Global trade policy reform and gender inequality in the labour market

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Abstract

On average, wages of female workers are lower than wages of male workers, leading to a gender wage gap at a global level. In this paper, we explore the gender bias in actual trade costs, explore to what extent trade reform could be instrumental in reducing the gender wage gap and analyse the potential for digitalisation-related reductions in trade costs to reduce the gender wage gap. First, we analyse the relation between various types of trade costs and female labour force intensity across sectors. We find that more female labour force intensive sectors face both higher tariffs and non-tariffs barriers when exporting to other regions. Moreover, they have to pay higher trade costs on the intermediate inputs used. Second, we explore different trade policy reforms with regards to goods and services trade, and establish that services trade policy reform has a stronger downward effect on the average global male wage premium than goods trade policy reform. The main reason for this result is that tariffs tend to protect female-intensive sectors from severe import competition, making it difficult to design a reduction in tariffs leading to higher female wages globally. Third, we simulate trade cost reductions driven by the reduced requirement for face-to-face interaction in jobs, a phenomenon driven by digitalisation. This change would generate a much larger reduction of the gender wage gap than the trade policy experiments.

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1 Introduction

Achieving gender equality in public and private spheres constitutes a crucial component of sustainable development (United Nations , 2015). Yet, removing the gender bias in the labour market poses a challenge for many regions at different levels of development. Experimental evidence shows that gender discrimination across industries and occupations continues to exist, and can still not be discounted (Blau and Kahn , 2017). Literature has recently demonstrated the presence of gender biases in trade barriers. Given that it accounts for nearly half of global GDP, international trade is an important component of the global economy, potentially having an important effect on the gender wage gap. As shown by World Bank Group and World Trade Organization (2020) (for a selection of countries) and Gailes et al. (2018) (for the United States), sectors employing more female than male workers in production are facing higher tariffs both when buying intermediate inputs, and when selling output.

The literature on the relation between trade and the gender wage gap is relatively small. Artuc et al. (2021) show that tariffs repress real incomes of female headed households by 0.6 percentage points relative to those of male headed ones. They argue that in developing countries, high tariffs in agriculture protect male workers who disproportionately earn their income in agriculture. Other recent work uses firm-level data to show that exporting firms have larger gender wage gaps (Boler et al. , 2018, Janse van Rensburg et al. , 2020). Other researchers have found that in the context of NAFTA, trade agreements seem to have benefited gender equality in Mexico but harmed it in the United States (Hakobyan and McLaren , 2018, Juhn et al , 2014, Saure and Zoabi , 2014). Moreover, some studies have used country specific quantitative models to identify impacts of trade liberalisation on labour market outcomes for female workers (Fofana (2003), Siddiqui (2009), Fontana and Wood (2000) and Fontana (2002)). They find that trade liberalisation is associated with an increased unskilled labour force participation. Moreover, some earlier work has examined how increased competition from imports leads to a narrowing of the gender wage gap in concentrated (i.e. non-competitive) industries relative to industries that were competitive before trade liberalisation (Black and Brainerd , 2004). Despite this progress in studying the role of trade in the gender wage gap, there seems to be a lack of global studies of this nature employing a general equilibrium framework.

In this paper, we address the research gap by studying the potential impact of global trade reforms in both goods and services trade on the regional and global gender wage gap. We first

establish stylized facts of the gender bias in trade policies analysing both tariffs and non-tariffs measures for goods and services. Then we examine the potential impact of trade reforms on the gender wage gap employing simulations. In particular, we study whether removal of the gender bias in both goods and services trade costs is effective in lowering gender inequality in the labour market.[1]
Starting with the stylized facts, we identify that there is a gender bias in both tariffs and non-tariffs measures (NTMs) for both goods and services trade. Globally, there is a positive relationship between tariffs and the female labour share in goods sectors. The relationship holds for both the tariffs on intermediate inputs and on final goods. Similarly, there is a positive relationship between the estimated ad valorem equivalent (AVEs) trade costs of NTMs (measured by Kee and Nicita (2016)) and the female labour share in goods sectors. However, econometric estimations show that only some correlations are significant. Furthermore, these correlations do not necessarily imply causation. Turning attention to the services sectors, we find a positive relation between the AVEs trade costs of NTMs in services, measured by the WTO Services Trade Policy Database, and the female labour force share. Lastly, we hypothesize that digitalisation policies could affect trade costs by reducing the need for face-to-face interaction in economic transactions. We explore the link between the sectoral face-to-face intensity and its female labour force intensity. We find that more face-to-face intensive sectors are more female labour force intensive and at the same time display higher trade costs.

We then conduct three sets of counterfactual experiments. First, we look at the effects of implementing tariffs reforms in the goods sector. Second, we evaluate the impact of reducing iceberg trade costs in the services sectors related to non-tariffs barriers. Third, we explore the potential impact of digitalisation reducing trade costs in face-to-face intensive sectors thus changing the business environment across sectors. To conduct the analysis we use the WTO Global Trade Model, a recursive dynamic computable general equilibrium (CGE) model, expanded with labour supply differentiated by gender based on the World Bank's Gender Disaggregated Labour Database (GDLD).

Our experiments generate the following results. First, simple tariffs reforms in goods trade

[1] This is similar in spirit to the work by Shapiro (2021) who shows that addressing the pro-pollution bias in tariffs policy can lower CO2 emissions. However, as we show in this paper, trade policy has a more limited effect on the gender wage gap due to the presence of general equilibrium effects.

have a marginal impact on the gender wage gap globally with oftentimes the wrong sign, i.e. simple tariffs reform is projected to favour male workers on net. The reason is that tariffs reform raises import competition in some regions in sectors which are female labour force intensive, thus offsetting favourable impacts of such reforms. Second, simple NTMs reforms in the services sectors can make a substantial contribution to the reduction in the gender wage gap. Given that services sectors are more female-intensivethan non-services sectors, simple NTMs reforms in services have a larger impact than simple reforms for goods trade. Third, sophisticated tariffs reforms in the goods sectors to stimulate the export opportunities of female labour force intensive sectors and at the same time protect such sectors from increased import competition are projected to lead to a small reduction in the female wage gap, although the effect is an order of magnitude smaller than a simple reduction of NTMs in services trade. Fourth, the projected reduction in the gender wage gap as a result of reduced trade costs because of increased digitalisation through a reduction in the need for face-to-face interaction in economic transactions is an order of magnitude larger than of trade policy reform for goods as well as services trade. Fifth, although the scope for substitution between intermediate inputs in production and final goods in consumption affects changes in sectoral output and regional wage premiums, it does not have a significant impact on the gender effects of trade policy reform at the global level. The modest impact of trade policy reform can better be explained from the fact that such reform also raises import competition.

The paper makes the following four contributions to the literature. First, it provides a comprehensive analysis of the relationship between the size of trade costs and female labour force participation across sectors, both for goods and services trade and for tariffs and NTMs. Second, it contains an in-depth analysis of the potential for sectoral trade policy reform to contribute to reducing the female wage gap. Third, the paper projects the expected impact of digitalisation through reduced importance for face-to-face interaction in economic transactions on the gender wage gap. Fourth, the paper makes a methodological contribution by developing a framework to analyse the impact of trade policy reform on sectoral outcome variables identifying three channels through which such variable are affected - the export opportunities channel, the intermediate input costs channel, and the import competition channel - and by exploring the role of complementarity in production and consumption in the effect of sectoral trade reforms.

The paper is organized as follows. Section 2 explores the relation between trade costs and female labour force intensity, focusing in turn on tariffs in goods trade, NTMs for goods trade, NTMs for services trade and on more general aspects of trade costs such as face-to-face intensity. Section 3 presents the design of all experiments simulated, including the model used to develop the analysis and the description of the different scenarios. Section 4 reports the projected changes in wage premiums for all experiments and contains an analysis of the mechanisms and model features driving the results. Section 5 concludes.

2 Stylized facts: goods and services sectors

We begin our analysis by establishing stylized facts to show the presence of a gender bias in trade barriers in goods as well as services trade. We constuct the female labour shares of different sectors at a global level, obtained from the World Bank‘s Gender Disaggregated Labour Database. Then, for both goods and services trade, we establish the relation between the female labour share and the AVEs trade costs, for goods consisting of both tariffs and NTMs and for services only NTMs. Next, we relate the female labour force intensity with inferred trade costs employing the WTO Trade Cost Index. Finally, we relate female labour force intensity with an important determinant of inferred trade costs, the need for physical presence in economic interactions, measured by face-to-face intensity of tasks.

2.1 Tariffs and non-tariffs related measures in the goods sector

Various empirical analyses have linked female labour intensity to higher input and output tariffs rates. World Bank Group and World Trade Organization (2020) conduct this analysis at a multi-regional level while Gailes et al. (2018) establish similar results for the United States. Here, we explore a similar relation between the female labour force intensity of sectors and tariffs rates faced by these sectors when exporting. In addition, we explore the relation between the female labour force intensity of sectors and tariffs rates charged on their intermediate inputs. Analogously, we explore the relation between the female labour force intensity of sectors and the estimated AVEs trade costs of NTMs in these sectors, both on the output and intermediate inputs side. All data used for goods trade costs are condensed to a 28-sectors aggregation of goods sectors.[2]

[2]The services sectors are ignored in the analysis of the goods sectors. For more detail refer to Table 5 in the Appendix A.

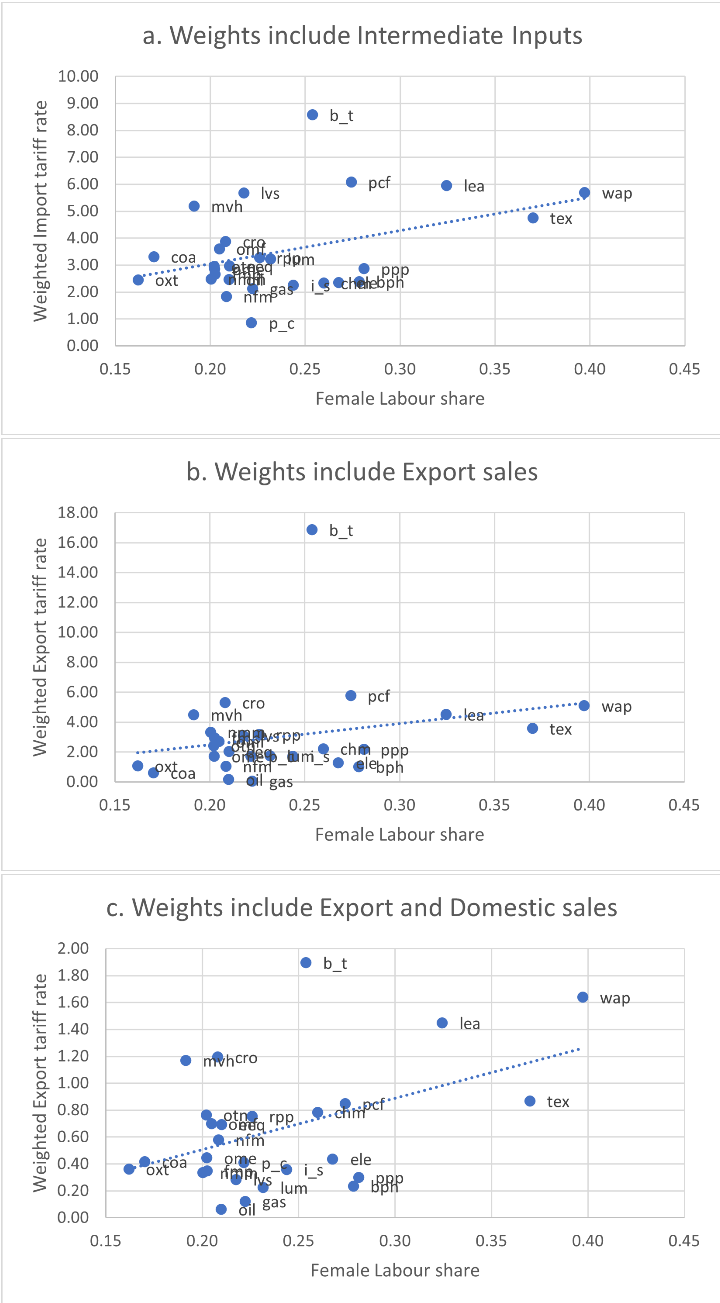
We begin with looking at the correlations for tariffs. We combine tariffs data and production data from the multi-regional input-output tables in the GTAP Data Base, with Gender Disaggregated Labour Database from the World Bank. Figure 1 shows our results. The first panel shows a positive relationship between the average tariffs on intermediate inputs and female labour force shares. Sectors with a high female labour share such as wearing apparel (wap) and textiles (tex) face higher tariffs on their inputs than sectors with a lower female share such as petroleum and coal products (p_c) and minerals (oxt). This result corresponds to previous analysis in World Bank Group and World Trade Organization (2020).

Interestingly, a similar picture arises for the export side. The lower panels of Figure 1 show that tariffs are higher in exporting sectors which are more female intensive. The middle panel shows the relationship with only export sales included and the lower panel depicts the scenario inclusive of domestic sales when calculating the average tariffs faced with tariffs on domestic sales set at zero. Considering only export sales (middle panel), beverages (b_t) is an outlier with high tariffs faced and only a median female share. However, textile (tex), wearing apparel (wap) and leather (lea) all face high tariffs and have a high female labour force intensity. With both export and domestic sales included (lower panel of Figure 1), the distribution of tariffs faced by exporters changes slightly and tariffs for female-intensive sectors such as wearing apparel, textile and leather increase.

We conduct a similar analysis for non-tariffs measures (NTMs) converted to trade costs using the methodology described in Kee and Nicita (2016). Non-tariffs measures considered are sanitary and phytosanitary measures (e.g. hygiene requirements) and technical tarriers to trade (e.g. labelling requirements). Compliance to these non-tariffs measures increases trade costs, by acting like a tariffs. Non-tariffs measures may also give firms incentives to under-report trade flows and even undermine the impacts of tariffs liberalisations. In fact, Kee and Nicita (2016) find that overall, the marginal impact of ad valorem equivalents (AVEs) of NTMs on trade discrepancies is larger than tariffs.

They estimate bilateral ad valorem equivalents (AVEs) of non-tariffs measures at a detailed product level, based on gravity regressions. According to their methodology, the AVEs of NTMs of product n between two trading partners measures the ad valorem tariffs that induces the same proportionate change in quantity imported as the presence of NTMs. The bilateral

Figure 1: Relationship between tariffs and female labour share



Source: World Trade Organization (WTO) Secretariat calculations based on GTAP multiregional input-output tables, and World Bank Household Surveys for the most recent available years. Note: Weighted input tariffs are calculated as a weighted average of sectoral tariffs with the weights being the import volume shares. Final averages across all regions for each sectors are unweighted.

AVEs of NTMs are computed at detailed product level in three steps. The first step is to estimate how much trade is reduced due to the presence of NTMs using a gravity regression. The second step is to estimate the import demand elasticity, which is the percentage of trade reduced due to the presence of a tariffs. The third step is to convert the first coefficient into an AVEs, by rescaling the coefficient using the import demand elasticity.[3]

Panel a in Figure 2 explores the relation between the average NTMs ad valorem equivalents on intermediate inputs used by a sector and its female labour force intensity. Panels b and c explores the relation between the average tariffs faced by an exporting sector and the female labour force intensity of the sector. For both relations we combine AVEs NTMs data from Kee and Nicita (2016) described in the above paragraph and production data from the multi-regional input output tables in the GTAP Data Base with data on female labour force intensity (in number of workers) from the World Bank Gender Disaggregated Labour Database (GDLD).

Figure 2 shows that there is a positive correlation between the estimated AVEs of NTMs for goods and the female labour share across sectors across all panels. Panel a shows a positive relationship between the average AVEs of NTMs on intermediate inputs and female labour force shares. Panel b shows the relationship with only export sales included and panel c shows the relationship with domestic sales and export sales included in the weighting. The AVEs NTMs are assumed to be zero for domestic trade.

[3] Detailed formulas on generating the NTMs AVEs can be found in p.16 of Kee and Nicita (2016).

