share in informal work (Lo Bue et al., 2022).

This research focused on hours worked in formal employment, referred to as 'paid work' in time-use science. This distinction is especially important in gender studies, as women often engage in significant amounts of 'unpaid work' outside of paid employment (Charmes, 2019; Beckmannshagen & Schröder, 2022; Lo Bue et al., 2022). Future research could bridge these two fields by comparing hours worked with other time-use categories, providing a more comprehensive picture of human time use outside the labor market.

The indicator used could be complemented with wage data to better understand financial independence for women, as labor market penetration involves not only working hours but also salaries (Auspurg et al., 2017; Lane et al., 2020; Jiang et al., 2023). While EU Klems offers average salaries, these are only split by gender from 2008 onwards, necessitating integration with ILO data or national statistics. The time constraints of this thesis put this topic outside the scope.

Lastly, literature has discussed the flaws and benefits of IO-models as well as the SDA-method (Minx et al., 2009; Smetschka et al., 2019). While this study considered the macro-level share of female hours, future analyses could incorporate female hours directly into the intensity vector calculation. Comparing the total hours per economic output with the female hours divided by total hours could be one approach to do so. Similarly, could the final demand be split into household, governmental, and investment categories, providing a more detailed breakdown of technological advances and consumption level increases (Appendix I).

These findings lay the groundwork for further investigation into the complexities of gendered labor dynamics, leading to a comprehensive conclusion that synthesizes these insights and suggests actionable recommendations.

5. Conclusions

This study provides an initial data basis for the global development of gendered hours worked. Contrary to the generally overview gender aspect, this research demonstrates a detailed and nuanced analysis of global labor trends, emphasizing the gender disparities in hours worked across different regions and industries.

Sub-Question 1: ***How much have working hours changed for women and men in which sectors and regions?***

From 1995 to 2019, global working hours for men increased by 907 billion hours, a 30% rise compared to 1995. In contrast, women's working hours increased by 606 billion hours, a 33% rise. Despite this relative increase for women, the total gender gap in working hours persists. However, a convergence in weekly hours per employment between men and women is observed.

For the North and China: Female working hours have increased more than those of men, with female participation rates approaching those of men. This indicates a trend towards gender parity in working hours in these regions. For the South, particularly India: Men's working hours have increased significantly more than women's, with a persistent participation rate gap. Women have not significantly entered the formal labor market, reflecting a massive and ongoing gender gap in total working hours.

The sectoral trends show that both genders have experienced a substantial decline in hours worked in the Agricultural sector, with a 25% decrease compared to 1995, particularly pronounced in China. The decline in agricultural hours has been offset for men by increases in Construction (+130%), Retail (+73%), Manufacturing (+36%), and Transportation (+84%) sectors. While for female hours this has happened in Retail (+75%), Service (+166%), Education (+93%), and Manufacturing (+23%) sectors. These increases predominantly occurred in sectors where each gender was already predominant.

While there has been a relative increase in women's working hours, significant regional and sectoral disparities remain. The Global North and China show a trend towards narrowing the gender gap in working hours, whereas the Global South, especially India, continues to exhibit a large and persistent gender disparity, closely correlating to their participation rates.

Sub-Question 2: ***What were the economic drivers behind these changes?***

The Structural Decomposition Analysis reveals that the primary drivers influencing changes in working hours have been similar for both men and women. Technological improvements have generally led to increased production efficiency, reducing massively hours worked, especially in agriculture. Nevertheless, these changes have been set off by rising levels of final demand, varying across sectors. While both genders have experienced changes in working hours due to similar economic drivers, men have slightly benefited more from production technology advances. The interplay of increased final demand and technological efficiencies has shaped the labor market differently across various sectors, contributing to the observed changes in working hours for men and women.

Research Question: ***How have global economic changes affected the working hours of men and women differently in the last three decades?***

Global economic changes over the past three decades have had distinct impacts on the working hours of men and women, varying by region and sector. While men saw a significant increase in total working hours, women experienced a slightly higher percentage rise, leading to a convergence in weekly hours per employment but maintaining the overall gender gap. In the Global North and China, women's working hours and participation rates have risen, suggesting a trend toward gender parity. Conversely, in the Global South, particularly India, men's working hours have increased significantly more than women's, with a persistent participation rate gap indicating that women are not entering the formal labor market at comparable rates. Sectoral, both genders saw a substantial decline in agricultural hours, especially in China. For men, this decline was offset by increases in construction, retail, manufacturing, and transportation, while for women, gains were seen in retail, service, education, and manufacturing. Technological advancements have generally increased production efficiency and reduced working hours, but rising final demand has counterbalanced these efficiency gains. Although both genders have experienced changes due to these drivers, men have slightly benefited more from technological advances. Overall, while there has been progress in increasing women's working hours, significant regional and sectoral disparities persist, driven by a complex interplay of technological advancements and varying levels of final demand.

In conclusion, my thesis highlights the pressing need for policies that support women's entry into the labor market, particularly in the Global South and in sectors dominated by men, where gender gaps are most pronounced. Additionally, it is crucial to explore strategies for managing consumption levels to align with technological advancements. This alignment could facilitate a more equitable distribution of work across populations, thereby increasing participation rates and promoting fairer labor practices in a globalized world.

Acknowledgments
Thank you, Rutger, for this very exciting topic to work on. The whole thesis has been a big learning process, and I appreciate a lot the freedom and guidance you gave me.
Thank you, Nthabi, for enriching these quantifications with critical questions and make us more aware of the limitations. I appreciated a lot the empathy in your supervision.
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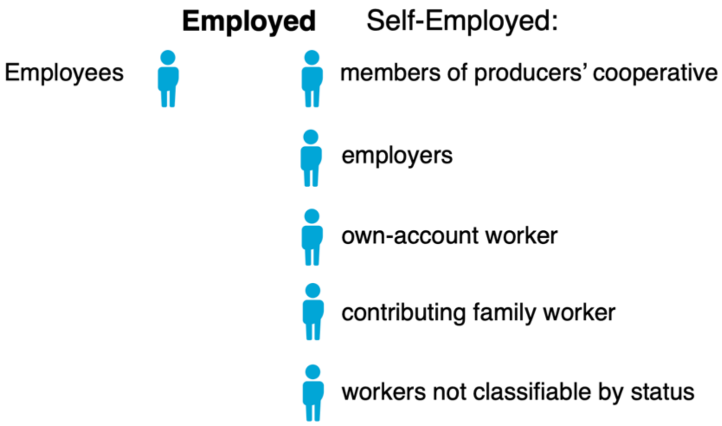
I want to thank Marie-Anne de Gier, Mira Kopp & Timothy Na for providing the basic code for the SDA, so that I could adjust it to my data and different approach. Special thanks to Mira for the extra meetings about the SDA and in general helpful comments. You are amazing.
Thank you, Pablo, this would have not been possible without you.

