Employment Responses to EU Food Safety Regulations: A Gendered Perspective

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Accepted: 20 October 2020 / Published online: 23 November 2020

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Abstract

In many developing countries, women constitute the bulk of agricultural sector's workers and might be susceptible to job loss or gain in the presence of regulations among which are food safety regulations. Thus, this study investigates the gender implications of EU food safety regulations on agricultural labour market between 1995 and 2012 using a panel data of 90 developing countries. In addition, it also investigates how the existing gender-specific obstacles and opportunities affect women's ability to engage effectively in the agricultural sector and benefit from such regulations. Our results show that in many of the countries considered, women are disproportionately disadvantaged in the agricultural sector not only because of the effect of the food regulations but also because of their unequal access to opportunities such as gender inequality in both secondary and tertiary schooling as well as low quality of time-saving infrastructure which make them less available for gainful employment. However, the near gender parity achieved in primary education increases their agricultural employment share. Thus, investment in infrastructure that reduces women care burden, and building the educational capacity of women could work to remove these gender-specific obstacles and enable women to respond to employment opportunities.

Keywords Gender · Agriculture · Labour market · Employment · Food safety regulations

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Introduction

Agriculture is the backbone of many developing countries, and a significant part of their production is exported to developed countries. Hence, trade is a veritable means of achieving sustainable economic growth and development (Nicita and Rollo 2015). However, as tariffs are negotiated down, there is an increased proliferation of non-tariff measures (NTMs) on agricultural products, especially food safety regulations, which may impact on the abilities of countries to access global markets. Recently, food safety regulations have emerged as an increasingly prominent tool in trade regulations and are regarded as one of the most important NTMs affecting developing countries' export products (Disdier et al. 2015; Fontagné et al. 2015; Kareem 2016a, b; Kareem et al. 2017; Maertens and Swinnen 2009).

Food safety regulations are usually imposed as safeguard measures to ensure plant, animal and human health safety (WTO 2015) and may either constitute barrier or catalyst for export success. They may constitute a barrier because complying with the regulations imposes excessive costs on producers. For instance, the average investment costs of complying with the regulations could be as high as 124% of firms' sales for Sub-Saharan Africa, 13.36% in Latin America, 44.1% in the Middle East, 15.75% in South Asia and 55.65% in Eastern Europe (Maskus et al. 2005). Such huge costs may be difficult to bear particularly for small-scale producers and farmers, many of whom are women. This might consequently limit their access to the global markets and lead to the contraction of labour in the agricultural export sector. However, such regulations can also be catalysts for export, which can in turn give rise to increased income and employment generation once countries comply with such regulations (Jaffee and Henson 2004; Henson and Jaffee 2008). Studies by Henson and Jaffee (2008) and Martens and Swinnen (2009) suggest that some developing countries are complying with developed countries' stringent food safety regulations, and are using such compliance to increase employment and alleviate poverty.

Nevertheless, available evidence suggests that trade has been less favourable for women due to the inequality of opportunities and gender-specific obstacles that exist in the society. These obstacles relate to inequality in education and training, land tenure system which discriminates against women. Other factors are inaccessibility to quality health care and infrastructure facilities which result in increased women's care burden, and more importantly, their lack of technical expertise to comply with agricultural and food regulations (Fontana and Paciello 2009). Women are usually at a disadvantage in complying with these food trade regulations because they usually lack job-specific technical expertise and skills since they seldom receive on-the-job, technical and/or vocational training (Kabeer 2012). More so, if training is available to women, they are not designed to meet women's limited time constraints—arising from their double burden of unpaid domestic care and productive activities, all of which inhibit their ability to comply with food safety regulations and increases their vulnerability to job losses in the sub-sectors requiring the compliance to such regulations. Thus, the purpose

of this study is to investigate the gender implications of food safety regulations on agricultural employment. In addition, we will investigate whether the existing gender obstacles and opportunities are widening or narrowing the gender gap in agricultural employment.