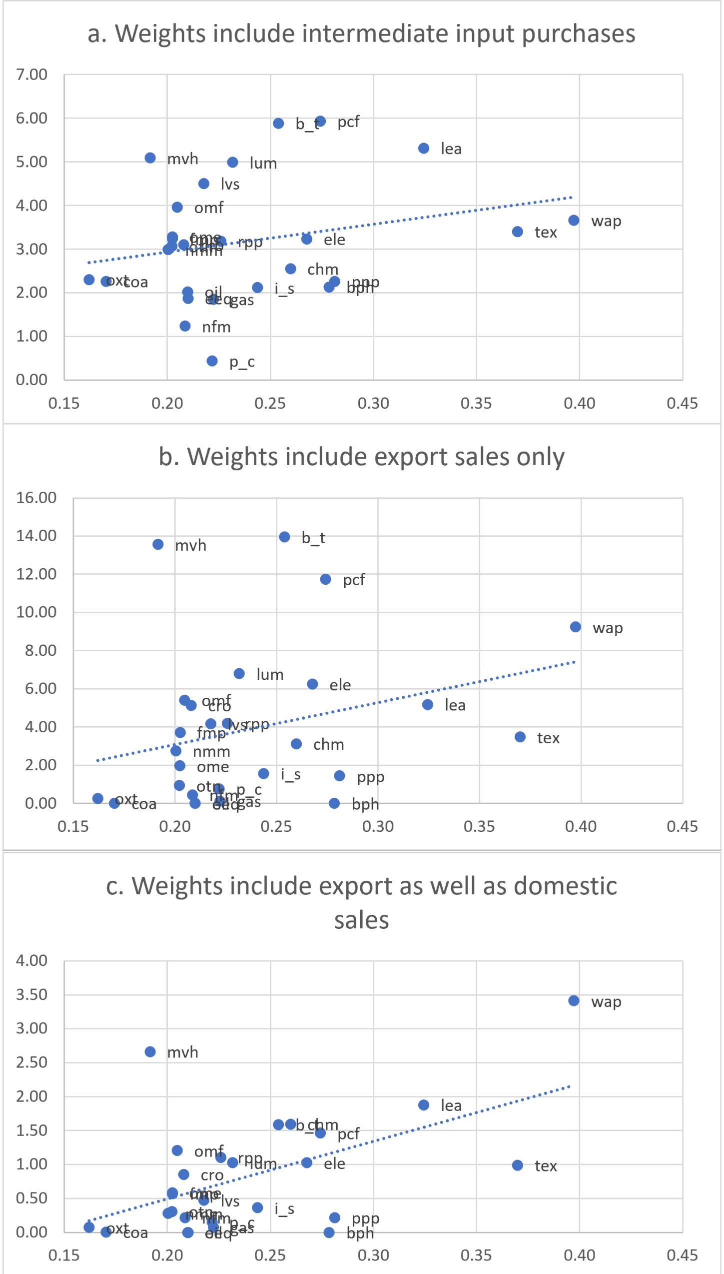


Figure 2: Relationship between NTMs and female labour share

Source: World Trade Organization (WTO) Secretariat calculations based on GTAP multiregional input-output tables, and Kee and Nicita (2016). Note: Y-axis plots the ad valorem equivalent (AVEs) of trade costs. Global averages across all regions for each sectors are unweighted.

To explore the link between the female labour share and tariffs as well as non-tariffs measures at the regional and sectoral level more formally, we run fixed effects regressions (Table 1). We control for regional fixed effects and cluster the standard errors at the sectoral (i.e., final good) level to observe how the sectoral variation in female intensity can explain non-tariffs measures.

Formally, we estimate equation $Y_{it} = \beta_0 + \beta_1.femint_{it} + \beta_2.a_c + u_{it}$ where the dependent variables are either the ad-valorem tariffs (Columns 1,3,5) or the estimated ad-valorem equivalents of NTMs (Columns 2,4,5) with different weightings.

NTMs and tariffs rates are weighted in three different ways in Table 1. In Column 1 and 2, the dependent variables are in turn the tariffs rate imposed on intermediate inputs and the estimated AVEs trade costs of NTMs (Kee and Nicita (2016)) imposed on intermediate inputs. In column 3 and 4, the dependent variables are in turn the tariffs rate weighted by the export sales and estimated AVEs trade costs of NTMs, weighted by the export sales. In column 5 and 6, the dependent variables are in turn the tariffs rate, weighted by the total export and domestic sales and estimated AVEs trade cost of NTMs, weighted by the total export and domestic sales. Table 1 shows that the coefficient on female share is significant at 5% level for columns 1 and 3 and not significant at the 5% level for any of the other regressions. This implies that the correlation presented in the figures above cannot be supported by econometric evidence for NTMs but holds for tariffs on intermediate inputs and on the export side.

Table 1: Co-efficients of regression of tariff and non-tariff measures on female labour force share

	(1)	(2)	(3)	(4)	(5)	(6)
	rtmsa	ntmsa	rtmso	ntmso	rtmsoda	ntmsoda
femint	4.937***	1.567	3.671	7.984*	1.552***	3.556***
	(3.84)	(1.30)	(1.70)	(2.05)	(4.00)	(4.06)
constant	2.345***	2.732***	2.279***	2.043*	0.314**	0.0259
	(7.14)	(8.85)	(4.14)	(2.05)	(3.17)	(0.12)
N	702	702	702	702	702	702

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author‘s calculations based on GDLD and GTAP database

Note: The regression is a panel regression with region fixed effects and errors clustered for sectors.

Our analysis in this section reveals that there is evidence of a partial gender bias in trade barriers. Moreover, these relationships are econometrically significant only for input and export weighted tariffs measures, but not for non-tariffs measures. In the next section, we look at similar relationships in the services sector.

2.2 Non-tariffs measures in services

The services sector accounts for 65.7% of global value added GDP (World Bank, 2020) and is one of fastest growing sectors in international trade. Services sectors do not have direct tariffs like goods trade, however they face myriad issues such as market access, lack of proper governance and regulations. Additionally, goods trade has been the subject of more formal policies and reforms in general and receives more attention when discussing trade liberalisation, especially in the context of gender inequality, even though services sector account for 59% of female employment globally, as of 2019 (ILOSTAT (2021)).

Baldwin (2022) highlights the growing importance of trade in services and expects that the role of services in development and global trade will increase in the future. This implies that the share of services in global GDP, which has already been rising is expected to rise further. Hence, any study looking at the impact of trade on gender inequality is incomplete without inclusion of this sector. In this section, we attempt to replicate the analysis done for the goods sectors. The analysis in this section is based on a 23-sectors aggregation which disaggregates the service-related sectors compared to the previous aggregation.[4]

One of the major issues with such analyses is that there are no direct observable trade costs in services trade akin to tariffs in goods. To resolve this issue of lack of data on trade barriers, the World Bank has developed a Services Trade Restrictiveness Index about fifteen years ago which attempts to convert all policies and regulations governing services trade to an index indicative of the levels of costs faced by various services sectors when being traded by different regions. This index has recently been updated in cooperation with the WTO and is now called the Services Trade Policy Database (STPD). OECD has developed a similar index - Services Trade Restrictiveness Index (STRI) which is also used by researchers to estimate ad valorem equivalents of policies and regulations to analyse trade barriers in services sectors. The STPD has data from 68 countries, for various years and for five major services sectors - finance, business, transport, communication and warehousing. These sectors can be further subdivided into 23 sub-sectors.[5]

We use this database to construct ad valorem equivalents based on estimation of a gravity

[4]For more details refer to Table 6 in the Appendix.

[5]See Borchert, Ingo, et al. (2020) for more details on how the database has been constructed.

equation with domestic sales and an interaction term of the STPD score and a dummy for international trade flows.[6] We then compare the AVEs to female labour shares in sectors using the same methodology as in the goods sector. The 23-sectors aggregation allows us to focus on the trends in the services sector.

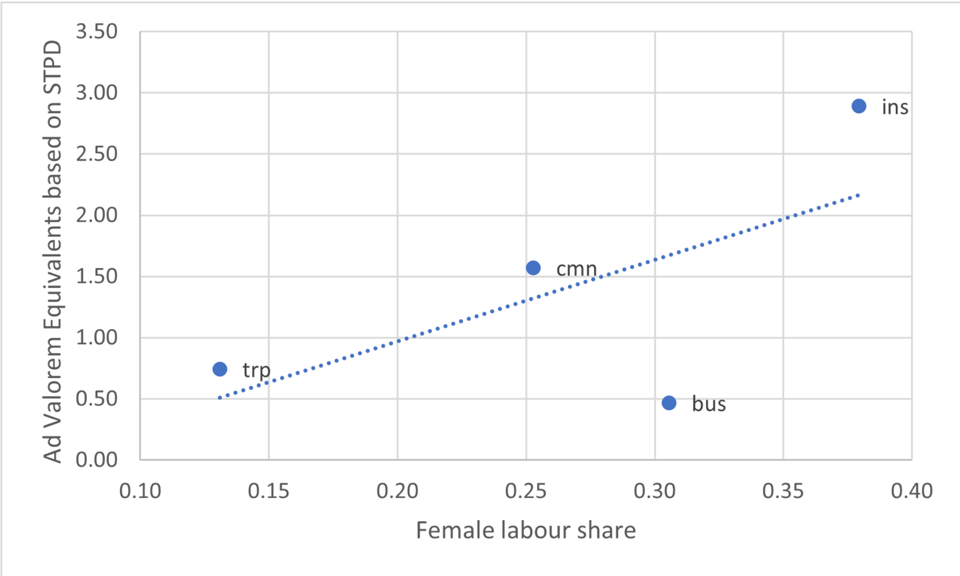


Figure 3: Relationship between female shares and ad valorem equivalents of NTMs on services trade

Source: Services Trade Policy Database created by World Bank and the World Trade Organization (WTO) and combined with Gender Disaggregated Labour Database by the World Bank Note: Ad valorem equivalent values are estimated using gravity estimation regressions with a border dummy and an interaction term with STPD and dummy.

Figure 3 shows the relationship between AVEs calculated using data from STPD.[7] Of the five overall sectors reported, we break finance into two sectors - insurance (ins) and other finance (ofi). We remove warehousing as the co-efficient for its estimate is not significant in our regressions. When calculating the AVEs we find that in finance the STPD displays a positive co-efficient in the gravity estimation, suggesting problems in the estimation of barriers related to this sector. Therefore, this sector is excluded from the analysis.[8] Hence, we have AVEs

[6]For more details on ad valorem equivalent estimations, see Benz and Jaax (2022).

[7]We use a constant elasticity of substitution of 3.8 and estimate the trade elasticity using a Poisson pseudo maximum likelihood (PPML) estimator, with regressions run separately for each sector. The overall methodology as mentioned earlier is similar to Benz and Jaax (2022).

[8]Constructing an index or database that translates policies and regulations to a numeric measurement of barriers to trade is far from easy. The task is herculean not only in the collation of all legal policies and assigning numeric values to them, but also in the aggregation of the same in one index. Take for example “synthetic measures”, which refer to singular policies that can have dual effects by changing access conditions for one type of entry but also affecting other types by changing access to alternatives. The World Bank STPD, assesses such policies jointly rather than individually (Borchert, Ingo, et al. , 2020). This example is just one indication of the scores of assumptions and judgement calls one needs to make while constructing these indices and hence, while informative and extremely useful, this dataset is not without its flaws. Shepherd (2020) in his draft paper develops an alternative method based on machine-learning, and uses banking as an example to show how it differs from OECD‘S STRI which in turn is similar to the STPD used here. Hence, the values of the index in financial services sector might be unreliable and are removed from our analysis.

estimates for four sectors - Business, Insurance, Communication and Transport. From Figure 3 we can see that these four sectors display a positive relationship between their AVEs and the female labour share.

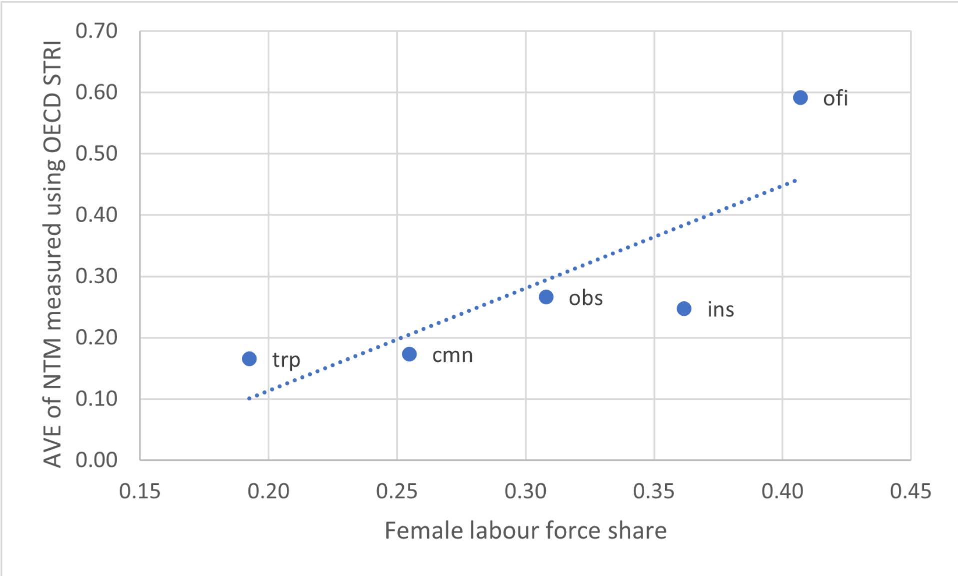


Figure 4: Relationship between female shares and ad valorem equivalents of NTMs on services trade

Source: Services Trade Restrictiveness Index created by OECD and combined with Gender Disaggregated Labour Database by the World Bank Note: Ad valorem equivalent values are estimated using gravity estimation regressions in line with Benz and Jaax (2022).

As a robustness check, we construct a similar figure (Figure 4) using data from OECD's STRI and find a similar positive trend. In the calculation of these AVEs, we use elasticities and co-efficients estimated by Benz and Jaax (2022) and STRI data from the OECD.

2.3 WTO Trade Cost Index

As a next step we analyse the relation between the female labour force intensity and total trade costs inferred from international relative to domestic trade flows employing the WTO trade cost index developed by Rubinova and Mehdi (2021). The WTO trade cost index is a measure of trade costs including all factors that burden foreign sales more than domestic ones. It is a summary measure, inclusive of tariffs and non-tariffs measures for both goods and services trade. We select the policy variant, which measures the overall trade costs if all countries were at minimum geographical, historical and institutional distance. Figure 5 shows that there is a positive relationship between the trade costs measured by Rubinova and Mehdi (2021) and the female labour share. This relationship is positively sloped, as long as we exclude the sector construction from the analysis. Construction disrupts the positive relation between the two variables, because it is an outlier with a very low female employment share and a very high overall trade cost, if all countries were at the minimum geographical, historical and institutional distance. Since the amount of trade in construction is marginal, this sector can be omitted from the analysis.

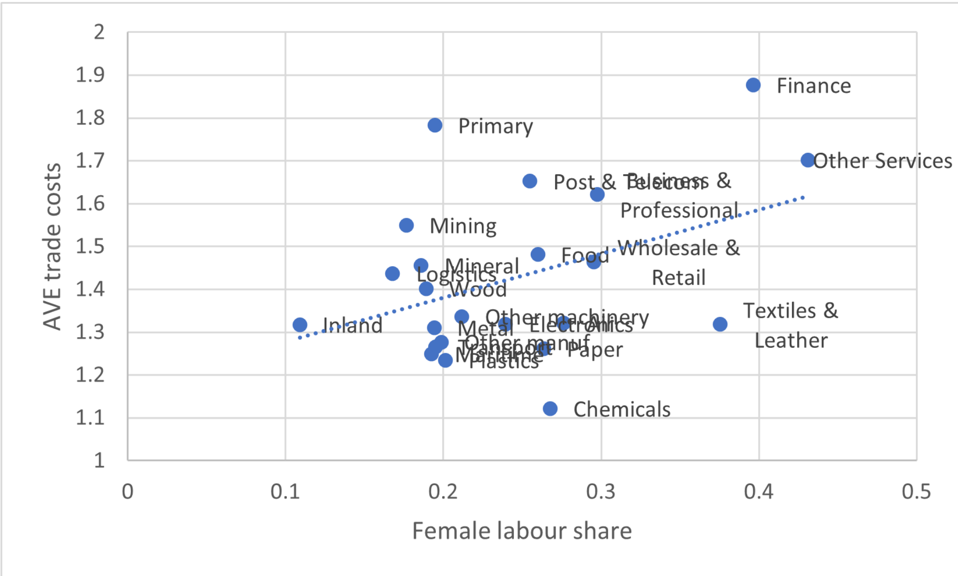


Figure 5: Relationship between female shares and ad valorem equivalents of Trade Costs Index

Notes: Estimated AVEs trade costs based on Rubinova and Mehdi (2021) and combined with Gender Disaggregated Labour Database by the World Bank.