Appendix

Appendix A: Employment categories by ILO



Appendix B: Overview of databanks and availability of data on hours worked

Databank	subsection	available indicatorrs							unit written	years	# regions	# sectors	classificatior	constant pri	reference yea	current price
		employm	employm	hours wo	hours wo	gender	skill-level	vulnerable employment								
		EMP	EMPE	H_EMP	H_EMPE											
OECD		x			x	x (for some u	-		hours worked annualy p	1950-2022	51	1		x		
ICIO										1995-2020	77	45	NACE 2/ISIC 4			x
EU KLEMS	growth acco	x	x	x	x	- (only for e	-		hours worked by person	1970-2020	28	55	NACE 2	x		
WORLD KLEMS																
	China			x					hours worked [millions]	1980-2010	1	37				
	LatinAmerica (Chile, Colombia, (			x					hours worked	1990-2018	8	9				
	Asia (KOR, T/	x	x	x	x					1980-2012	3	33				
	India	x								1980-2012	1	27				
	ARG								relative labour intensity	1990-2010	1	1				
	Russia			x						1995-2014	1	46				
	CAN	x	x	x	x					1961-2010	1	45				
	JAP	x		x						1973-2009	1	89				
	US	x	x	x	x					1947-2010	1	39				
PWT		x		x (avh)		-			engaged people/ # worke	1950-2019	189	1		x		
ILO				x		x			Hour bands: No hours a	1976-2023	186	1	ISIC 2/3/4	x		
Eora		x				x			1000 full time equivalen	1990-2022	138	26				x
WIOD	2016 release	x	x		x				H_EMPE: Total hours worke	2000-2014	43	56	NACE 2	x	2010	x
	2014 release	x	x	x	x		x		H_EMP: Total hours wor	1995-2011	40	35	ISIC 3			
	2012 release	x	x	x	x		x			1995-2009	40	35	ISIC 3			
	long run WIOD									1965-2000	25	32	ISIC 3	x	1995	x
Exiobase		x		x		x	x	x	Employment1000 p.Emp	1995-2022	49	163				x
Gloria	latest release	x				x	x		employment	1990-2027	164	120				
EWCS									working hours in <35; 3!	2010, 2015	34	1				

Appendix C: Details of country specific assumptions

#	Code	Country	Main Source	Comments
1	ARG	Argentina		
2	AUS	Australia		
3	AUT	Austria	EU Klems	
4	BEL	Belgium	EU Klems	Average hours worked for Sector B for Female assumed to be same as in Germany
5	BGR	Bulgaria	EU Klems	
6	BRA	Brazil		Missing Averages Hours for 1995-2012 development assumed to be same as in Argentina

7	BRN	Brunei Darussalam		Average hours development assumed to be same as Australia
8	CAN	Canada		Measured 6 aggregates were split into ILO-Modelled sector share, further split was done according to USA's share of sectors.
9	CHE	Switzerland		
10	CHL	Chile		
11	CHN	China (People's Republic of)		Missing hours for 1995-2005 & 2017-2020: development assumed to be same as in Vietnam, Sector N assumed to be same as M & E = D, Hours in Sector S assumed to be same as T; Aggregated sectors from ILO-Model were split according to Russian sector share of 2020 (accordingly per gender),
12	COL	Colombia		Hours available: 2002-2020; Employment 1995-2000 & 2005-2020
13	CRI	Costa Rica		
14	CYP	Cyprus (1)	EU Klems	
15	CZE	Czechia	EU Klems	
16	DEU	Germany	EU Klems	
17	DNK	Denmark	EU Klems	Average Hours of Sector B assumed to be same as Germany
18	ESP	Spain	EU Klems	
19	EST	Estonia	EU Klems	
20	FIN	Finland	EU Klems	
21	FRA	France	EU Klems	
22	GBR	United Kingdom of Great Britain and Northern Ireland	EU Klems	
23	GRC	Greece	EU Klems	
24	HKG	Hong Kong, China		Missing average hours were copied from Japan; equally missing Employment split for Sectors were taken from Japan; Sector X is weirdly huge.
25	HRV	Croatia	EU Klems	
26	HUN	Hungary	EU Klems	
27	IDN	Indonesia		
28	IND	India		Average hours missing values 1995-2017: develeopment taken from Indonesia;Employment scattered for 2000,2005,2010 & 2018-2020 (mainly ILO-Modelled)
29	IRL	Ireland	EU Klems	Average female hours for Mining copied from UK
30	ISL	Iceland		
31	ISR	Israel (2)		
32	ITA	Italy	EU Klems	
33	JPN	Japan	EU Klems	Average hours 1995-1998 development assumed to be same as Republic of Korea; Average hours of sector E assumed to be same as D; H_EMP of sector M & N were split according to ILO-derived values
34	KAZ	Kazakhstan		Average hours copied from Russia
35	KHM	Cambodia		Average hours development assumed to be same as in Vietnam
36	KOR	Republic of Korea		

37	LAO	Lao People's Democratic Republic		Missing average hours development assumed to be same as in Vietnam
38	LTU	Lithuania	EU Klems	Average female hours for sector B copied from Estonia
39	LUX	Luxembourg	EU Klems	
40	LVA	Latvia	EU Klems	Average female hours for sector B copied from Estonia
41	MAR	Morocco		Average hours taken from Turkiye & employment data completely taken from ILO-Modelled values (additional sectors splits orientated around Turkiye as well)
42	MEX	Mexico		Average hours for 1995-2001 extrapolated; Sector D & E split assumed to have same relationship as Brazilian sectors D & E
43	MLT	Malta	EU Klems	New own calculations of hours worked are way below EU-Klems estimate, but more coherent.
44	MMR	Myanmar		Hours development assumed to be same as Vietnam
45	MYS	Malaysia		Hours development assumed to be same as Indonesia
46	NLD	Netherlands	EU Klems	
47	NOR	Norway		
48	NZL	New Zealand		
49	PER	Peru		Actually measure employment values are not consistent with total employment values
50	PHL	Philippines		
51	POL	Poland	EU Klems	
52	PRT	Portugal	EU Klems	
53	ROU	Romania	EU Klems	
54	RUS	Russian Federation		Average hours for 1995-2008 (Extrapolated)
55	SAU	Saudi Arabia		No data for hours nor employment; Hours taken from Qatar & employment sector split taken from Qatar but values based on ILO-Model
56	SGP	Singapore		Hours assumed to develop same as Korea & employment data mainly filled up with ILO-modelled data
57	SVK	Slovakia	EU Klems	
58	SVN	Slovenia	EU Klems	
59	SWE	Sweden	EU Klems	
60	THA	Thailand		Missing average hours for 1995-2002: development assumed to be same as in Indonesia
61	TUN	Tunisia		Average hours development assumed to be same as Turkey & main employment gaps filled with ILO-Modelled data/development
62	TUR	Türkiye		
63	TWN	Chinese Taipei		
64	USA	United States of America	EU Klems	Sector D-E split according to development of EU15 countries; Average hours for 1995-2002 assumed to have same broad development as Canada
65	VNM	Viet Nam		Missing average hours development assumed to be same as in Indonesia
66	ZAF	South Africa		Actually measure employment values are not consistent with total employment values
67	ROW	Rest of the World		ILO-Modelled employment data, total was reduced by 18% corresponding to World-Bank data on employment for these regions. Further sectorial splits were undertaken by assuming same composition as