A perusal of the literature indicates that there is a growing body of studies investigating the gender effects of trade policies (Kucera et al. 2012; Tejani and Milberg, 2010; Fontana and Paciello 2009; Maertens and Verhofstadt 2013). However, the gender impacts of food safety regulations on agricultural employment are still ambiguous as this area remains under-researched despite the fact that the agricultural sector accounts for the bulk of trade-related employment activities especially for women in many developing countries (Fontana and Paciello 2009). The limited but existing empirical studies on the gender impacts of food safety standards had focused on analysing only a single export product (i.e. coffee) focusing on a single developing country that is located in Africa (Chiputwa and Qaim, 2016; Meemken et al. 2018). The results, however, remain inconclusive given the limited study. More so, the existing studies have predominantly focused on sustainability of food standards, which results into a partial overview of the impact in relation to the aggregate impacts of all existing food standards.

Thus, our study contributes to the existing studies in 3 ways. First, we investigate the gender impacts of all food safety standards imposed by the European Union (EU) on agricultural employment. Second, distinct from previous empirical studies which focused on only a developing country in Africa, this study investigates the gender impact of EU food safety on 90 developing countries using panel data. Third, we account for potential endogeneity in the standards–gender relationship following Klasen and Lamanna (2009), Bandara (2015) who noted the potential endogeneity between gender inequality and some economic variables.

The implications the gender outcomes of food safety regulations are important given the fact that gender equality can stimulate economic growth and development (Baliamoune-Lutz and McGillivray 2009). This is because women's control over resources increases the share of household budget allocated to children's health, education and nutritional-related expenditures, which in turn significantly increase human capital development (Quisumbing and Maluccio 2003; Udry et al. 1995; Kamath and Dattasharma 2017). More so, unused female employment potentials are indicative of an inefficient allocation of a country's resources. New evidence on the gender impacts of food safety standards is thus needed to help to proffer targeted policy interventions that would remove gender-specific obstacles that hinder women's abilities to engage effectively in the agricultural sector and benefit from trade.

In a panel data of 90 developing countries, we address the identified research gap by analysing the gender impacts of EU food safety regulations on their agricultural employment between 1995 and 2012. Our focus on the EU is due to two important reasons. Firstly, the EU standards remain one of the strictest in the world. Secondly, EU import a third of world's exports, thus, any trade policy implemented by the EU would have significant implications on its trading partners, thus necessitating our focus on the EU.

The rest of the paper is organized as follows. The next section contains the theoretical background. Section 3 reviews the literature. Section 4 contains the methodology of the study, while Sect. 5 discusses the empirical results. The last section concludes.

Theoretical Background

The implications of food safety regulations for international trade and employment have been theoretically documented in the literature in the framework of *demand-enhancing effect* and *trade cost effect* (Xiong and Beghin 2014). This is based on the proposition that food safety standards can either be a *barrier* or *catalyst* to trade and employment (Henson and Jaffee 2008). On the one hand, the theoretical view of ‘standards as a catalyst’ for increased export penetration and expansion argument is in line with the *demand-enhancing effects* of standards. According to this stance, standards help in building value into certified goods and services as they provide consumers with information and assurance about their health and safety, therefore stimulating import demand (Blind 2004). Standards also remedies asymmetric information, providing information to producers about the specifications and technicalities of the products, which can lead to technology diffusion and innovation (Baller 2007). Compliance with such measures can thus trigger increased market access, with significant impact on the female workforce as they dominate the agricultural sector. Women thus stand to gain if they can harness the opportunities to increase production for the export markets and also export their agricultural export products.