2.4 Other components of trade costs: face-to-face intensity

At this stage, it is evident that tariffs as well as NTMs like market access and regulations display a gender bias in both goods and services trade. However, there are other components of trade costs that are not directly driven by policy but more by the business environment. When Baldwin (2019) argues the growing importance of services in the global economy, he also discusses how this growth will be lead by a wave of digitalisation which makes the trade of these services less costly.

Services sectors differ from the goods sectors in one key aspect - tangibility. Since services are not tangible goods, their exchange often requires face-to-face interaction which is not always necessary for non-service sectors. While tangible goods may require physical presence or face-to-face interaction to be produced, it generally does not require the same to be transacted. For

example, a doctor diagnosing or operating on a patient needs face-to-face interaction for the transaction to be complete. Whereas a pharmacist can simply deliver its medicines and receive payment without necessary face-to-face interaction.
With increased "serviification" of industries, there would be an increase in this face-to-face requirement. However, with digitalisation, face-to-face interactions would no longer need physical presence. On top of this, new technologies would allow for reduced face-to-face interactions in all sectors - goods and services. For example, the doctor can now diagnose its patient over a video call and the pharmacist can use an app to determine orders of his regular customers, receive payment for the same online and get it delivered to their doorstep without seeing their faces even once. Hence, technology can change the operating environment and affect trade costs.

While the process of technology seems to be bereft of any gender notions, we were curious to see if the gender bias in the current structure of industry is preserved or reversed by such technological trends. To explore this further, we use a measure of face-to-face requirements developed by Blinder, A.S. (2009) using data from the American O*NET database,[9] which records data collected by surveys filled by employees for almost 800 different occupations across the United States.

The index uses data on the importance scores assigned to various tasks in various occupations and condenses it into a measurement of face-to-face requirement based on task intensities calculated using Oldenski (2012) method for scoring. We then calculate the share of each occupation in a particular sector using labour force data from the US government,[10] and hence, construct a measure of face-to-face requirement in each sector.

We plot the relationship of this measure with trade costs as measured by the Head and Ries index for trade costs[11] (Figure 6) as well as female intensity (Figure 7) in various sectors. The Head and Ries index of trade costs is calculated based on the amount of international relative to intranational trade and is thus similar to the the WTO Trade Cost Index (Head, K., and Ries, J. (2001)). We find a positive correlation of face-to-face intensity with both inferred trade

[9]See O*NET Resource Center (2022).
[10]See Bureau of Labor Statistics (2017).
[11]Referred to as HR index by us, this is a measure of total trade costs inferred from the amount of international relative to intranational trade calculated using the methodology from Head, K., and Ries, J. (2001) and Chen and Novy (2011) with data from GTAP version 11.

costs and female labour intensity, implying that sectors that have a higher face-to-face intensity are not only more female-intensive but also has display higher trade costs.

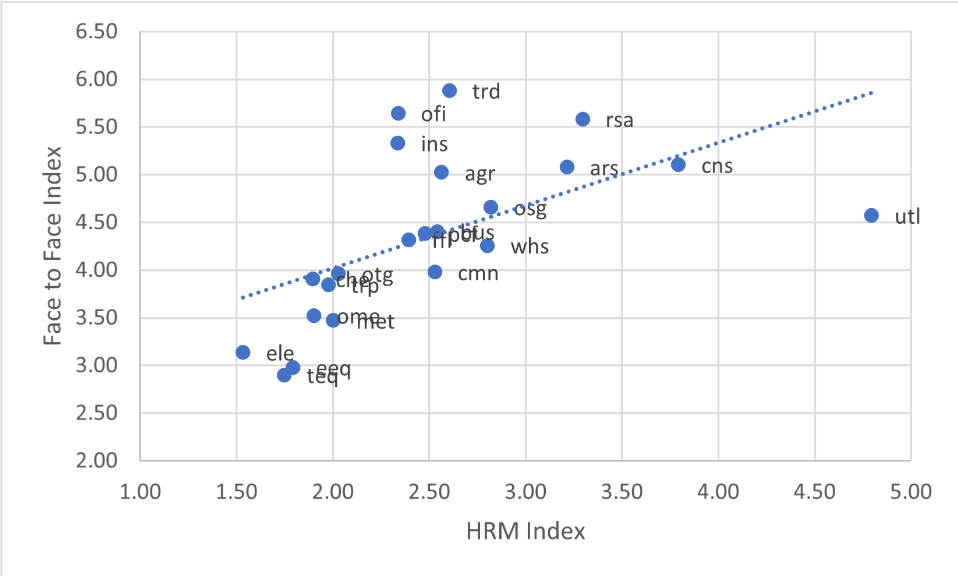


Figure 6: Relationship between trade costs measured by the HR Index and face to face index

Source: Author's calculations based on data retrieved from GTAP v11, O*NET 27.0 and US bureau of labour statistics.
Note: Methodology for construction of face-to-face index and HR index are discussed in detail in the text.

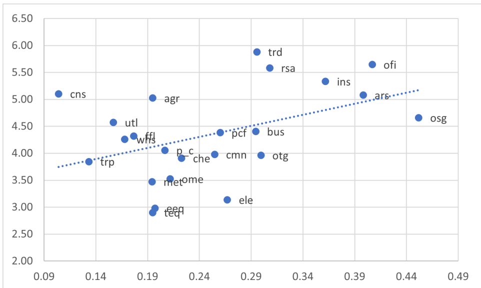


Figure 7: Relationship between face to face index and female labour share

Source: Author's calculations based on data retrieved from O*NET 27.0, US bureau of labour statistics and Gender Disaggregated Labour Database by the World Bank.
Note: Methodology for construction of face-to-face index and HR index are discussed in detail in the text.

To conclude the stylized facts section, we observe that in i) trade costs in goods and services trade; ii) overall trade costs; and iii) face-to-face intensity component of trade costs, there is a gender bias with larger trade costs in female labour force intensive sectors. In the next section, we explore whether trade policy reforms in both goods and services and changes in trade costs because of digitalisation can help to reduce the gender wage gap.

3 Model and Policy Experiments

Having established a relationship between female intensity in the both goods and services sectors and the level of trade barriers, we move to devising reforms and analysing their impacts on female wages.

3.1 Model : WTO Global Trade Model

Policy experiments are conducted using the the WTO Global Trade Model (GTM),[12] which is a recursive dynamic extension of the standard GTAP model (Corong et al. , 2017). The GTM features multiple sectors and factors of production, intermediate linkages, demand by economic agents (private demand, government demand, investment demand, and intermediate demand by firms), non-homothetic preferences for private households, and a global transport sector. Factor income and tax revenues are collected by a representative agent that in turn distributes total income into three spending categories, namely: private consumption, government consumption, and savings. In each region, perfectly competitive firms choose the optimal mix of factor inputs and intermediate inputs by maximizing profits.

It is useful to emphasize that GTM has complete factor mobility, which means that arbitrage equalizes the cost of labour across all sectors. Hence, when output rises in some sectors, but falls in others in a particular region, it is expected that labour from the latter would move to the former. If more sectors face a fall in output (e.g., due to higher import competition than a rise due to export opportunities), in a particular region, then factor demand would fall and lead to a fall in wages.

The GTM features recursive dynamics, with capital stock in the current period specified as a function of net investment and capital stock created in the previous period. National investment is determined by global savings with the latter derived as the sum of all national savings. National savings are a fixed share of household income and are collected by a global trust which then allocates global savings to investment in each of the regions in the model according to changes in rates of return on capital. The model allows for isoelastic factor supply of land and

[12]Detailed description is provided in Aguiar et al. (2019).

natural resources. Preference changes in domestic and import demand, and changes in labour to capital ratios in total value added are allowed via the twist-parameter approach developed by Dixon and Rimmer (2002). The trade structure is standard with Armington preferences. In equilibrium all markets clear: goods market, factor market, transport services market, and global savings market.

We calibrate the model based on the GTAP 11 Data Base, which as 2017 as reference year. We aggregate the data comprising 65 sectors and 158 regions into 28 sectors and 26 regions for analyses relating to goods trade and 23 sectors and 26 regions for analyses relating to services sectors. Sectoral and regional aggregations can be found in Tables 4, 5, and 6 in the Appendix. We construct baseline values until 2026 targeting GDP, population, and labour force growth rates and changes in savings rates drawn from IMF World Economic Outlook. Counterfactual experiments are introduced in 2022 and results reported are for 2026, thus representing medium-run effects.

We disaggregate both skilled and unskilled labour endowments into male and female skilled and unskilled labour employing a CES function. Therefore, we need to introduce an elasticity of substitution between male and female workers. In the literature on this topic there is broad consensus that male and female workers are imperfect substitutes. However, different estimates for the elasticity of substitution is reported. Girogio et al (2014) and Acemoglu et al (2004) both use natural experiments, the former based on Italian province data and the latter on post-war US data, and find the estimates of elasticity ranging from 1.0 to 1.4 in the former and approximately 3 for the latter. Weinberg (2000) uses U.S. data to model the effects of increased computer use on the demand for female workers and estimates three elasticities of substitution between males and females - 1.6, 2.4 and 3.2. Given the widely varying range of values across these three papers, we choose to use 1.6 as a benchmark elasticity of substitution. We assess the impact of changing this value on the simulation results in the robustness checks.

3.2 Scenario Design

Based on the stylized facts, we design scenarios for counterfactual trade policy experiments implying changes in trade costs and simulate their effects with the Global Trade Model. Simulating these scenarios enables us to shed light on the possible impact of policy changes and identify the policies that are most likely to have a beneficial impact on reducing the gender wage gap. Table 2 summarizes all the policy experiments conducted and discussed in the following section.

	Tariff reform	Non-Tariff reform	Digitalization
Merchandise sector	•S1.1 – Equalize tariffs across sectors •S1.2 – 50% reduction in tariffs in the five most female intensive sectors. •S3.3 - Formula based tariff reduction	S2.1 – Reduction of AVE of NTMs by 50%	•S6.1 – 50% reduction in AVE of the face-to-face requirement in all sectors and regions. •S6.2 – AVE of the face-to-face requirement reduced to the minimum value across sectors
Services sector		•S4.1 – 50% reduction in AVE of NTMs in all regions •S5.1 – AVE of NTM reduced to minimum value for all sectors in a particular region	

Two types of trade policy changes can be modelled (tariffs or NTMs) and the latter can be implemented for both goods and services trade. However, Carrere and De Melo (2011) argue that the objective of NTMs such as technical barriers to trade (TBTs) is difficult to identify, since they can have policy objectives that are not protectionist. Furthermore, the database on NTMs contains many missing countries. Therefore, we restrict our focus on tariffs related reform for goods trade and NTMs reform in services trade. We distinguish between simple trade policy reform, such as an equalization or a uniform percentage reduction rule and sophisticated reform which is based on the channels playing a role in the impact of reform.

Finally, trade costs do not only depend on trade policies but also on other factors, one of which is the business environment. In Section 2.4 we saw that sectors with a larger face-to-face intensity display higher trade costs and are also more female labour force intensive. Although face-to-face intensity does not have a direct policy angle, it does have an indirect one. For example, policy measures can affect the level of broadband availability which in turn affects digitalisation and digitalisation can result in a reduction of the need for face-to-face interaction thus reducing trade costs in particular for services trade.

Based on these different types of policies and different types of sectors, we have five categories of scenarios. Scenarios S1.1 and S1.2 are simple tariffs scenarios for goods trade while S4.1 is a simple scenario for services trade. S3.1 and S5.1 are sophisticated scenarios for respectively goods and services trade. Lastly, S6.1 and S6.2 explore changes in business environment, specifically reductions in trade costs associated with the reduced need for face-to-face interaction driven by digitalisation. In the remaining part of the section we discuss in more detail how the shocks are constructed for each of these scenarios.[13]

S1.1 and S1.2 involve tariffs changes in the goods sector. In S1.1, we equalize tariffs across all sectors. Thus, the tariffs shock is negative for some sectors and positive for others. In S1.2, we reduce tariffs by 50% for the five most female-intensive sectors, globally - tex, wap, lea, bph and ppp.[14]

Under S4.1 AVEs of NTMs in services sectors are reduced by 50%. The AVEs of NTMs are estimated based on the STPD in five service sectors. An equal per cent reduction should lead to a larger reduction in percentage points in the female labour force intensive sectors, since Section 2.2 shows that within the service sectors AVEs of NTMs are larger in more female intensive sectors.

S3.1 refers to sophisticated shocks in tariffs policy in the goods sector. Based on the results of the simple scenarios for tariffs, we develop a formula to identify the effect of different transmission channels, namely - export opportunities, intermediate inputs and import competition. We then construct a shock using a combination of these three metrics to calculate the tariffs reduction in each sector. We calculate the tariffs shock under tariffs revenue neutrality like in the simple tariffs scenarios.[15]

S5.1 contains a more sophisticated scenario for services trade than S4.1. The reduction in trade costs is not a simple percent change, but a sector specific change. We identify best practices by calculating the minimum value of STPD for a sector in the world and reduce the STPD of that sector in each region to the world minimum, thus, simulating the effect of implementing global best practices in all regions.

Scenarios S6.1 and S6.2 are based on a reduction in trade costs due to an increase in digitalisation. To calculate the shock we regress inferred trade costs calculated using the Head and Ries index on the measure of face-to-face intensity described in Section 2.4 and a range of control variables determining trade costs such as distance. The resulting AVEs of face-to-face intensity is then reduced in the experiments.[16] More specifically, S6.1 constitutes a simple scenario with

[13]See Appendix 5 for details on formulas used for the sophisticated tariffs reform scenario, S3.1.

[14]For all tariffs related shocks, we ensure revenue neutrality by keeping the ratio of tariffs revenue to income constant.

[15]In the Appendix 5, we include detailed formulas to explain the calculation of the various effects included in this shock.

[16]See Appendix C 5.0.3 for more details.

the AVEs of face-to-face intensity cut by half. In S6.2, the AVEs of face-to-face intensity is reduced to the lowest value across all sectors. These scenarios provide an upper bound as they are based on the assumption that technology growth will provoke drastic changes in economic interactions, in particular in services sectors.[17] Since we explore the potential for reform in all policies explored in the previous section, it is important to emphasize that we do not explore policy experiments based on the WTO Trade Cost Index, a generic measure of policy-related trade costs. Although this seems appealing since it covers all policy-related trade costs, conducting simulations is not feasible because the WTO Trade Cost Index is based on the TiVA database. Hence, the calculated trade costs are not consistent with the data employed in the counterfactual experiments.

4 Simulation Results

4.1 Wage Premia effects

This subsection describes the projected effects of the trade cost scenarios presented in Section 3.2 on the gender wage gap between males and females. To measure the projected changes in the wage gap, we calculate the percentage change in the wage of male workers relative to female workers, WP, defined as:

$$WP = [\frac{1 + \frac{pe_m}{100}}{1 + \frac{pe_f}{100}} - 1] * 100 \tag{1}$$

pe_m and pe_f represent the changes in factor prices for males (both skilled and unskilled) and females (both skilled and unskilled), respectively. A negative value of WP implies that female wages increase relative to male wages. In the interest of brevity, we present results on the wage premia at the regional and at the global level, aggregating results for skilled and unskilled workers. Regional and global values are weighted averages, using wage bills as weights. Appendix C describes the computation of regional and global averages.

Overall, the impact of trade reforms on wage premia by 2026 is small in magnitude, both at the regional and global level. Simple tariffs reforms in goods generate an increase in male wages relative to female wages. On the other hand, simple NTMs reform in goods leads to an increase in female wages relative to male wages, although the size of the impact is still marginal.