				for signficant representative countries with data (Russia, China, Indonesia, India, Egypt, Bangladesh, Brazil, Mexico, Turkey). Equally, the average hours worked were derived from an average of the mentioned regions.

Appendix D: ILO concordance table for different revisions

While this summary captures the main procedure, various difficulties occur in the actual data work. The International Standard Industrial Classification of All Economic Activities (ISIC) was reformed and published a new revision in 2008, so most countries have a change of sector structure in this year. The latest data with the newest classification was prioritized and considered most accurate, this is why a method needs to be found to create a bridge value for 2007 where the development of the old sector structure can be considered to be the same as with the new sectors. Therefore, the development of broad aggregates was considered to represent the changes in every industry sector. Broad industry aggregates were mostly available. The allocation of sectors was done according to the official concordance table of the ILO. Furthermore, important economies such as China did not have publicly available employment data for different sectors. However, the ILO modelled employment data for 13 industry sectors split by gender for all countries in the time range of 1995-2020. So wherever possible, actual surveyed data was used and where this was not possible the ILO estimates were taken. Further details can be taken from the supplementary tables with comments for every country (see Supplementary material). Additionally, excel files were created for every country with different sheets for the 'original data', 'extrapolated data', 'preliminary values', 'final values'. With this structure it is transparent which values originate from EU-Klems or ILO databases and which values were derived from assumptions and extrapolations. The 'final values' depict the concluding multiplier on 'hours worked' for 67 countries, for 19 sectors (if available) split into total, male and female. This statistical approach hopes to be more precise and accessible as other IO-databanks so far.

Table D.1: ILO concordance table for industry classifications

Broad sector concordance with ISIC

Aggregate Economic Activity			Sections ISIC- Rev. 4	Sections ISIC- Rev. 3	Sections ISIC- Rev. 2
Agriculture			A	A, B	1
Non Agriculture	Industry	Manufacturing	C	D	3
		Construction	F	F	5
		Mining and quarrying; Electricity, gas and water supply	B, D, E	C, E	2, 4
	Services	Market Services (Trade; Transportation; Accommodation and food; and Business and administrative services)	G, H, I, J, K, L, M, N	G, H, I, J, K	6, 7, 8
		Non-market services (Public administration; Community, Social and other services and activities)	O, P, Q, R, S, T, U	L, M, N, O, P, Q	9
Not elsewhere classified			X		0

Retrieved from https://ilostat.ilo.org/methods/concepts-and-definitions/classification-economic-activities/ at the 27th of May 2024.

Appendix E: Regional grouping

Region	Rest of South	Rest of World	North America	Europe	Rest of North
Countries	Argentina Brazil Brunei Chile Colombia Cote Ivory Indonesia Kazachstan Lao Morrocco Mexico Myanmar Malaysia Peru Philippines Saud Arabia Thailand Tunisia Turkey Vietnam South Africa	Afghanistan, Albania, Algeria, Angola, Armenia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belize, Benin, Bhutan, Bolivia (Plurinational State of), Bosnia and Herzegovina, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Channel Islands, Comoros, Congo, Congo Democratic Republic of the, Cuba, Côte d'Ivoire, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Fiji, French Polynesia, Gabon, Gambia, Georgia, Ghana, Guam, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Iran (Islamic Republic of), Iraq, Jamaica, Jordan, Kenya, Korea (the Democratic People's Republic of), Kuwait, Kyrgyzstan, Lebanon, Lesotho, Liberia, Libya, Macao China, Madagascar, Malawi, Maldives, Mali, Mauritania, Mauritius, Mongolia, Montenegro, Mozambique, Namibia, Nepal, New Caledonia, Nicaragua, Niger, Nigeria, North Macedonia, Occupied Palestinian Territory, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Puerto Rico, Qatar, Republic of Moldova, Rwanda, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Senegal, Serbia, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sri Lanka, Sudan, Suriname, Syrian Arab Republic, Tajikistan, Tanzania United Republic of, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United States Virgin Islands, Uruguay, Uzbekistan, Vanuatu, Venezuela (Bolivarian Republic of), Western Sahara, Yemen, Zambia, Zimbabwe	Canada, United States of America	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, Great Britain, Greece, Croatia, Hungary, Ireland, Iceland, Italy, Lituania, Luxenburg, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Rumania, Slovakia, Slovenia, Sweden	Australia, Switzerland, Hongkong, Isreal, Japan, Korea, Aotearoa (New Zeeland), Singapore, Russia, Taiwan

Appendix F: Methodological formula for the SDA

The before mentioned formula can be also expressed in a sum of the different effects which refer to the changes in the components. In this case, an analysis is done to study the Leontief effect ($\mathbf{D_L}$) showing the contribution of changing production recipes ($\mathbf{\Delta L}$), and final demand effect ($\mathbf{D_y}$) showing the contribution of changes in final demand ($\mathbf{\Delta y}$), and the intensity effect ($\mathbf{D_f}$) showing the contribution of changing impact intensities of hours worked ($\mathbf{\Delta f}$). This results in:

$$\mathbf{\Delta u} = \mathbf{D_f} + \mathbf{D_L} + \mathbf{D_y} \quad (3)$$

Leontief effect $\mathbf{D_L}$ describes the share of how much of the total change $\mathbf{\Delta u}$ is derived from a change in the production recipe of industries and their sourcing:

$$\mathbf{D_L} = f^{t-1}\Delta L\, y^{t-1} + \frac{1}{2}\,\Delta f \Delta L\, y^{t-1} + \frac{1}{2}\, f^{t-1}\,\Delta \mathrm{L}\,\Delta y + \frac{1}{3}\,\Delta f\,\Delta \mathrm{L}\,\Delta y \quad (4)$$