[17] We are unable to follow the best practices hypothesis per country employed in scenario S5.1 as the face-to-face intensity has only a sectoral and no country dimension.

Simple reforms in services have the potential to increase female wages relative to male wages, with effects larger compared to simple reforms in goods sectors. Lastly, more targeted tariffs reforms in the goods sector raise female wages relative to male wages, which thus constitutes a reversal of the direction of the overall impact on global wage differences from the effect under a simple reform in the goods sector. However, the magnitude of the projected change is smaller than under a simple reform in the services sector.

Given that trade reform scenarios are not designed exactly in the same manner due to the nature of different measures, their impact might differ not only because they are different measures, but also because the size and the coverage of the shock differs. For example, for tariffs, we examine equalizing tariffs across all sectors to remove the gender bias in tariffs, whereas we cut the NTMs in by 25% across all goods sectors. In section 3.2 we motivate why the design of the scenarios are the way they are. However, these scenarios are hypothetical trade liberalisation scenarios and the scenarios in goods and services are not meant to be fully symmetric because these measures are inherently different by their purpose and implementation. Section 4.2 analyses the economic effects of the different shocks into detail.

4.1.1 Changes in wage premia in simple reforms for goods

As a first counterfactual experiment we equalize tariffs across all sectors. We ensure revenue neutrality by keeping the ratio of total tariffs revenues to income constant. Given the evidence that both tariffs faced by exporters on the output side and tariffs on intermediate inputs on the input side are higher in sectors with a larger share of female workers, this reform is expected to improve the labour market position of female workers globally. Figure 8 displays the change in the wage premium by 2026, at a regional and global level. It is observed that a simple tariffs reform equalizing tariffs across all sectors within a region does not have the desired impact on the wage premium globally. The average global change in wage premia is 0.0001, implying that the male wage increases relative to the female wage by 0.0001%. Hence, this indicates, first, that the impact on the wage premium is small, and second, that the wage premium of male workers is projected to increase instead of decrease, which posits a puzzle. This prompts us to believe that there might be other channels at play, such as increased import competition in the female intensive sectors, which prevents the wage premia to move in the favorable direction for the females. Section 4.2 explores these channels in depth.

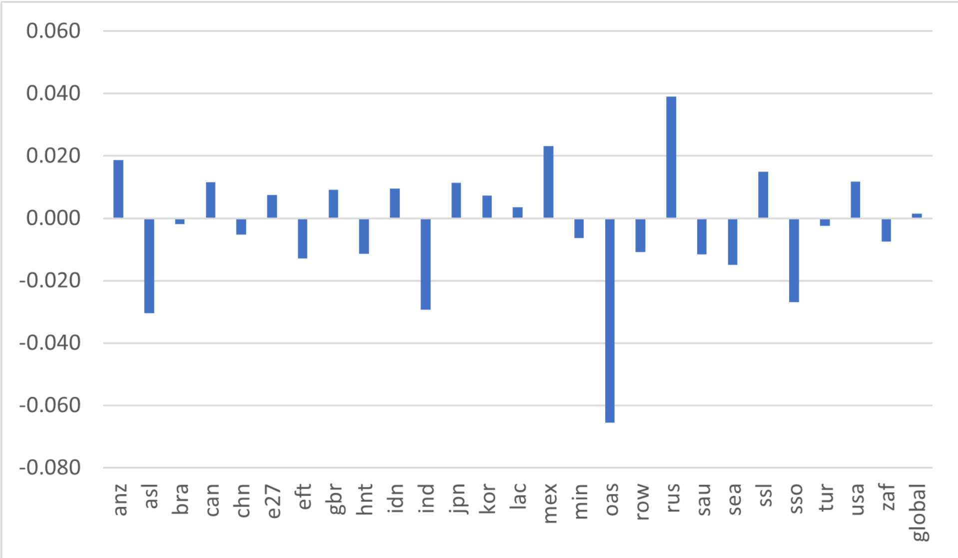


Figure 8: Changes in wage premia when tariffs are equalized for all sectors for all regions

Source: Author's calculations. Note: Global weighted average calculated using total factor prices for labour as weights.

As a next experiment, we identify the sectors in each region with a female share higher than the median for that region and reduce tariffs to zero for these sectors. We ensure revenue neutrality again by keeping the ratio of tariffs revenues to income constant.

Figure 9 shows that globally, the male wage premium rises by 0.007% which is seven times larger compared to the previous scenario. Thus, complete removal of tariffs in the most female labour force intensive sectors does not result in a reduction in the wage gap either. This suggests that tariffs liberalisation provokes other effects besides increased export opportunities and reduced costs of intermediate inputs in female labour force intensive sectors, such as increased import competition. This may suggest that contrary to our initial hypothesis, higher tariffs in female-intensive sectors might serve in some cases as protection for those sectors.

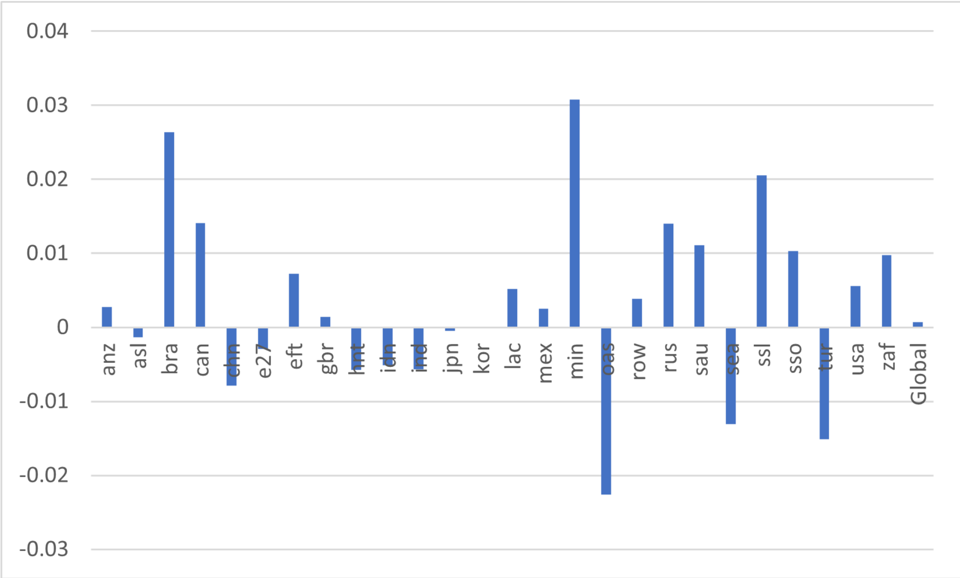


Figure 9: Changes in wage premia when tariffs are removed for the five most globally female-intensive sectors

Source: Author's calculations. Note: Global weighted average calculated using total factor prices for labour as weights.

4.1.2 Changes in wage premia in simple and sophisticated reforms for services

Next, we turn our attention to the scenarios which simulate a NTMs reform on the services sector (S5.1 and S4.1). As described previously, in these scenarios, we restrict our focus to the estimated AVEs trade costs in services, calculated using the WTO Services Trade Policy Database, and implement shocks in four sectors: business services (bus), transport services (trp), communication services (cmn) and insurance services (ins).

Figure 10 displays the projected change in the male wage premium at a regional level. In both scenarios, the projected change in the male wage premium is mostly negative, indicating that female wages rise relative to male wages for most regions. Globally, the overall change in the male wage premium is small but negative (reaches -0.05 % in S4.1), implying that globally, females gain more than males as a result of a reduction in services trade restrictiveness. Moreover, the size of the change in the global male wage premium, is larger than its size under the tariffs reform scenarios. This implies that liberalisation in the services sector has a larger impact on female relative to male wages than a liberalisation in the goods sector, according to our projections. On the other hand, in absolute terms, the impact of such liberalisation on the size of the change in wage premiums continues to be low: For all regions, the male wage premium falls less than 1%.

It must be noted that the reduction of NTMs in the goods sector (scenario S2.1) is only

25%, whereas for the services sectors the shock is a 50% reduction. Hence, the difference in magnitude of effects is also driven by differences in the size of shocks. However, non-tariffs measures in goods serve more often non-economic objectives, whereas NTMs in services tend to have a more pure market access limiting character. Therefore, from a welfare optimizing perspective there is less potential to reduce such barriers. This indicates that services trade policy reform might have a larger potential to reduce the female wage gap than goods trade policy reform.

It is also interesting to note that changes are larger for scenario S4.1 than scenario S5.1. This is because, the minimum value of the estimated AVEs of services trade costs based on STPD in the world is close to the average value. Hence, when the STPD is reduced to the minimum of the world for each sector in each region, the resulting shock is not so bad as with a 50% reduction in the AVEs of services trade costs and the reduction in the gender wage gap is higher.

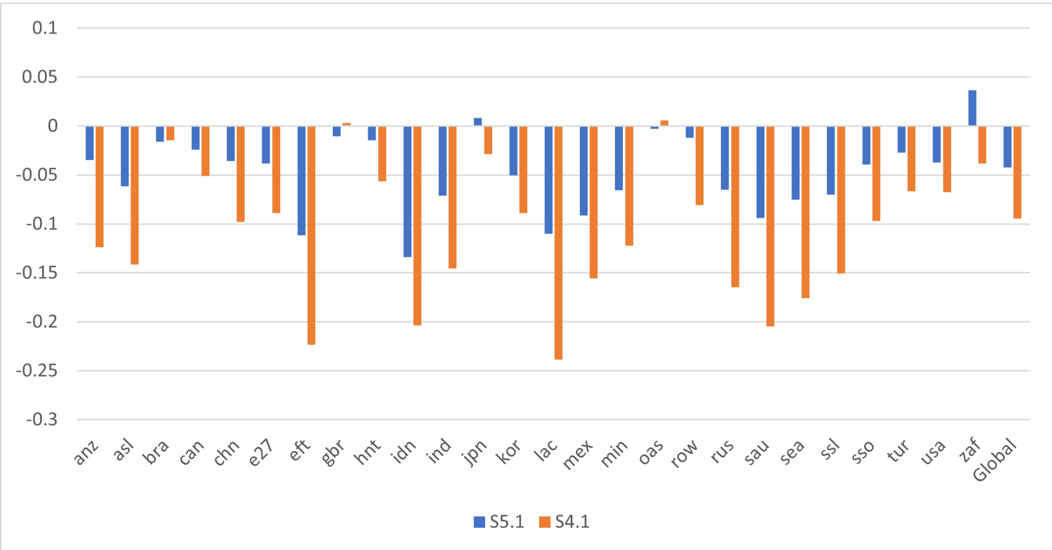


Figure 10: Change in male wage premia across the services trade reform scenarios based on the STPD

Source: Author's Calculations based on simulation results.

4.1.3 Changes in wage premia in sophisticated tariffs reform in goods

Given that the simple tariffs reform in the goods sector was inconclusive in terms of wage premium effects, we explore whether more targeted tariffs reforms can have a larger impact on reducing the gender wage gap. As described in the previous sections, these scenarios are developed to identify the effect of different transmission channels, namely - export opportunities, intermediate inputs and import competition channels- on how trade reforms could impact the wage gap. In the scenario with all three of these effects accounted for (S3.1), we ensure revenue neutrality with the same rule as the naive tariffs scenarios.

Figure 11 shows that compared to previous tariffs reform experiments in the goods sector, a reduction in male wage premia is projected in more regions. Globally, the wage premium is projected to fall, but only by 0.002% which is marginal compared to the initial level of the wage premium of 1.27 for skilled workers and 1.2 for unskilled workers.[18]

Naive tariffs reforms only reduce tariffs in sectors that have high female shares. They, hence, often end up hurting the females in the liberalized sector as without protection from import competition, these sectors now face a contraction. However, in the sophisticated scenario tariffs reductions are higher in sectors that have a high female labour share and that are less vulnerable to import competition. As a result, it reverses the effect on wage premia. However, the shock size is relatively small, resulting in extremely marginal effects on wages with the maximum reduction only reaching 0.06% in SSO, compared to maximum changes in the previous scenarios of almost 0.15% (LAC, in scenario S4.1). Although globally, this reform results in a decline in male wage premia, there are still various regions where import competition effects dominate and male wage premia rise, for example, Russia, Korea, Australia and New Zealand. In particular, Korea has high tariffs at the onset of this experiment which may be indicating that it would be more heavily affected by increased import competition with import tariffs liberalisation. This might indicate that Korea sets higher tariffs than usual for protection of domestic sectors. A reduction in tariffs, even though sophisticated, is not enough to reverse the effects of import competition.

[18] Global total calculated as weighted average of male to female wage premia for each region.

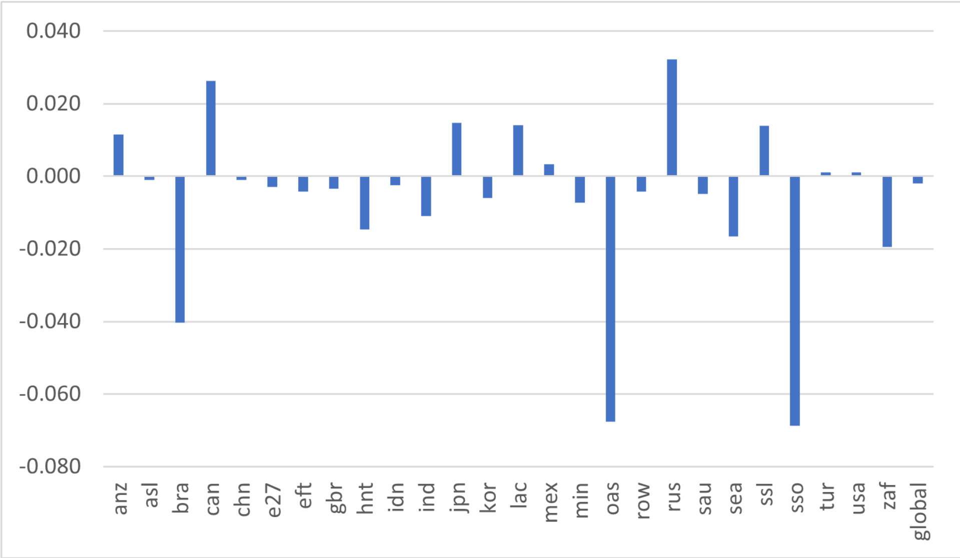


Figure 11: Changes in male wage premia by region for experiment with sophisticated tariffs reform

Source: Authors'calculations based on simulation results.
Note: Weighted average across sectors with total value shares for factors as weights. Global wage premia changes are weighted averages across regions as described in detail in Appendix .

4.1.4 Changes in wage premia in digitalisation scenarios

In the final set of scenarios (S6.1 and S6.2), we explore the effect of reducing the estimated AVEs trade costs associated with the need for face to face interaction across regions.

Figure 12 displays the projected change in the male wage premium in scenarios S6.1 and S6.2. In both scenarios, female wages rise more than the male wages for most of the regions. This suggests that a decrease in the face-to-face requirement across all sectors would lead to an increase in female relative to male wages. Moreover, in the digitalisation scenarios, the global increase in female wages is larger than in all other scenarios analysed. In the scenario in which the face-to-face intensity is reduced to lowest value for that sector in the world (S6.2), the male wage premium is projected to fall by up to 0.6 %.

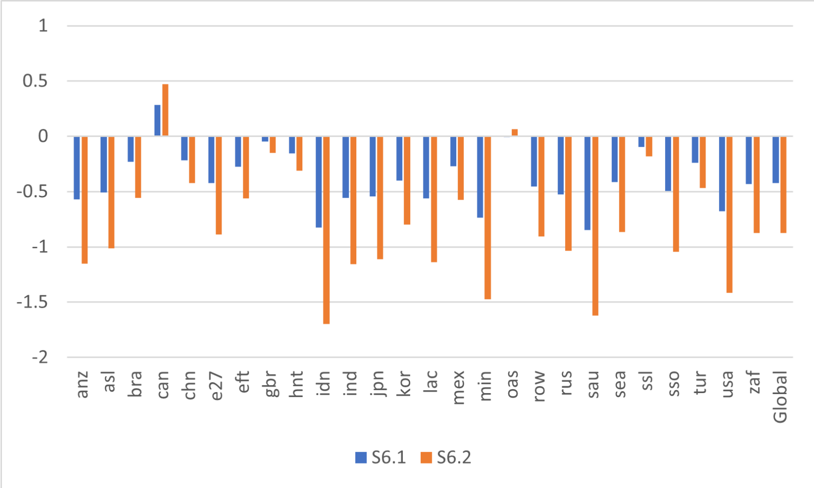


Figure 12: Change in male wage premia across the face-to-face requirement reduction scenarios

Source: Author's calculations based on simulation results.

Three main conclusions can be drawn from these results. First, given that female-intensive sectors require more face-to-face interaction, a reduction in the face-to-face requirement across all sectors tends to reduce the gender wage gap by reducing the male wage premia across regions. Second, the positive effect of increased digitalisation on the gender wage gap is larger than of all the tariffs and NTMs reforms in the goods sectors and larger than of a reduction in services trade restrictiveness in selected services sectors. Third, the effect of reducing the estimated AVEs trade costs associated with the face-to-face requirement of a sector, to the minimum level across all sectors on the gender wage gap is stronger than the effect of cutting the AVEs requirement by 50%.[19]

[19]This is because the minimum AVEs trade costs associated with the face-to-face requirement is near zero, implying that some sectors do not have any trade costs due to the necessity of face-to-face interaction. Thus, the scenario with a reduction to the minimum value (S6.2) is similar to a full reduction. Therefore, it is more impactful than a 50% reduction (S6.1) of the AVEs, for all sectors.

4.1.5 Concluding remarks on the effect of trade cost changes on female wage gap

Table 2: Global average wage premia and real income changes

Scenario	WP change	Female Income	Male Income
S1.1	0.0003	0.004	0.005
S1.2	0.007	0.013	0.016
S3.1	-0.002	0.038	0.038
S4.1	-0.05	0.981	0.975
S5.1	-0.02	0.522	0.531
S6.1	-0.272	3.278	3.195
S6.2	-0.565	7.019	6.800

Source: Authors' calculations based on simulation results.

Results on the wage premia across these scenarios, presented in Table 2 analysed in the complete section establish the following insights - First, the simulations suggest that for goods trade simple tariffs reform eliminating the gender bias in tariffs is not effective in reducing the gender wage gap and could even raise the male wage premium although the effects are very marginal. Substantial NTMs reductions could deliver a small contribution to the reduction of the gender wage gap. Second, reductions in services trade barriers in four tradable services sectors deliver a more meaningful contribution to the reduction in the gender wage gap by about 0.05%. Third, more sophisticated tariffs reforms considering the different channels through which tariffs affect the demand for female relative to male workers, only delivers a very marginal contribution to the reduction in the female wage gap. Fourth, increased digitalisation leading to a reduced importance of face-to-face interaction in economic transactions results in a higher impact on wage premia globally, mainly driven by changes in the services sector. This is because services sectors currently have a high face-to-face index and a high female labour share (Figure 7), and thus the highest potential to benefit from digitalisation.

In Table 2, we also show the global average real income changes for females and males. The regional distribution for these values are presented in the Appendix and they show that for the experiments in the goods sectors, there are winners and losers in the world. However, for service sector and digitalisation scenarios, income rises for both factors across all regions. One explanation for this, can be the difference in the shock modelling where goods sector shocks are tariffs reductions while service sector and digitalisation shocks are an improvement in productivity. However, in scenario S2.1, we reduce the NTMs in goods sector by 50%. The results for this scenario are present in the robustness check and the changes in real income reported in the Appendix, show that there are still winners and losers, implying that it is the overall dominance of import competition in goods sector that causes a distribution of positive and negative effects across the world.

In the next subsection we provide a further in-depth analysis of the findings presented here on projected changes in the wage premium.

4.2 Further analysis on the drivers of the wage premium effects

The projected effects of trade policy reform on the global average female wage gap are small and sometimes even have the wrong sign (i.e. raising the male wage premium). The question is what is driving these results. In this section we provide an in-depth analysis exploring the role of four mechanisms and modelling features driving the results. First, there is complementarity in production between intermediate inputs from different sectors and near-complementarity between consumption goods from different sectors in private household demand. This implies a lack of scope for substitution towards liberalized sectors which could explain why output in female labour force intensive sectors and thus demand for female workers does not increase sufficiently. Second, increased import competition in female labour force intensive sectors as a result of liberalisation of these sectors could be responsible for the small and sometimes adverse effects of trade policy reform on the gender wage gap. While trade liberalisation in female-intensive sectors will raise output on such sectors in exporting countries because of rising export opportunities, it will also reduce output in such sectors in importing countries. Third, the effects of trade policy reform differ between tariffs and iceberg trade cost changes, because the effects on output differ between these two types of experiments. Fourth, the effects reported can be driven by general equilibrium (GE) effects, i.e. changes in other sectors than the liberalized sectors. Two such GE effects are intermediate linkages and changes in final demand across sectors driven by non-homothetic preferences.

To develop a better understanding of how these effects come into play, we take two examples - simple tariffs reform where we reduce tariffs rates by 50% in five most female-intensive sectors (S1.2) and simple NTMs reform in services where we reduce AVEs of NTMs by 50% (S4.1). Before going into the role of the four mechanisms in the two scenarios, we first show that changes in global wage premia are affected by the weights of different regions in aggregating regional changes in male wage premia and that changes in regional wage premia are driven by changes in sectoral output in female relative to male intensive sectors.

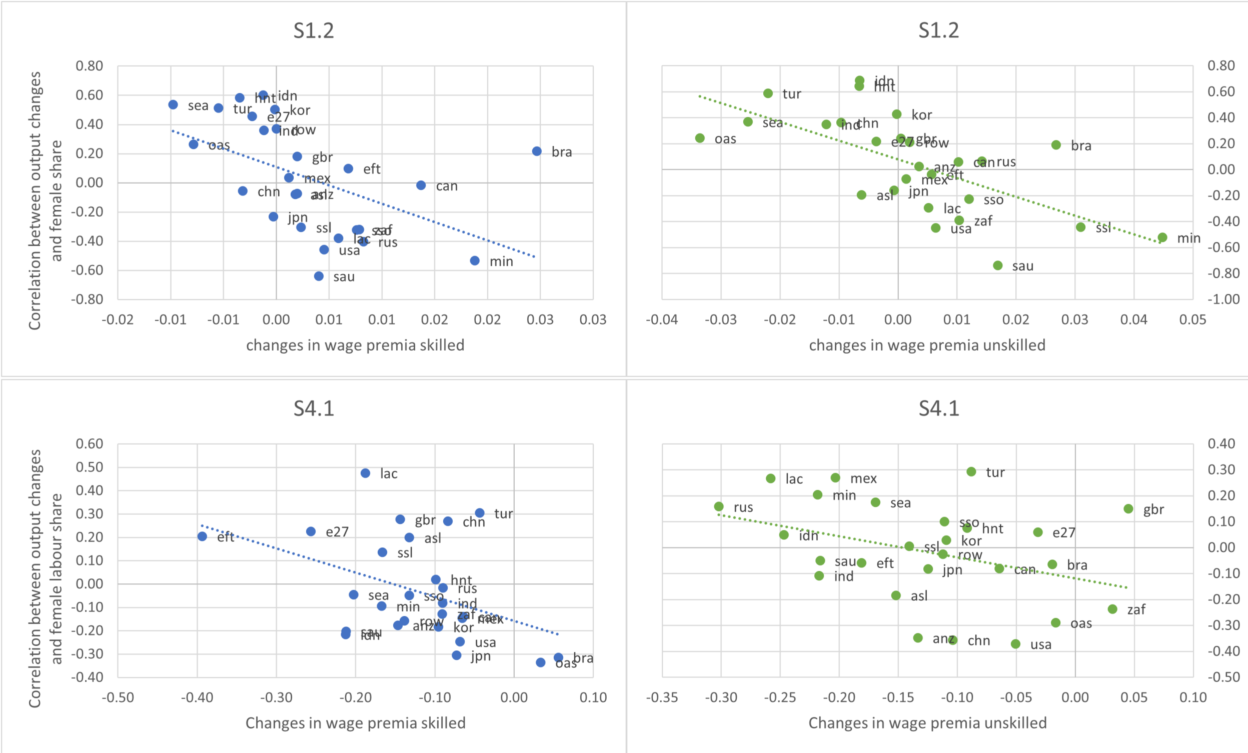


Figure 13: Relationship between correlation of output changes and female labour force intensity and change in female relative male wage

Source: Author's calculations based on simulation results.

4.2.1 Relationship between output and wage premia and the role of weights in global wage premia

Changes in wages and thus wage premia in a country are driven by changes in labour demand which in turn are driven by changes in output across sectors. More specifically, female wages are expected to rise relative to male wages if output in female-intensive sectors is expected to rise more than in male intensive sectors. In Figure 13, we calculate the correlation between the female share of a sector in a region and the output change in that sector for Experiment S1.2 and S4.1, and plot this correlation against the overall wage premia change in that region. We observe that the change in the male wage premia is negative wherever correlation between the output change and female share of sector is positive. This establishes the relationship between the direction of wage premia changes and output changes, i.e. whenever output rises on average in relatively female intensive sector, male wage premia fall and vice versa. The negative relation holds also for the other experiments, although slopes are different. The varying slopes can be explained by the variation in the size of wage premia changes, which is determined among others by the initial level of female wages or initial female labour employed in a region.

In the previous section we reported projected changes in the global wage premium which are calculated as weighted averages of regional changes in the wage premium with the weights given by the regional wage bill in the global wage bill.[20] This implies that the changes observed in the larger regions such as the USA, China and the EU have a large impact on the projected change in the global wage premium. In each of the experiments the trade policy experiments lead to an increase in the male wage premium in some regions and a reduction in other regions. If male wage premia rise in the larger regions, the global average male wage premium is more likely to move in that direction, even when other regions witness a fall. For example, experiment S3.1 leads to a marginal drop in the global average male wage premium even though the male wage premium rises substantially in multiple regions, because regions with a large weight in the global wage bill such as the EU and the USA report falling male wage premia. A similar pattern occurs for other experiments.

Hence, we conclude that changes in the global average male wage premium are driven by changes in the wage premium in regions with large weights in the global average and that changes in the regional wage premia are driven by changes in output in female-intensive sectors. In the next section we analyse the effects of trade reform on sectoral output to explain the global wage premia results of the different experiments. A key question to answer is why output does not expand sufficiently in female-intensive sectors under the tariffs liberalisation experiments reducing tariffs in female intensive sectors.

4.2.2 Four different mechanisms and model features

Trade liberalisation affects output across sectors in multiple ways. We discuss four mechanisms and model features affecting the impact of trade policy reform on output in female relative to male intensive sectors and thus on the male wage premium:

1. Complementarity of intermediate inputs and near complementarity of consumption goods
   In our model intermediate inputs are perfect complements and consumption goods in private household demand are near perfect complements. Technically, this corresponds with a substitution elasticity of zero between intermediate inputs (Leontief specification) and an elasticity close to zero between consumption goods from different sectors. Complementarity of intermediate inputs implies that an increase in output requires a proportional expansion in the intermediate inputs purchased from all sectors. In contrast, if intermediate inputs are substitutable, the demand for intermediate inputs becoming cheaper

[20]Described in detail in the Appendix

will increase, with more expensive intermediates substituted for by cheaper intermediate inputs, leading to a net increase in their output.

Recent empirical literature finds support for a Leontief specification of intermediate input demand (Atalay, E. (2017) and **?**), an approach followed in most CGE models focusing on trade. Nevertheless, we will analyse the impact of shifting away from complementarity, because complementarity of inputs in production and final goods in consumption plays a role in the impact of trade policy reform on the female wage premium, since complementarity precludes substitution towards sectors becoming cheaper because of trade cost reductions. So if trade is liberalized in a female intensive sector, the output in this sector may not necessarily enlarge because output in other sectors has to rise proportionally. In contrast, if the female-intensiveinput can substitute other inputs, the output in the sector which uses the female-intensiveinputs may enlarge as it gets cheaper because of trade liberalisation.

2. The impact of trade liberalisation on import competition, export opportunities, and intermediate inputs costs

Tariffs affect sectoral output in different regions along three channels. First, a reduction in tariffs faced by exporters raises export opportunities. Second, on the import side tariffs reductions of intermediate inputs will reduce the costs of production raising the demand for factor inputs because of the complementarity between value added and intermediates in production. Third, on the import side tariffs reductions generate additional import competition. For example, reducing import tariffs will raise the export opportunities of female labour force intensive sectors and reduce the intermediate input costs of such sectors. However, it also harms the output of female labour force intensive sectors through increased import competition. If the last effect dominates, a tariffs reform aimed to eliminate the gender bias of tariffs might lead to an increase in male wage premia.

The results in Figure 13 reflect the strength of the three channels in different regions. In regions where the export opportunities and cost of intermediates channel are dominant, output in female labour force intensive sectors increases leading to a fall in the male wage premium. Instead, in regions where the male wage premium is increasing the import competition channel leads to a reduction in output in female labour force intensive sectors because of increased import competition. The projected change in the global wage premium depends on the importance of regions (measured by the share in the global wage bill) where respectively the import competition and export opportunities channel is dominant.

One indicator that the import competition channel is expected to dominate globally in the impact of tariffs reform comes from a regression of the sectoral output changes on sectoral tariffs changes. Table 3 shows that the changes in import tariffs imposed have a higher explanatory power for changes in sectoral output than changes in export tariffs faced. This regression stresses the importance of the import competition channel.

Table 3: Regression of sectoral output changes on sectoral tariff changes

	(1)	(2)	(3)
	qo	qo	qo
tms_exp	0.164***		-0.294***
	(0.094)		(0.108)
tms_imp		0.390***	0.486***
		(0.053)	(0.064)
_cons	0.010	0.046	0.031
	(0.037)	(0.035)	(0.036)
N	728	728	728
R^2	0.004	0.069	0.078

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author‘s calculations.

3. Differences between the impact of tariffs and iceberg trade cost shocks on output

   Since changes in male wage premia are driven by changes in sectoral output in female relative to male intensive sectors, the impact of different types of trade cost shocks on output are relevant. And there are important differences in the impact of tariffs and iceberg trade cost shocks in this respect. Reductions in iceberg trade costs work as an increase in productivity in international transactions. This means that they generate both a rationalization and a substitution effect. According to the expansion effect, a reduction in iceberg trade costs reduces the quantity exporters produce. According to the substitution effect a reduction in iceberg trade costs decreases the price of exports and therefore raise demand and thus output produced through a substitution away from goods from other sources. Hence, for the relative importance of the expansion and substitution effect the degree of complementarity in production is relevant as will be discussed below. Reductions in tariffs instead only generate a substitution effect.

4. The role of general equilibrium effects such as intermediate linkages and changes in income
   Two general equilibrium effects play a role as well in the impact of trade policy reform on the male wage premium. First, every sector has both forward and backward linkages. Forward linkages towards female labour force intensive sectors such as education could raise output in such sectors even if trade costs are not reduced in the sectors themselves but in the sectors selling intermediate inputs to such sectors. Similarly, backward linkages could play a role in the impact of trade liberalisation if sectors selling to expanding sectors are female labour force intensive. Second, trade policy reform, especially through reductions in NTMs decreasing iceberg trade costs, generate positive income effects. In case preferences are non-homothetic this income expansion could lead to a shift in demand towards female-intensive sectors. Figure shows that there is a positive correlation between the female labour force intensity of a sector and its income elasticity employed in our model.

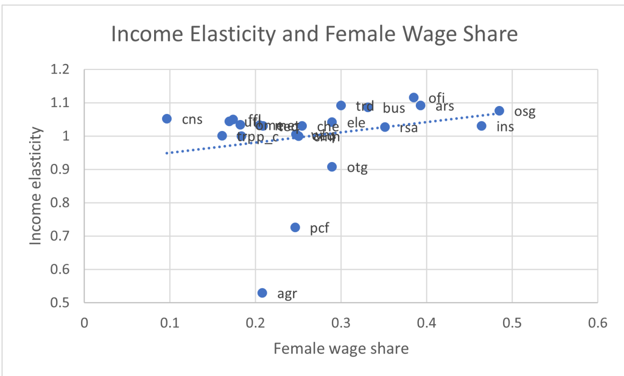


Figure 14: Relationship between the income elasticity and female wage shares
Source: Author's calculations based on basedata from GTAP v11.