Final Demand effect $\mathbf{D_y}$ describes the share of how much of the total change $\mathbf{\Delta u}$ is derived from a change in final demand of consumers and governments:

$$\mathbf{D_y} = f^{t-1}L^{t-1}\,\Delta y + \frac{1}{2}\,\Delta f\, L^{t-1}\,\Delta y + \frac{1}{2}\, f^{t-1}\,\mathrm{L}^{t-1}\,\Delta y + \frac{1}{3}\,\Delta f\,\Delta \mathrm{L}\,\Delta y \quad (5)$$

Intensity effect $\mathbf{D_f}$ describes the share of how much of the total change $\mathbf{\Delta u}$ is derived from a change in efficiency of industries:

$$\mathbf{D_f} = \Delta f\, L^{t-1} y^{t-1} + \frac{1}{2}\, \Delta f \Delta L\, y^{t-1} + \frac{1}{2}\, \Delta f\, L^{t-1}\, \Delta y + \frac{1}{3}\, \Delta f\, \Delta L\, \Delta y \qquad (6)$$

For the research of this thesis the separation of the intensity vector into male ($\mathbf{D_{male}}$) and female ($\mathbf{D_{female}}$) contribution is applicable with ($\mathbf{D_f} = \mathbf{D_{male}} + \mathbf{D_{female}}$). This leads to two SDAs, one for female and one for male hours. Results are then compared.

$$\mathbf{D_{f\_male}} = \Delta f_{♂}\, L^{t-1} y^{t-1} + \frac{1}{2}\, \Delta f_{♂} \Delta L\, y^{t-1} + \frac{1}{2}\, \Delta f_{♂}\, L^{t-1}\, \Delta y + \frac{1}{3}\, \Delta f_{♂}\, \Delta L\, \Delta y \qquad (7)$$

$$\mathbf{D_{f\_female}} = \Delta f_{♀}\, L^{t-1} y^{t-1} + \frac{1}{2}\, \Delta f_{♀} \Delta L\, y^{t-1} + \frac{1}{2}\, \Delta f_{♀}\, L^{t-1}\, \Delta y + \frac{1}{3}\, \Delta f_{♀}\, \Delta L\, \Delta y \qquad (8)$$

Figure F.1: Schematic overview of Structural Decomposition

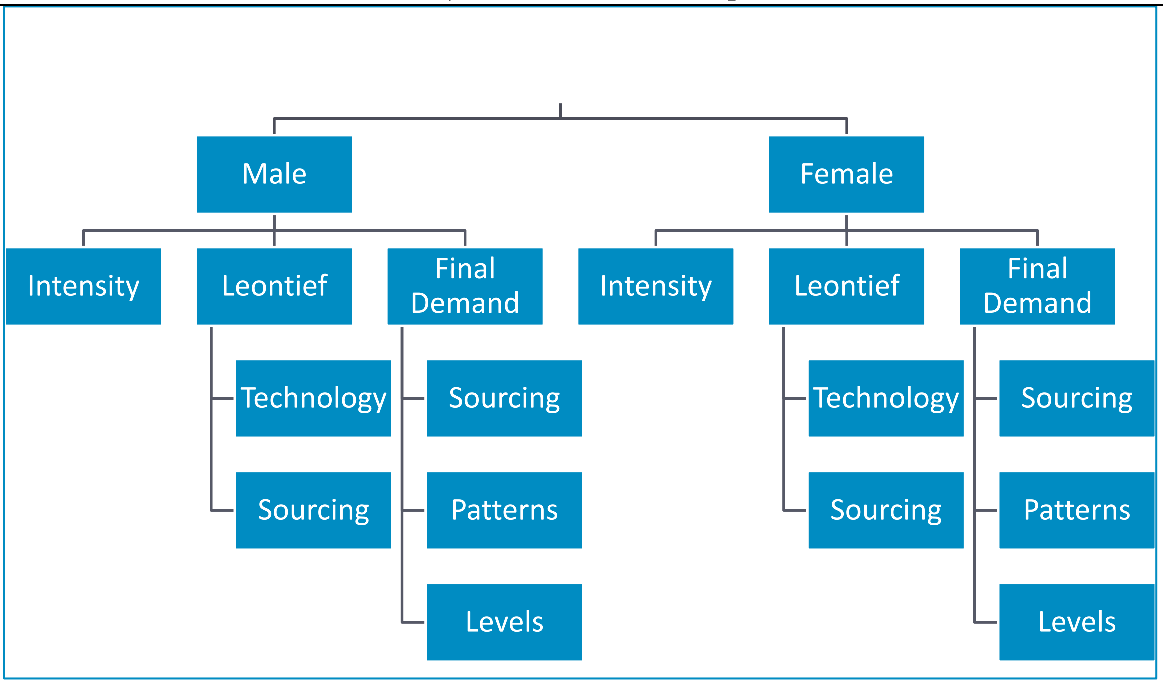


Table F.2: Variables and settings

	Variable	Formula	Unit / comment	Shape
Industries	N			
Countries	M			
Input-Output matrix	Z		€	MN x MN
Final Demand matrix	Y			MN x Final Demand categories
Total output	x	= **Z** + **Y**	€	MN x 1

Technical coefficient matrix	A		€ / €	MN x MN
Integrity matrix	I	= shape(**A**)		MN x MN
Intensity vector	f	= **F / x**	hours worked [thousands]/ €	MN x 1
Leontief matrix	L	= $\mathbf{(I\text{-}A)^{-1}}$	€ / €	MN x MN
Final demand vector	y	= **sum(Y)**	€	MN x 1
Hours worked footprint	u	= **fL**diagonalized**(y)**	hours worked [thousands]	MN x MN
hours intensity	F			
Production technology	A_tech	A_summed by industries * M	Global outputs of each industry (regardless of origin)	MN x MN
Proudction sourcing	A_source	A/A(global)	Share of global output (considering origin)	MN x MN
Consumption levels	Y_levels (Y_tech)	Y_summed by industries * M	Total Final Demand irrespective of origin	MN x M
Consumption sourcing	Y_source	Y/Y(global)	Share of global Final Demand (considering origin)	MN x M
Consumption patterns	Y_pattern	Y_levels*M	Share of each industry of total Final Demand	MN x M