4.2.3 The role of the four mechanisms in goods and services trade policy reform

Next, we analyse the role of the four mechanisms on the impact of two trade policy scenarios on the global wage premium driven by changes in regional wage premia and the distribution of sectoral output effects between female and male intensive sectors. We choose the simple trade policy reform scenarios in goods trade, Scenario S1.2 (removing tariffs in five sectors with the highest global female labour share), and in services trade, Scenario S4.1 (reducing services trade restrictiveness in five sectors by 50%).

Table 2 showed that the simple tariffs reform scenario, S1.2, leads to a marginal increase in the global average male wage premium. To understand this result and analyse the role of the different mechanisms, we plot output changes in the five liberalized sectors in each of the regions (in bars) as well as projected changes in the male wage premium (in dots) in Figure X?. The figure shows that output in the liberalized sectors rises in some regions and falls in others, reflecting variation in the strength of increased export opportunities and import competition across regions. The figure also indicates that regions with an increase in output display a negative change in male wage premia, reflecting the relation between changes in the wage premium and sectoral output changes in female intensive sectors. Averaging over all countries, the projected change in the global male wage premium is marginally positive. This result is driven by the strength of the output decreasing import competition effects and output raising export opportunities effect in relation to the share of the different economies in the global wage bill. For example, the USA has a large share and is projected to see a male wage premium increase thus having a big impact on the increase in the global average male wage premium.

To analyse the role of complementarity, we re-run the simulation with a Cobb-Douglas production function and private household utility function featuring a substitution elasticity of 1. Figure X? shows that output increases more or falls less in the female labour force intensive sectors, as would be expected: with substitutability consumers and producers can shift towards the cheaper liberalized female-intensive sectors thus raising its output. The change in the male wage premium becomes less positive or more negative now in the different regions. However, the shift is too small to turn the change in the global male wage premium negative.

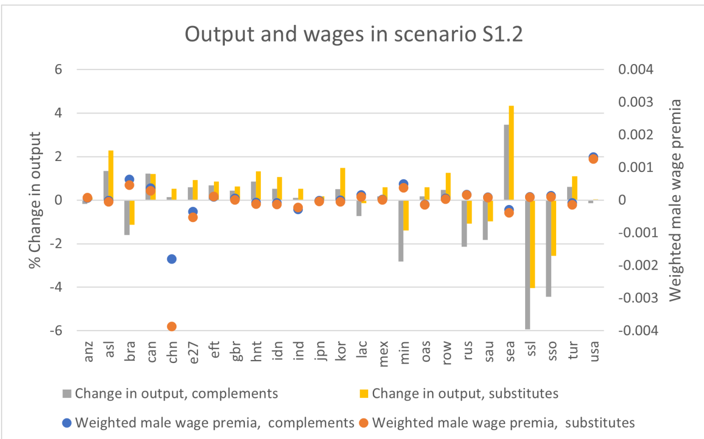


Figure 15: Wage premium and output in the scenario S1.2
Source: Author's calculations based on simulation results.

Next, we analyse the simple services trade reform scenario. In this experiment services trade costs are reduced globally by 50% in five sectors for which data are available in the WTO and World Bank STPD. Under this scenario the male wage premium is projected to fall by about 0.1%, which is much larger than under the sophisticated tariffs reform. We analyse the role of the different mechanisms with a similar bar and dot graph as for the goods trade policy reform discussed before. The figure contains two main findings. First, under complementarity output falls in the five liberalized services sectors, whereas output is projected to rise in most regions in these five sectors with substitutability (Cobb-Douglas specification). The fall under complementarity could be due to higher import competition. However, since output is projected to fall in most regions other effects are at play. More specifically, instead of modelling trade liberalisation as a tariffs reduction as for goods trade, liberalisation is modelled as a reduction in iceberg trade costs which can be seen as an increase in productivity. Under complementarity the rationalization effect will dominate the substitution effect leading to a decline in produced output in the liberalized sectors. However, when the substitution elasticity is equal to one between intermediate inputs and consumption output increases in most liberalized sectors indicating that the subsitution effect dominates. Firms and consumers can now substitute sufficiently to the liberalized sectors thus leading to an increase in output.

Second, moving to substitutability the male wage premium does not fall more and in many countries the improvement in the gender wage gap is actually smaller. Hence, substitution towards intermediates and consumption goods in the liberalized sectors does not seem to raise female wages relative to male wages, because these sectors do not have the highest female shares in the different rations. Furthermore, the projected reduction in the global male wage premium must be driven by changes in other sectors. As a matter of fact, if the changes in the male wage premium were driven by output effects in the five liberalized sectors, the male wage premium would not fall under complementarity and it would be fall more when moving to substitutability featuring increasing output in these sectors.

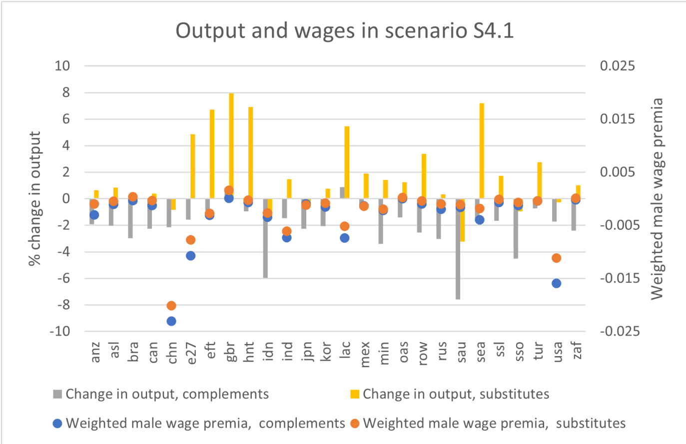


Figure 16: Wage premium and output in the scenarios S4.1
Source: Author's calculations based on simulation results.

Since output effects in the liberalized sectors cannot explain the wage premium effects, they must driven be general equilibrium effects towards other sectors. Figure XX? [INSERT HEATMAP] in the appendix shows that changes in the male wage premium are driven by changes in other sectors than the liberalized sectors. The heatmap displays the contribution of the wage premium change in each of the sectors to the total wage premium change, showing that the changes in the two sectors other services (osg) and accommodation and recreation services (ars) have a large impact. Two types of general equilibrium effects introduced in the previous subsection can explain the changes. First, the liberalized sectors have strong forward linkages that lead to a rise in output in sectors such as osg ars, both of which are female intensive. Second, increases in income shift demand towards higher income elastic sectors which are more female labour intensive.

4.3 Additional simulation results and robustness checks

In this subsection we present robustness checks and additional simulation results, exploring in turn the impact of trade policy reform of goods trade NTMs, the impact of omitting tariffs revenue neutrality, raising the substitution elasticity between male and female workers, and omitting upward sloping labour supply instead imposing fixed labour supply..

4.3.1 Reduction of NTMs in goods by 50%

Since data on NTMs in goods are lacking for a substantial share of countries and regions in our aggregation of countries, the results of a reduction in goods NTMs will be distorted by the asymmetry in liberalisation between regions. Nevertheless, to provide insights into the potential impact of NTMs reform in goods trade we conduct a simple experiment reducing goods NTMs by 50%. The shock is equivalent to a reduction in iceberg trade costs at importer, exporter and product level. Annex X shows how the iceberg trade costs are computed based on the estimated AVEs trade costs of NTMs.

Figure 17 displays the projected change in the wage premium for male workers in this experiment. Contrary to the experiments on tariffs, female relative to male wages move in a favourable direction. Globally, the change in the male wage premium amounts to -0.05 %.

Table 1 show that in a regression of AVEs of goods NTMs on female labour shares the coefficient is insignificant, whereas the relation is significant when the dependent variables is the AVEs tariffs rate.

We do not run further policy experiments with NTMs in the goods sector (e.g. an experiment with further reduction in NTMs, or an experiment with equalization of NTMs across goods) for various reasons. First, NTMs are trade policy measures designed to achieve public policy objectives such as protecting public health, consumer safety, and the environment (UNCTAD (2022)). So, they include measures like sanitary requirements whose elimination can be welfare decreasing. Since we use an aggregate estimated AVEs for NTMs for goods, we cannot differentiate between NTMs that can be fully eliminated and those which cannot because of public policy objectives, i.e. between actionable and non-actionable NTMs. In a similar vein, equalization of NTMs across goods may neither be a viable experiment because some goods require strict sanitary requirements, and others do not. Lastly, data on NTMs in goods may not always be fully transparent. That is, some regions may not report the trade barriers they impose fully transparently which may lead to measurement issues.

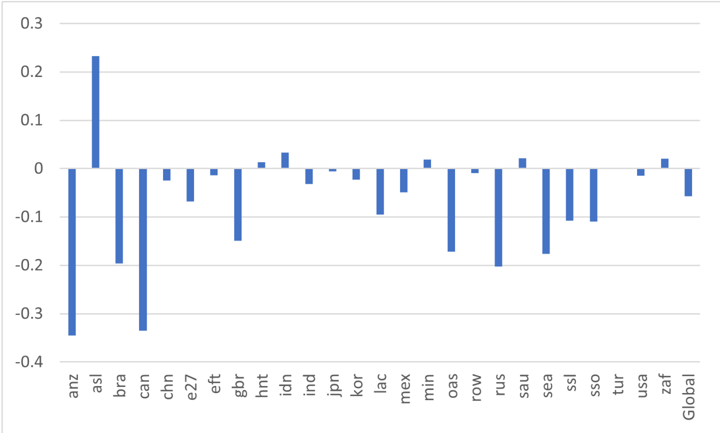


Figure 17: Changes in wage premia when non-tariffs measures are reduced by 50% for all sectors for all regions

Source: Author's calculations based on simulation results.

4.3.2 Omitting revenue neutrality in the sophisticated tariffs experiment

In the sophisticated tariffs reform scenario, S3.1, we assume tariffs revenue neutrality, i.e. reductions in tariffs in specific sectors are compensated for by generic increases in tariffs rates in all other sectors to keep the revenues from tariffs constant. This raises the following question: what is the role of the increase in tariffs rates in some sectors to achieve the revenue neutrality? As a robustness check for tariffs reform simulations, we conduct an experiment with the same shock as Scenario S3.1, without keeping tariffs revenues constant. Figure 18 shows the effects of this experiment on the projected change in male wage premia. We find that the result is similar to the scenario S3.1 with revenue neutrality as shown previously in Figure 11. The global weighted average effect on male wage premia is 0.0006% which is higher than the previous results in relative terms, but similar in sign, i.e. the male wage premium is still projected to go up. However, in absolute terms, the magnitude continues to be negligibly small.

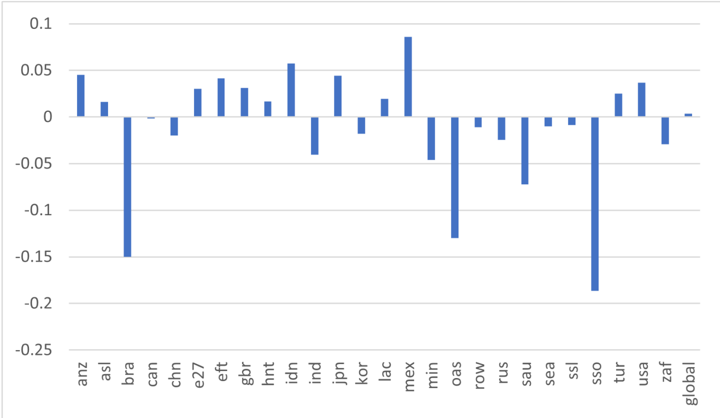


Figure 18: Wage premia effects of scenario S3.1 without keeping tariffs revenue constant

Source: Authors' calculations based on simulation results.
Note: Global average calculated as before.

This result helps establish that maintaining revenue neutrality doesn't change the overall result. However, it shows that revenue neutrality dampens the upward impact on the male wage premium, which might be because it raises tariffs rates in male intensive sectors to compensate for the reductions specified by the reform.

4.3.3 Increasing the substitution elasticity between male and female workers

Our model uses an elasticity of substitution between males and females of 1.6, as discussed in section 3.1. However, given that the literature on this topic is divided with these values differing across studies, it becomes important to explore how the size of the substitution elasticity affects the projected male wage premium change. More specifically, we replicate the two experiments discussed in more detail in the above section - S1.2 and S4.1 - with a higher elasticity value of 3. The new wage premia results are reported in the Figures 19 and 20.

Figure 19: Wage premia effects of scenario S1.2 with substitution elasticity between male and female workers (esubt) increased to 3

Source: Authors' calculations based on simulation results
Note: Global average calculated as before

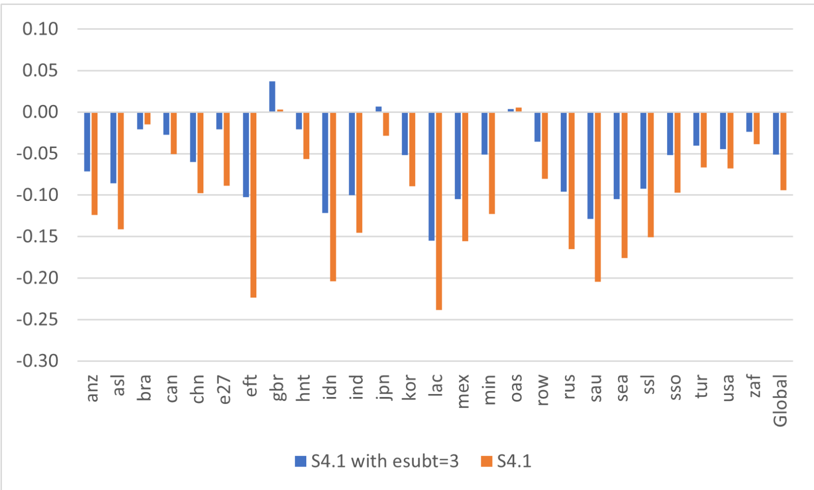


Figure 20: Wage premia effects of scenario S4.1 with substitution elasticity between male and female workers (esubt) increased to 3

Source: Authors' calculations based on simulation results
Note: Global average calculated as before

As is evident from the figures, for both goods and services trade, increasing the substitution elasticity between male and female workers reduces the magnitude of male wage premium changes. This result is intuitive. In regions where the male wage premium is falling, it falls less with a higher substitution elasticity and in regions where the male wage premium is rising, the premium rises less. This is because the more exchangeable the factors are, the smaller is the change in wages and thus wage differentials, because there will be more adjustment in employment. Hence, the magnitude of the wage premium change is lower.

4.3.4 Omitting upward sloping labour supply curve

Our baseline model includes an upward sloping labour supply curve with labour supply rising if wages increase. Here we explore how the projected wage premium changes across regions change when labour supply is kept fixed constant in the counterfactual experiment.