			(considering origin)	

Appendix G: Additional Results

Table G.1: Global developments (Worldbank data & own data):

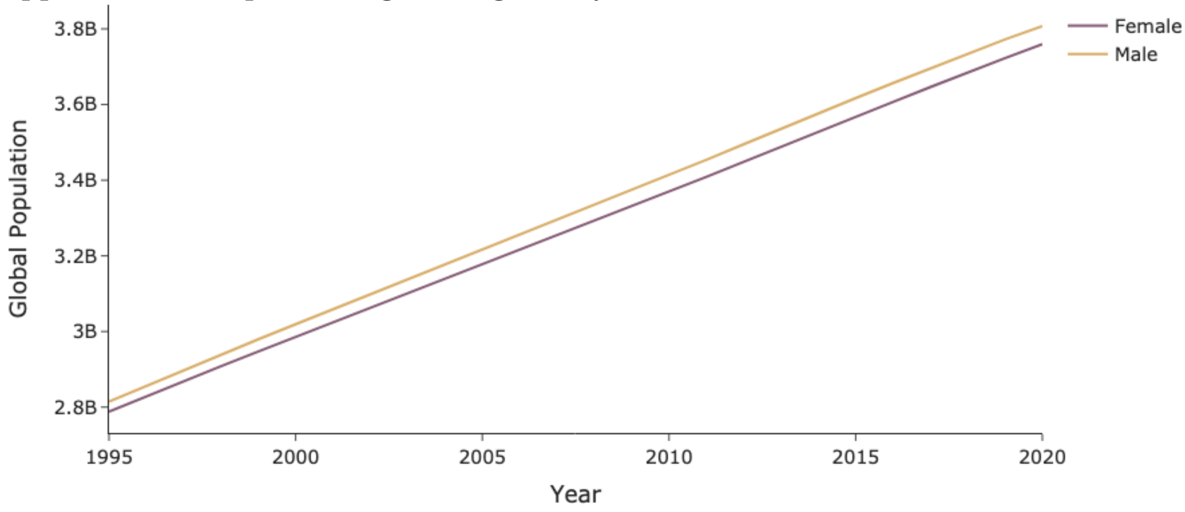
Year	1995	2019	Change
Male annual hours	$3.1x10^{12}$	$3.9x10^{12}$	+ 30 %
Female annual hours	$1.8x10^{12}$	$2.3x10^{12}$	+ 33 %
Male population	$2.8x10^{9}$	$3.7x10^{9}$	+ 34 %
Female population	$2.8x10^{9}$	$3.7x10^{9}$	+ 34 %
Male participation rate (of 15-64 aged males)	80%	80%	± 0 %
Female participation rate (of 15-64 aged females)	57%	64%	+ 7 %
Male employment	$1.5x10^{9}$	$2.0x10^{9}$	+ 33 %
Female employment	$1.0x10^{9}$	$1.3x10^{9}$	+ 33 %
Annual hours per employment male	2100	1987	- 5 %
Annual hours per employment female	1850	1805	- 3 %
Weekly hours per employment male	40,4	38,2	- 5 %
Weekly hours per employment female	35,6	34,7	- 3 %

Return to text.

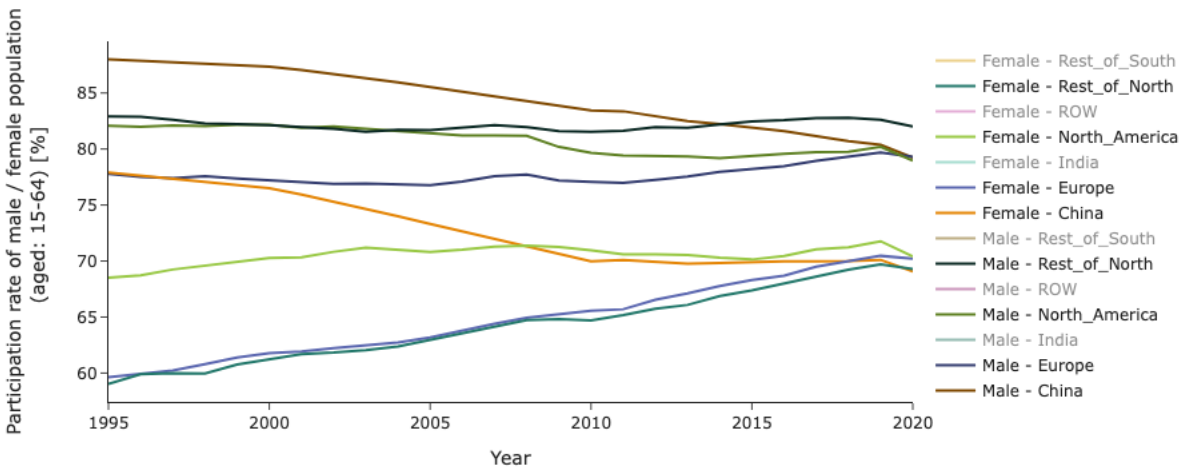
Table G.2: Regional population development (world bank data):

Region	1995 (% of global)	2020 (% of global)
Rest of World (RoW)	$1.1x10^{9}$ (20%)	$1.8x10^{9}$ (24%)
Rest of South	$1.0x10^{9}$ (18%)	$1.4x10^{9}$ (18%)
India	$1.0x10^{9}$ (18%)	$1.4x10^{9}$ (18%)
China	$1.2x10^{9}$ (21%)	$1.4x10^{9}$ (18%)
Europe	$0.5x10^{9}$ (9%)	$0.5x10^{9}$ (7%)
North America	$0.3x10^{9}$ (5%)	$0.4x10^{9}$ (5%)
Rest of North	$0.5x10^{9}$ (9%)	$0.6x10^{9}$ (8%)

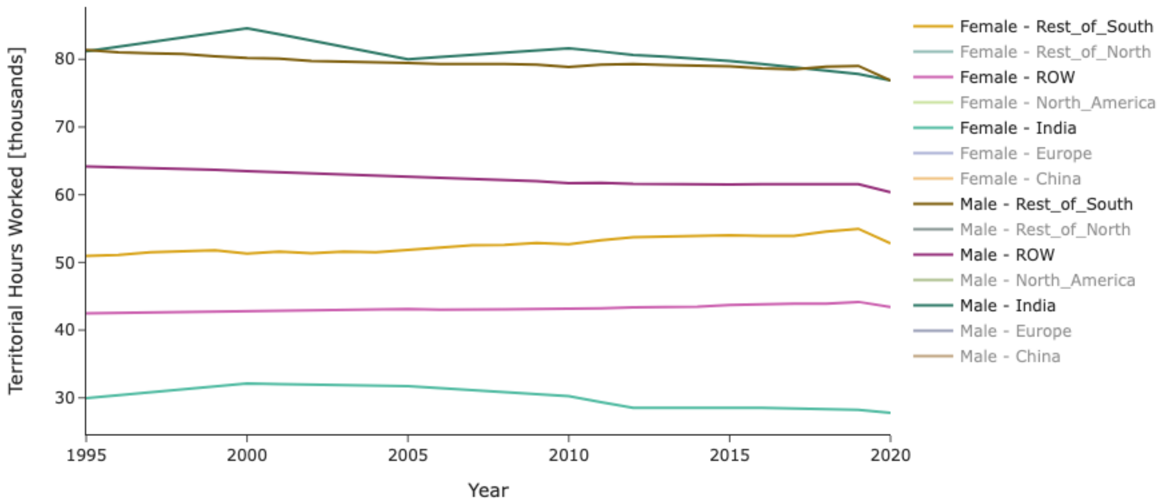
Appendix G.3 Population growth globally



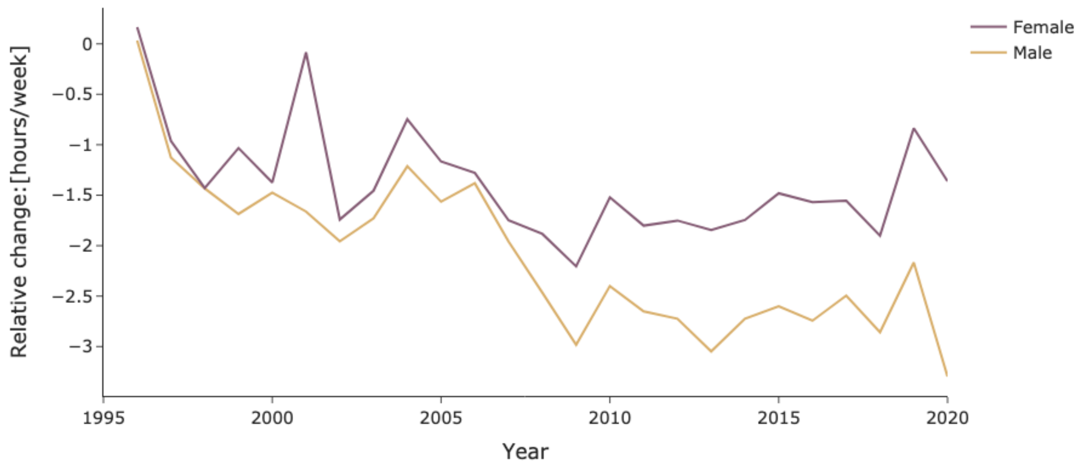
Appendix G.4 Participation rates North & China