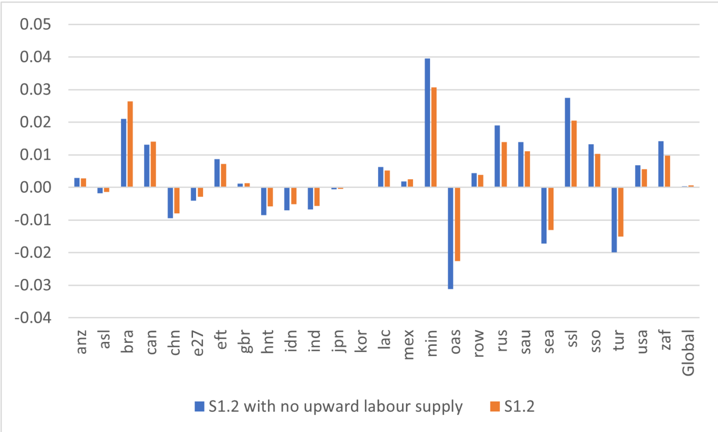


Figure 21: Wage premia effects of scenario S1.2 with labour supply being fixed

Source: Authors' calculations based on simulation results
Note: Global average calculated as before

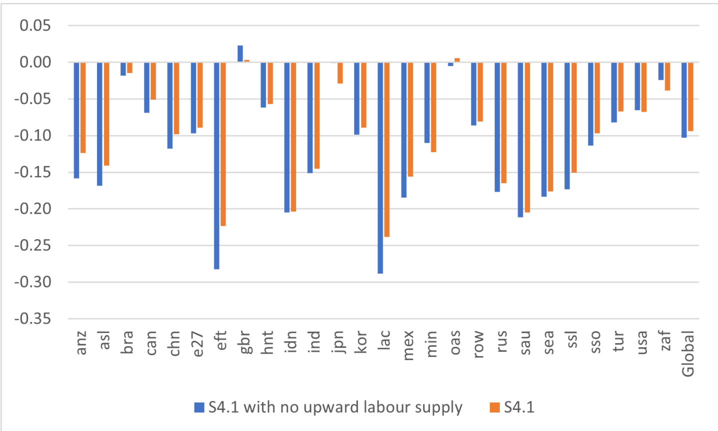


Figure 22: Wage premia effects of scenario S4.1 with labour supply being fixed

Source: Authors' calculations based on simulation results
Note: Global average calculated as before

The results for the new experiments presented in Figures 21 and 22 show that the projected changes in the male wage premium increase when the upward sloping labour supply is deactivated for both goods and services trade. The reason for this result is that under a vertical supply curve (fixed labour supply) a shift in the labour demand curve generates a larger change in the wage. This contrasts with an upward sloping labour supply curve under which the equilibrium wage rises along the supply curve and both wages and employment increase implying that the wage increases less. However, there are a few regions where this result does not hold. This can be explained from the fact that the change in the male wage premium is determined by the ratio in the change of the female and male wage premium. If both rise and the female wage rises more, the male wage premium will fall more under a fixed labour supply. However, if they both fall and the female wage premium falls less, the reduction in the male wage premium will be smaller. Although fixed labour supply modifies the size of the projected effects somewhat, the main findings of the analysis do not change.

5 Conclusion

The primary objective of our paper is to assess the potential of trade policy reform to contribute to a reduction in the gender wage gap and determine the best policies to implement such trade reforms.

We first establish the presence of a gender bias in the current structure of trade costs in both goods and services trade for both tariffs (for goods trade) and for NTMs (for both goods and services trade). In addition to this, we find that trade costs related to the need for face-to-face interaction are larger in female labour force intensive sectors. The positive correlation between levels of trade costs and female labour force intensity is significant in some cases in panel regressions with country fixed effects.

These results motivate our design of policy experiments attempting to neutralise the gender biases in trade costs, expecting a reduction in the female wage gap. We first equalize tariffs in the goods sectors and then remove tariffs for female-intensive sectors. In both scenarios, the male wage premia are rising globally although marginally, contrary to our expectations. The reason for the counter-intuitive effect on the male wage premium is that although a reduction in tariffs rates increases export opportunities and sometimes reduces intermediate input costs, it also increases import competition in female labour force intensive sectors. Hence, a reduction in tariffs in female-intensive sectors reduces the protection awarded to them by their respective governments. Even though goods trade NTMs are not significantly larger in female labour force intensive sectors, we analyse the potential of a 50% reduction in goods trade NTMs, finding that this reform would generate a modest decrease in male wage premia globally by about 0.05%.

To tackle the problem that increased import competition in female labour force intensive sectors reduces demand for female workers on net, we design more sophisticated tariffs reform scenarios which aim to provide larger export opportunities and reduce intermediate input costs for female-intensive sectors, while at the same time maintaining protection from import competition in such sectors. This sophisticated tariffs reform leads to a global decline in the male wage premia but only by a very small 0.0001%. We conclude that tariffs reform aimed at changing the sectoral incidence of tariffs does not have the ability to reduce gender inequality in the labour market substantially. Since NTMs reform is projected to lead only to a negligible change in the female wage gap, we conclude that goods trade policy reform has little potential to reduce the female wage gap and may not be advantageous for women in all regions.

Policy experiments with the services sectors generate two main findings. First, trade policy reform through a reduction in NTMs in four tradable services sectors leads to a reduction in male wage premia of a magnitude equivalent to the NTMs reduction for goods sectors. Second, output effects of the tradable services sectors whose NTMs were reduced are sensitive to the degree of complementarity between intermediate inputs in production and final goods in consumption with output projected to fall under complementarity in these sectors and to rise under substitutability.

Finally, digitalisation leading to a reduced need for face-to-face interaction in all sectors leads to the largest reduction in male wage premia globally by about 0.6%. Since face-to-face requirements are higher in the services than in the goods sectors, digitalisation automatically implies a higher cost reduction for services sectors which are generally more female intensive, thus explaining the global reduction in male wage premia.

As a conclusion, our set of policy experiments show that trade liberalisation is expected to deliver only a modest contribution to the reduction in gender inequality on the labour market. However, the experiments suggest that reform seems most fruitful in the services sector. Moreover, a promotion of digitalisation, which is expected to foster services trade, is projected to promote gender inequality by a higher order of magnitude than trade policy reform. This implies that trade policy reform aiming to reduce the female wage gap should be focused at policies allowing acceleration of digitalisation.

The projected effects of trade policy reform are based on a quantitative trade models and hence focuses on measurable metrics. Trade liberalisation may have qualitative benefits that such models fail to consider. These can include but are not limited to cultural exchange leading to reduction in gender discrimination in firm policies, exchange of knowledge allowing adoption of more female oriented technology (Juhn et al), changes in female bargaining power in the household, upward mobility of females in the next generation and other spillover effects. Additionally, designing policy concentrated on improving female wages alone may not benefit female welfare holistically (Fontana and Wood (2000) and Fontana (2002)). Studying the impacts of trade liberalisation on such variables can be a part of further studies. More specifically, the employed model can be extended with household production and a labour-leisure decision as well as bargaining in the household. Finally, in the analysis our main outcome variable is the global average male wage premium with different regions weights equal to their share in the global wage bill. However, the impact of changes in the wage premium might be non-linear and heterogeneous across regions. This would require linking the trade model with a framework modelling the welfare impact of gender inequality.

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Appendix A: Sectoral and regional aggregations

Table 4: Regional aggregation

Region	Region description
anz	Australia & New Zealand
asl	Asia LDC
bra	Brazil
can	Canada
chn	China
e27	European Union 27
eft	EFTA
gbr	United Kingdom
hnt	Hong Kong & Chinese Taipei
idn	Indonesia
ind	India
jpn	Japan
kor	Republic of Korea
lac	Latin America
mex	Mexico
min	Middle East and North Africa
oas	Other Asian countries
row	Rest of World
rus	Russia
sau	Saudi Arabia
sea	Southeast Asia
ssl	Sub-Saharan Africa LDC
sso	Sub-Saharan Africa other
tur	Turkey
usa	United States
zaf	South Africa

Table 5: Sectoral aggregation - 28 sectors

Sector	Sector description
b_t	Beverages and Tobacco products
bph	Manufacture of pharmaceuticals, medicinal chemical and botanical products
chm	Manufacture of chemicals and chemical products
coa	Coal
cro	Crops
eeq	Electrical Equipment
ele	Manufacture of electrical equipment
fmp	Manufacture of fabricated metal products, except machinery and equipment
gas	Gas
i_s	Iron & Steel: basic production and casting
lea	Manufacture of leather and related products
lum	Lumber: manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
lvs	Livestock
mvh	Manufacture of motor vehicles, trailers and semi-trailers
nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
nmm	Manufacture of other non-metallic mineral products
oil	Oil
ome	Manufacture of machinery and equipment n.e.c.
omf	Other Manufacturing: includes furniture
otn	Manufacture of other transport equipment
oxt	Other Mining Extraction (formerly omn): mining of metal ores; other mining and quarrying
p_c	Petroleum & Coke: manufacture of coke and refined petroleum products
pcf	Processed food
ppp	Paper & Paper Products: includes printing and reproduction of recorded media
rpp	Manufacture of rubber and plastics products
ser	Services
tex	Manufacture of textiles
wap	Manufacture of wearing apparel

Table 6: Sectoral aggregation - 23 sectors

Sector	Sector description
agr	Agriculture
ffl	Fossil Fuel dependent sectors
pcf	Processed Food and Beverages
otg	Other goods like Textile, Apparel, Leather, Wood products, paper products
p_c	Petroleum and coal products
che	Chemical, Pharmaceutical, Rubber and Plastic products
met	Ferrous and other metal products
teq	Manufacture of transport equipment such as motor vehicles, trailers and semi-trailers
ome	Manufacture of machinery and equipment n.e.c.
eeq	Electrical Equipment
ele	Manufacture of computer, electronic and optic equipment
utl	Provision of utility serivces such as electricity, water and gas
cns	Construction services
trd	Trade related services
ars	Accommodation, Food and recreational services
trp	All transport services
whs	Warehousing and related services
cmn	Communication and related services
ofi	Other financial services
ins	Insurance and related services
rsa	Real Estate services
bus	Other business related services
osg	Other services including education, health, dwellings, public adminisitration and defence

Appendix B: Data Sources

We use the input output tables of GTAP version 11 for all our simulations. We collate the GTAP data with various other sources to delineate our stylized facts, in order to ensure robustness and a more holistic look at possible results. To establish the relationship between female labour force shares and tariffs imposed by importing countries, we use Gender Disaggregated Labour Database (GDLD), created by the World Bank and combine it with the tariffs data from GTAP to establish a positive relationship. GTAP has gender disaggregation in its labour database as well. However, it does not report wage rates or number of people employed separately and hence, to calculate the number of female workers in the labour force we employed World Bank'S GDLD.

Non-Tariff measures are notoriously difficult to measure with varying debates among researcher on how to condense the various policies falling under the umbrella of this category to one measurable metric. For Non-Tariff measures in goods, we use the metrics calculated by Nicita and Kee (2016). Whereas, for non-tariffs measures in services we use the two major databases existing for the same - Services Trade Policy Database (STPD) by the World Bank and World Trade Organisation and the Services Trade restrictiveness Index (STRI) by the OECD. Wwe successfully establish a positive relationship between barriers to trade and female participation in the labour force, for both datasets, thus, ensuring our result is robust to the selection of methodology for calculation of ad valorem equivalents of Non-Tariff measures.

As an additional robustness check, we also use the Trade Cost Index developed by Rubinova () to estbalish a positive relationship between female labour participation and trade barriers.

For measurement of face-to-face index which represents the level of face-to-face interaction required in the sale and purchase transaction of a particular sector, we employ the use of the O*NET database that uses extensive survey data to create different importance levels of various tasks in different types of employments existing in the United States of America. Assuming that the general task requirement of a particular employment is similar across the world, we use this database as a representation of the world's face-to-face requirements for various sectors and use this to create a face-to-face index. This index helps us establish the stylized fact that females form a larger portion of the labour force in sectors where face-to-face requirements are higher and thus, trade barriers are higher. We use this database along with the GTAP database (which helps generate the Head and Reis measure of trade barriers) to generate iceberg costs related to the face-to-face requirement and generate shocks representing digitalisation that are then employed in our simulations.

Since we use data from different sources with motivations varying from concentration on results for the goods sector and services sector, the data is aggregated sectorally at different levels for each dataset. For the goods sector results, we primarily use a 27 sector aggregation which combines all services sector into one sector, while expanding the primary and manufacturing sectors. Whereas, in case of analysis related to services sector, we use a 23 sector aggregation which combines all primary and manufacturing sectors into bigger groups, while expanding services sector into all possible divisions. This aggregation is different when we sue Trade cost Index which uses data from the Tiva database. To ensure our aggregations don't change the result, we preserve the initial sectoral aggregation for this analysis.

Appendix C

We move the following mathematical descriptions to the Appendix. We present a detailed description of each scenario and how we calculate its shock for the remainder of this section.

5.0.1 Shock designs for sophisticated tariffs reform in goods sector

Based on the analysis in the previous section of the tariffs equalization scenario, in this section a better designed tariffs liberalisation scenario will be developed to improve the labour market position of women. The starting point is that variation in sectoral tariffs affects the demand for different types of workers along three channels: through the impact on export opportunities, through the costs of intermediate inputs, and through import competition. We construct three metrics to measure them separately and then create a shock taking into account the cumulative of all three metrics. For each tariffs scenario, we impose tariffs revenue neutrality by ensuring that the ratio of total tariffs revenues to regional income is held constant.[21]

In all three metrics the change in the ad valorem tariffs rate in region j in sector s, Δt_{js}, are reduced in proportion to their initial tariffs, t_{js}, with the factor of proportion a function of a coefficient varying by sector, $coef_{js}$:

$$\Delta t_{js} = -coef_{js} * t_{js} \tag{2}$$

[21] A minor detail is that there are no tariffs in services. Therefore, changes in tariffs in the services sector to establish tariffs revenue neutrality are excluded.

For the first channel the coefficient determining the size of the tariffs reduction is designed to generate more export opportunities in exporting sectors with a high female labour force share. Hence, the metric governing the tariffs reduction in importing region j in region s is determined by the share of imports from exporting region i and the female labour force intensity in exporter i in sector s:

$$v1 = \sum_i imp\_share_{ijs} * flf_{is} \tag{3}$$

imp_share_{ijs} is the import share of exporting region i into the importing region j in sector s and flf_{is} is the female labour force share in the exporting region i for sector s.

In the second channel, the tariffs are reduced not only to promote export opportunities in female labour force intensive sectors but also to reduce the costs of intermediate inputs used in female labour force intensive sectors. A reduced cost of intermediate inputs is expected to raise production and thus demand for labour force inputs because of the complementarity in production between intermediate inputs and factor inputs such as labour and capital. The metric is

$$v2 = \sum_i \sum_t int\_input\_import.share_{ijst} * flf_{jt}$$

Where $int\_input\_import.share_{ijst}$ is the intermediate input import share of importer j from exporter i of intermediate inputs s used by sector t and flf_{jt} the female labour force share in importing region j and sector t.

In the third channel the import competition is added. The analysis of the results of the tariffs equalization experiment, showed that in many regions output was not promoted in the female labour force intensive sectors, because of fiercer import competition. Therefore, we added a third channel for our final shock, to prevent output from falling in female labour force intensive sectors where import competition is strong.

$$v3 = imp.share_{js} * flf_{js}$$

Where $imp.share_{js}$ is the share of imports in total absorption in sector s in importing region j. It is calculated as the share of imports in total absorption consisting of investment, private household demand, government demand and intermediate inputs demand. Finally, the overall coefficient for tariffs reduction is calculated as a follows,

$$coef_{js} = [\frac{(v1)*(v2)}{v3}]^{1/3} \tag{4}$$

Since the import competition term is in the denominator it reduces the tariffs shock for female labour force intensive sectors facing more import competition, while the other two channels increase the reduction.

Table B-1 and B-2 below, show the final shock values by sector and region. We see that the overall shock is not very high in magnitude.

Table B-1: Initial female wage share and variation in tariffs by sector

Sector	Initial female wage share (in %)	Change in tariffs (in percentage point) Scenario 3
b_t	0.22	-1.47
bph	0.24	0.27
chm	0.21	0.43
coa	0.17	-0.21
cro	0.17	-1.75
eeq	0.17	0.43
ele	0.24	0.81
fmp	0.18	-0.07
gas	0.20	0.11
i_s	0.21	0.46
lea	0.27	-0.66
lum	0.19	-0.51
lvs	0.18	-3.33
mvh	0.18	-0.57
nfm	0.17	1.26
nmm	0.17	-0.11
oil	0.21	0.32
ome	0.17	0.48
omf	0.17	0.09
otn	0.18	0.56
oxt	0.15	0.95
p_c	0.21	1.49
pcf	0.24	-2.24
ppp	0.26	-0.43
rpp	0.21	-0.82
ser	0.31	0
tex	0.33	-2.06
wap	0.35	-0.44

5.0.2 Shock designs for Trade Reform in Services sector

As discussed in Section 2.2, there are multiple ways to measure the trade costs related to non-tariffs measures in the services sector. While conducting our experiments, we restrict our focus to the ad valorem equivalents (AVEs) calculated using the World Bank - WTO database called Services Trade Policy Database (STPD). We use the 5 sectors for which data is available and draw the positive relation between the estimated AVEs trade costs and female intensity. However, due to possible errors in measurement, we avoid using the sector "ofi" or other financial

Table B-2: Initial female wage share and variation in tariffs by region

Region Change in tariffs (in percentage point)	Initial female wage share (in %)	
		Scenario 3
anz	0.42	0.06
asl	0.18	-0.23
bra	0.37	-0.13
can	0.27	0.07
chn	0.30	-0.14
e27	0.29	0.06
eft	0.30	0.03
gbr	0.26	0.06
hnt	0.26	0.03
idn	0.20	0.02
ind	0.23	0.17
jpn	0.25	0.37
kor	0.24	1.25
lac	0.35	0.05
mex	0.28	0.03
min	0.22	0.04
oas	0.22	0.16
row	0.25	0.21
rus	0.46	0.26
sau	0.22	-0.13
sea	0.32	0.18
ssl	0.29	-0.02
sso	0.25	0.26
tur	0.28	-0.05
usa	0.42	0.20
zaf	0.39	0.03

services in our analysis[22]. Hence, we finally analyse and implement the shocks on four services sectors - Business services (bus), transport services (trp), communication services (cmn) and Insurance services (ins).