Appendix G.5 Participation rates South & India



Appendix G.6 Absolute changes in weekly hours

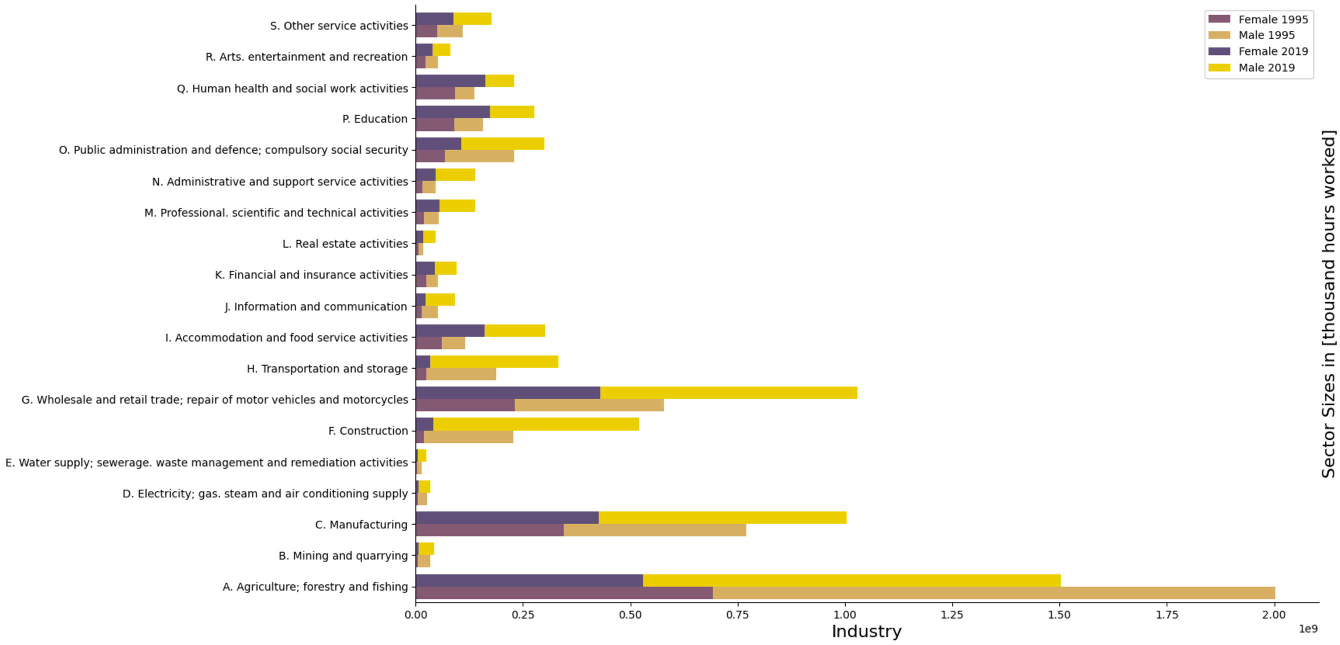


Appendix G.7 Population and Hours share

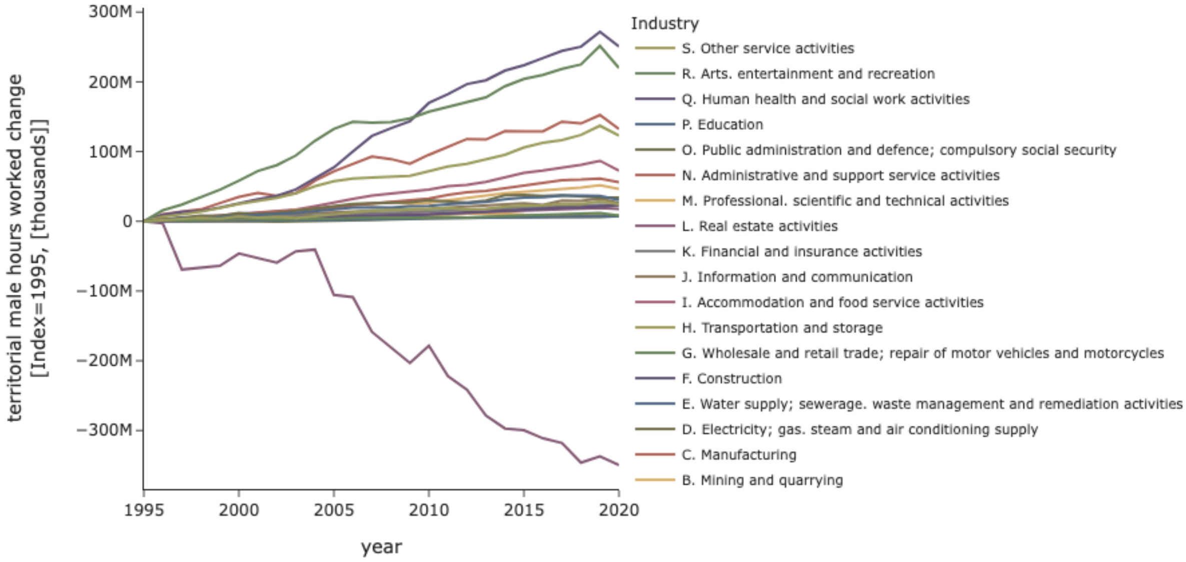
	Population 1995	% of Global	Hours worked total 1995	% of Global
China	1.204.855.000	22%	1.753.027.689	36%
Europe	488.857.815	9%	349.469.543	7%
India	964.279.130	17%	594.206.593	12%
North America	295.580.311	5%	253.137.765	5%
Rest of World	1.068.437.837	19%	695.595.698	14%
Rest of North	561.025.516	10%	362.657.547	7%
Rest of South	1.020.467.345	18%	846.768.710	17%

	Population 2019	% of Global	Hours worked total 2019	% of Global
China	1.439.130.020	19%	1.826.147.231	29%
Europe	508.808.326	7%	395.100.073	6%
India	1.428.650.114	19%	975.229.041	15%
North America	362.820.720	5%	312.891.736	5%
Rest of World	1.777.229.510	24%	1.178.731.092	19%
Rest of North	641.117.586	8%	396.750.219	6%
Rest of South	1.386.233.226	18%	1.282.408.156	20%

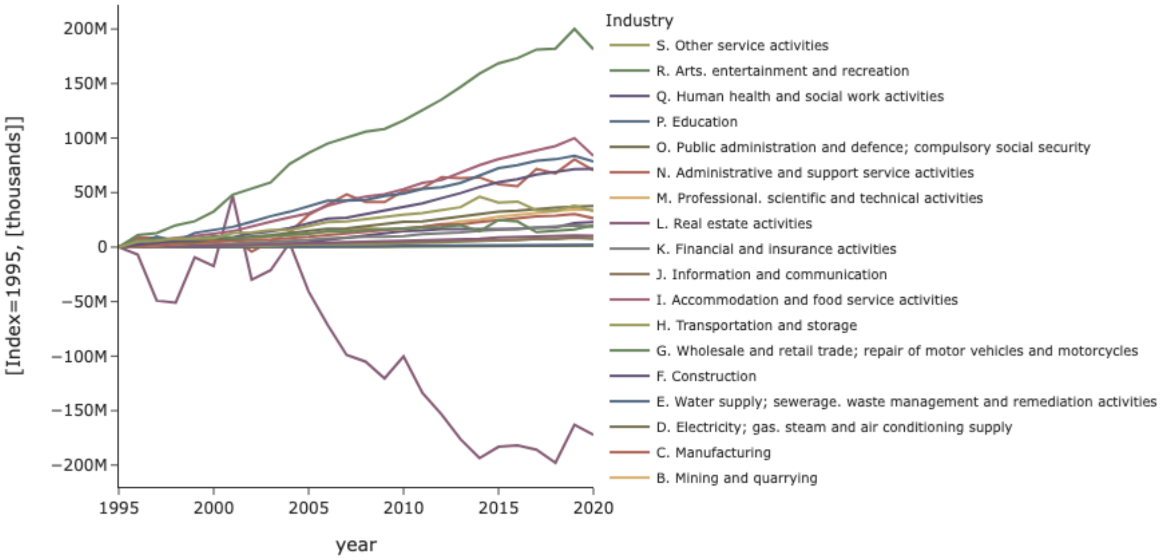
Appendix G.8 Sector sizes and gender share



Appendix G.9 Male hours worked change per sector



Appendix G.10 Female hours worked change per sector



Appendix G.11 SDA per sector male

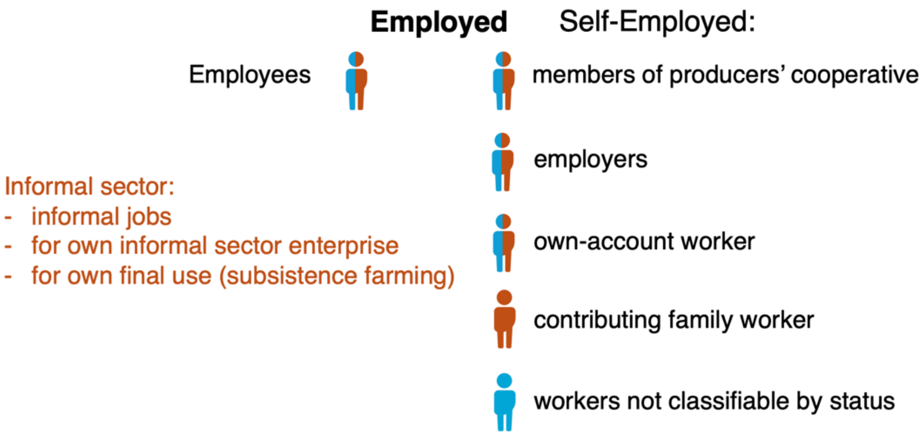
Male (Industry)	Technology (%)	Sourcing (%)	Consumption patterns (%)	Consumption level (%)	Total (%)
A	-185	18	-41	171	-37
B	-3	0	0	4	1
C	-57	12	2	60	17
D	-3	0	0	3	1
E	-1	0	0	1	1
F	-10	0	-3	43	30
G	-35	6	3	54	28
H	-16	4	1	26	15
I	-2	1	0	10	10
J	-4	0	2	5	4
K	-2	0	0	4	3
L	0	0	0	2	2
M	1	1	0	4	6
N	1	0	0	5	7
O	-17	0	-2	23	4
P	-6	0	-1	11	4
Q	-4	0	0	6	2
R	-4	0	0	4	1
ST	-6	0	0	9	3
Total	-353	45	-38	447	100

Appendix G.12 SDA per sector female

Female (Industry)	Technology (%)	Sourcing (%)	Consumption patterns (%)	Consumption level (%)	Total (%)
A	-142	17	-35	134	-27
B	-1	0	0	1	0
C	-94	24	1	82	13
D	-1	0	0	1	0
E	0	0	0	1	0
F	-2	0	0	6	4
G	-33	9	1	56	33
H	-4	1	0	5	1
I	-4	1	0	19	17
J	-3	0	1	3	1
K	-3	0	1	5	3
L	0	0	0	2	2
M	1	0	0	4	6
N	1	0	0	3	5
O	-8	0	-2	15	6
P	-11	0	-1	26	14
Q	-7	0	1	17	12
R	-6	1	0	8	3
ST	-9	1	1	13	6
Total	-322	55	-31	398	100

Appendix H: Informal sector

Figure H.1: Definition of informal employment



The ILO databank provides information on the informal employment of every country, but unfortunately with a similar scatteredness as other data. So there is little to no data available for a majority of countries. When there is data, it is only for the years of 2009 onwards. This would mean an extrapolation of data for 14 years back to 1995 which was considered unrobust.

Other concepts emerge to measure the differences of employment with respect to the Global South. The indicator of vulnerable employment is explained in Appendix I. (Simas et al., 2014) approached the question of secured work with a 'bad labor footprint' which entails indicators from vulnerability, low-skilled work, occupational health damages, up to forced or child labour. While a mixture of various indicators promises better comprehension of the issue, it was too hard to extract that data from solely two data banks for period of analysis. For future research EXIOBASE could be considered a valuable starting point of analysis.

Another rather positive approach to question on the stability of work is the concept of decent work. With a long history of definitions this indicator genuiely refers to job creationg, social protection, worker's rights, and participation (ILO, 2013) – broadly speaking freedom for dignified work without exploitation (Ferraro et al., 2016). This wide definition leaves intentionally room for interpretation and local application of the principles. It makes it adaptive towards regional meaning and is especially valuable when being applied to the context of Global South countries (Mohlakoana et al., 2024). While being one of the Millenium Development Goals, this indicator entails even more variables not covered by the used data bases. Hence, the author tried to combine the quantitative assessments with qualitative add-ons counterbalancing some of the numerical limitations.

Appendix I; SDA potential expansions

Considering that the Final Demand of the ICIO table is split into: *Household Final Consumption Expenditure, Non-Profit Institutions Serving Households, General Government Final Consumption, Gross Fixed Capital Formation, Changes in Inventories and Valuables,* and *Direct purchases abroad by residents,* we can divide these categories into 'Household', 'Government', and 'Capital Formation'. So that we can see which of them is causing more hours worked, are triggered by Household's purchases or Governmental ones. The corresponding formula would be:

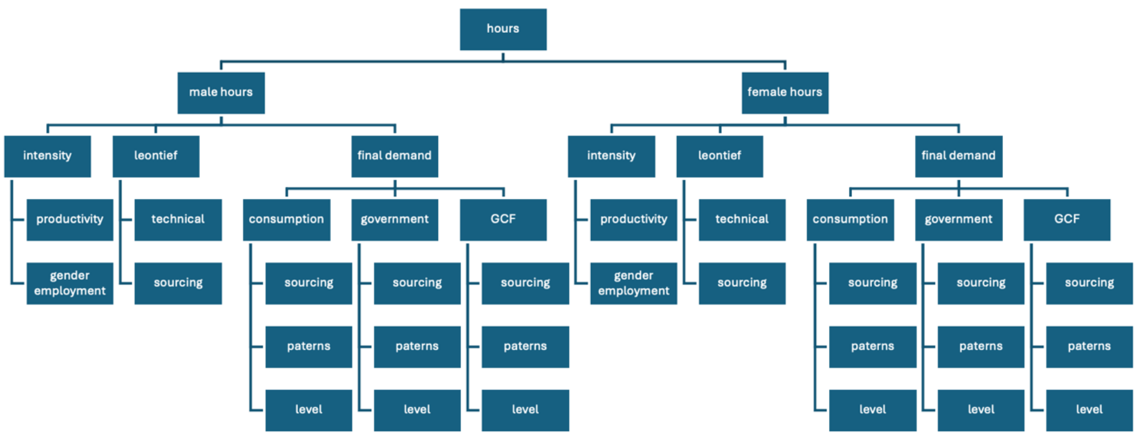
$$\mathbf{D}_y = \mathbf{D}_{HH} + \mathbf{D}_{Gov} + \mathbf{D}_{cap} \quad (10)$$

$$\mathbf{D}_{y\_HH} = f^{t-1}L^{t-1}\,\Delta y_{HH} + \frac{1}{2}\,\Delta f\; L^{t-1}\,\Delta y_{HH} + \frac{1}{2}\, f^{t-1}\,\mathrm{L}^{t-1}\,\Delta y_{HH} + \frac{1}{3}\,\Delta f\;\Delta \mathrm{L}\;\Delta y_{HH} \quad (11)$$

$$\mathbf{D}_{y\_Gov} = f^{t-1}L^{t-1}\,\Delta y_{Gov} + \frac{1}{2}\,\Delta f\; L^{t-1}\,\Delta y_{Gov} + \frac{1}{2}\, f^{t-1}\,\mathrm{L}^{t-1}\,\Delta y_{Gov} + \frac{1}{3}\,\Delta f\;\Delta \mathrm{L}\;\Delta y_{Gov} \quad (12)$$

$$\mathbf{D}_{y\_Cap} = f^{t-1}L^{t-1}\,\Delta y_{Cap} + \frac{1}{2}\,\Delta f\; L^{t-1}\,\Delta y_{Cap} + \frac{1}{2}\, f^{t-1}\,\mathrm{L}^{t-1}\,\Delta y_{Cap} + \frac{1}{3}\,\Delta f\;\Delta \mathrm{L}\;\Delta y_{Cap} \quad (13)$$

Figure H.1 Schematic overview of potential improvements for SDA



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