To estimate AVEs, we convert STPD values using the following formula,

$$AVE = (e^{\frac{coeff * \Delta STPD}{\sigma - 1}} - 1) * 100$$

Where σ is the elasticity of substitution equal to 3.8, taken from the baseline data. The coefficient is estimated using a Poisson pseudo maximum likelihood (ppml) regression for gravity estimation. Our calculations are based on Bekkers and So (forthcoming). Table 2 discusses the two different kinds of shocks designed for these sectors. The first scenario (S5.1) refers to shocks where we first identify the lowest AVEs value for each of these sectors in the world and then reduce the AVEs in other regions to this value. The term $\Delta STPD$ in this scenario is the gap between actual AVEs and the global minimum AVEs for that sector. In the second scenario (S4.1) we cut the AVEs in these sectors, in all the regions by 50%. The term $STPD$ in this case is half of the actual STPD value.

[22]The estimated AVEs trade cost for this sector is negative

5.0.3 Shock designs for digitalisation scenario

For the face-to-face index we use a measure of face-to-face requirements developed by Blinder (2009) using data from the American O*NET database. The index uses data on the importance scores assigned to four kinds of tasks in various occupations and condenses it into a measurement of face-to-face requirement using the Oldenski (2012) scoring method and data from U.S. bureau of labour statistics for industry shares of each occupation as per the following formula[23] .

$$M_{sz} = \sum_{c} \alpha_{zc} l_{sc}$$

Where s indicates tasks, c occupation and z industries, such that M_{sz} indicates the importance of task s in industry z. α refers to the share of occupation c in industry z and l refers to the average importance value for task s in occupation c, taken from the ONET survey. To calculate the final face-to-face index we normalize each score and take an average value of importance score across the four selected tasks.

We design shocks for experiments related to this field by converting the face-to-face requirement index into iceberg trade costs using a simple gravity estimation equation with the HRM index as a measure for trade costs. The HRM index refers to trade costs calculated as a ratio of international to intranational trade, based on Head and Ries (2001) and Chen and Novy (2011). To calculate the shocks we first run a gravity estimation using HRM index as a measure of trade costs and including face-to-face index in the vector of independent variables. We use the standard gravity variables complemented by country specific variables such as the credit and contract environments, a dummy for a common language, logistics efficiency, customs procedures as well as broadband subscriptions. Using the coefficient from these regressions, we convert changes in face-to-face requirement to changes in iceberg trade costs with the same formula as described below.

$$shock = (e^{(-coeff * \Delta FacetoFaceIndex)} - 1) * 100$$

Where the coeff is the coefficient obtained from the gravity regression and the change in face-to-face index is the expected reduction as per the scenario design. For scenario 6.1, it is reduced to half its original value and for scenario 6.2 it is reduced to the lowest current value across the sectors.

[23]Refer to Blinder(2009) for more details regarding the calculation of importance score for each task and selection of tasks for this index

An important point to keep in mind regarding face-to-face index is that its one-dimensional and based on U.S. data. For further research, this index can be reconstructed at a world level with industry shares for occupations collated separately for each region.

5.0.4 Shock designs for counterfactual scenarios - NTMs in goods sector

As a robustness check, we look at non-tariffs measures in goods sector. Although the regression results in Section 2.1 revealed that the apparent positive correlation between the female share and non-tariffs measures in goods is not significant, we still conduct a policy experiment to see if reducing them has any impact on gender wage gap. Since the measures cannot be related to female share, the shock is constructed as simple 50% reduction in barriers across sectors. To measure this value we use AVEs of NTMs taken from Kee and Nicita (2016) as explained in 2.1. The shock is equivalent to a reduction in iceberg trade costs at importer, exporter and product level. Given that for exporter i, importer j and good t, iceberg trade costs are defined as :

$$itc_{ijt} = 1 + AVE_{ijt} \tag{5}$$

The 50% iceberg trade cost reduction across all sectors is calculated as:

$$\Delta itc_{ijt} = -0.25 \times \frac{(1 + AVE_{1,ijt}/100) - (1 + AVE_{0,ijt}/100)}{1 + AVE_{0,ijt}/100} \times 100 = -0.50 \times \frac{AVE_{1,ijt} - AVE_{0,ijt}}{1 + AVE_{0,ijt}/100} \tag{6}$$

where $AVE0_{ijt}$ is the current estimated ad valorem equivalent trade cost of NTMs in % terms, estimated by Kee and Nicita (2016). For example, a value of 20 would imply that the ad valorem equivalent of NTMs imposed on good t, by importer j to the exporter i is 20%.

Appendix D: Calculation of regional and global wage premia values

This appendix describes how regional and global values of male wage premia are calculated.

We start by defining 2 variables defined over the set of regions (listed in Appendix A) and the set of genders male and female (g). The variable $pe_{r,g}$ denotes the percentage change in the wage of gender g, in region r, by 2026 relative to the baseline. For example, if $pe_{asl,male} = 2$, this implies that male wages in region ASL have increased by 2 %. [24]. The variable $evfb_{r,g}$ denotes the total wage bill (in nominal terms) in the base year 2017.

The regional wage premium value (wp_r) is computed as:

$$wp_r = 100(\times \frac{1 + \frac{pe_{r,m}}{100}}{1 + \frac{pe_{r,f}}{100}} - 1)$$

The global wage premium value is a weighted average of the wp_r, using the total wage bill in the region as weights. Thus, the weight assigned to each region is computed as:

$$evfb_r = \sum_s evfb_{r,s}$$

Thus, the global wage premium (gwp) value is computed as:

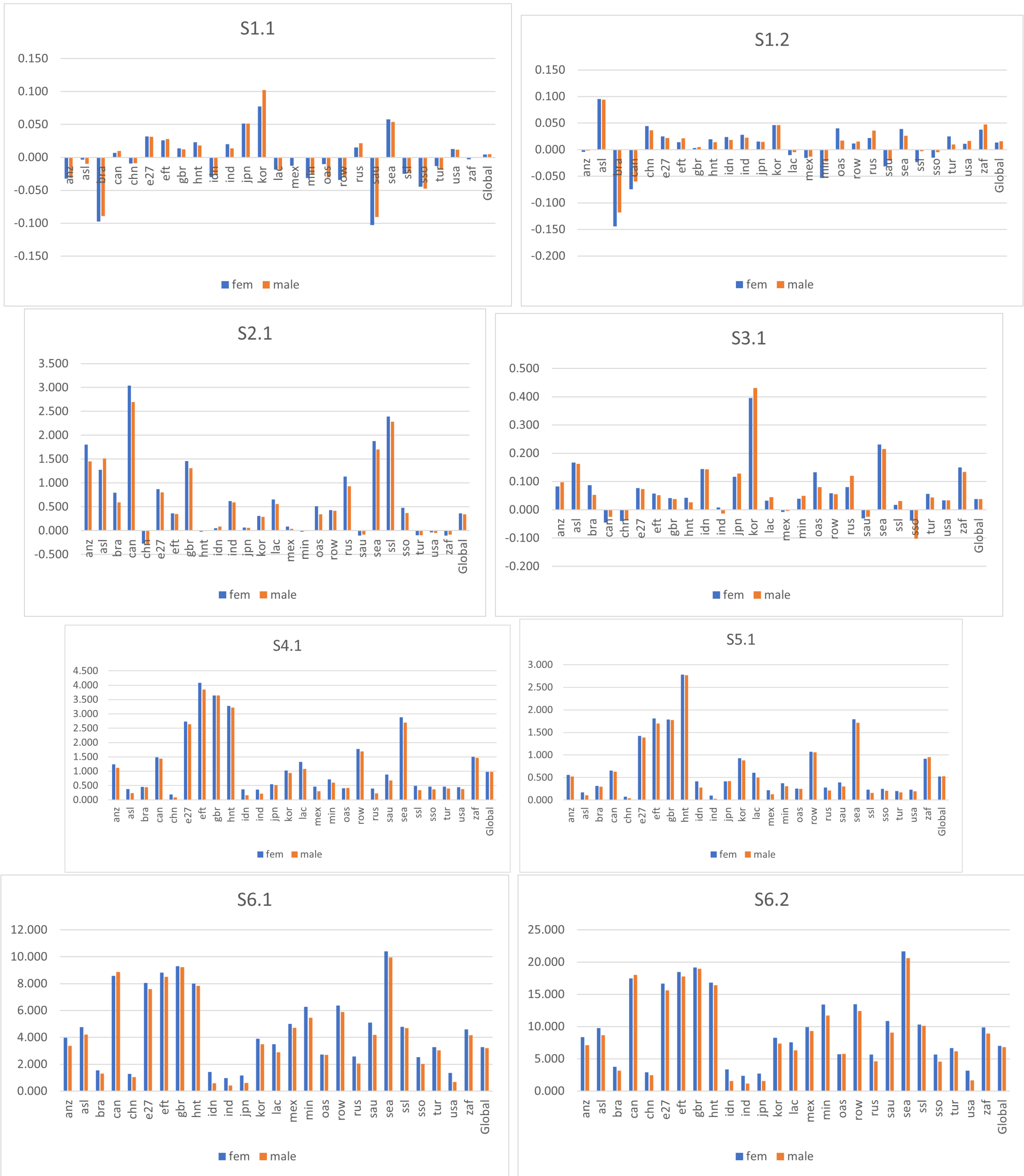
$$gwp = \frac{\sum_r wp_r \times evfb_r}{\sum_r evfb_r}$$

[24]Given that we have full factor mobility in our model, male and female workers allocate their labour across sectors depending on labour demand, such that wages are equalized across sectors.

Appendix E: Additional Simulation Results

5.1 Changes in Real Income across experiments:

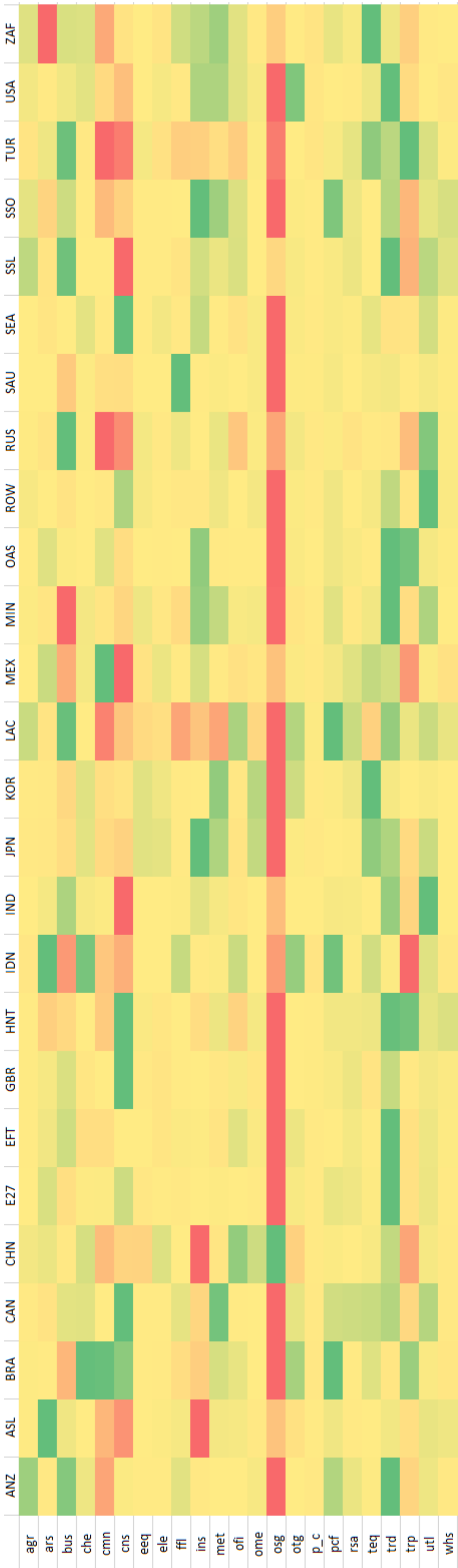
Figure B-1: Real income changes by region



Source: Authors'calculations based on simulation results
Note: Global weighted average across sectors taken using factor value shares as weights

5.2 Heatmap Analysis for experiment S4.1:

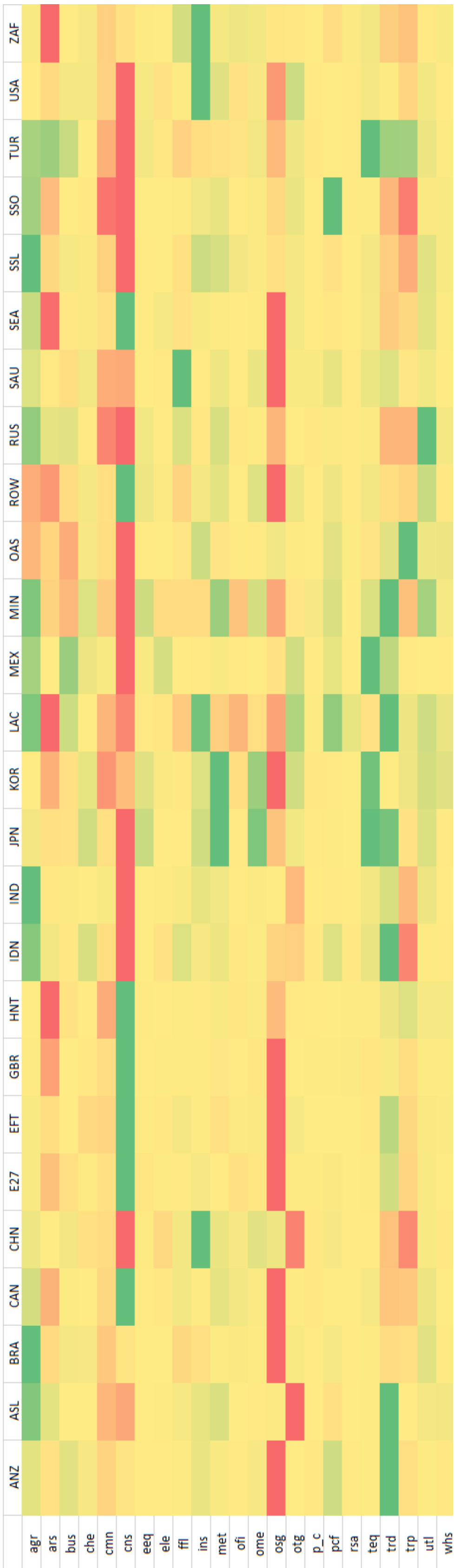
Figure B-2: Heatmap analysis for skilled labour



Source: Authors'calculations based on simulation results

Note: The heatmap shows the contribution of each sector into the difference between the market equilibrium amount of skilled labour supply for females and males. Red values are the largest values, implying that demand for the equilibrium amount of female labour exceeds that for male labour the most.

Figure B-3: Heatmap analysis for unskilled labour



Source: Authors'calculations based on simulation results

Note: The heatmap shows the contribution of each sector into the difference between the market equilibrium amount of unskilled labour supply for females and males. Red values are the largest values, implying that demand for the equilibrium amount of female labour exceeds that for male labour the most.