On the other hand, there is the theoretical stance of ‘standards as barrier’ perspective via the *trade costs effects*. The proposition is that standards constitute barriers to trade because meeting stringent standards imposes excessive costs of compliance on producers which might erode export competitiveness and affect the profitability of the export product, thereby acting as an impediment to trade (Maskus et al. 2005). The investment costs can be enormous for small-scale farmers and exporters who characterize the exporting sectors of most developing countries, thereby preventing them from accessing global markets. This gave rise to the concern that small-scale producers might become excluded from the value chains as well as developed countries’ markets (Bolwig et al. 2013). In the EU, exporters, domestic producers or farmers producing for export markets who could not comply with EU food standards are driven out of the international market, consequently, contrasting employment in the agricultural sector and other forward and backward integrated sectors such as the service sector. Women would be more affected and are vulnerable to job loss as they are in the first place hired to cut costs and are easy to lay off in times of crisis because they work under insecure working conditions (Fontana and Paciello 2009; Chan 2013).

Given the above, the imposition of food safety measures can thus bring about changes in the structure of production of the country as some export-oriented sectors would contrast or expand in response to the stringency of the measures, depending on how inhibiting or trade promoting the measures are. Thus, food safety regulation may or may not contribute to employment generation and

gender gap in employment. It is important to acknowledge that men also face food safety concerns, however, these constraints might be gender-intensified. More so, women and men are usually affected differently by trade policies due to the social inequality already existing in the country as well as the entrenched gender norms (Tejani and Milberg 2010). For instance, gender roles in households where females contribute to unpaid care economy tend to be rigid and may prevent them from taking up employment even when compliance with food safety regulations brings in expansionary employment benefit for them. Gender roles in labour market and labour market discrimination may also prevent them from entering the expanding sector. Thus, food safety regulations may or may not contribute to gender equality in agricultural employment depending on a wide number of factors, including the existing gender structure and norms in the country, the economic structure and the labour market regulations.

Related Literature

The empirics on the gender impact of food safety standards are rather limited. Exceptions are Memmken and Qaim (2018) and Chiputwa and Qaim (2016) whose studies focus explicitly on private/sustainability standards. In their study, Meemken and Qaim (2018) investigate the gender impacts of private Fairtrade and UTZ standards and find that private standards cannot completely eliminate gender disparities, even though such standards increase wealth in female-headed households and improve access to agricultural extension for both male and female farmers. Similar results were found by Chiputwa and Qaim (2016) who show that three private standards on coffee increase gender equality among coffee farmers, with women having greater control of the production of coffee and revenue. Nevertheless, Wamboye and Seguinto (2015) argue that the influence of export sector on gender inequality depends on the region being considered. Their study on sub-Saharan Africa shows that the expansion of cash crop exports in the region has generated more job opportunities for men than women.

Furthermore, emerging evidence indicates that women, many of whom are small and marginal farmers, are unable to compete in international markets due to a considerable number of constraints they face. Prominent among the constraints are those relating to inequality in education and training; women's career breaks due to the reproductive activities; heavy domestic duties which are unpaid resulting in significant time poverty and mobility constraints; the lack of technical expertise to comply with food safety regulations and other NTMs which limit their ability to fully comply with international trade regulations (Fontana and Paciello 2009; Kabeer 2012).

In sum, based on these divergent empirical findings, it is difficult to claim that trade has benefited women as it is hard to make a valid conclusion given the limited evidence available. In addition, the limited existing quantitative studies have mainly focus on private coffee standards and not on the plethora of all food

safety regulations that are increasingly governing agricultural trade—a concern that this paper addressed.

Empirical Analysis

Prior to specifying the model for the study, we describe some key explanatory variables that would influence gender employment gaps. The explanatory variables along with our main dependent variable are explained below.

Measuring Gender Gap

Our dependent variable is agricultural employment, segregated by gender. Following the feminist literature, we construct unique measures of gender inequality to measure the relative access of males and females to opportunities. The first is the gender parity index (GPI), constructed as the ratio of the number of females to males employed in the agricultural sector over time, given as follows:

$$GPI_{it} = \frac{F_{it}}{M_{it}}, \quad (1)$$

where ‘*i*’ indicates the exporting country, ‘*t*’ is the time, F_{it} and M_{it} are, respectively, the female and male employees in the agricultural sector at time *t*. In Eq. (1), a GPI of one denotes gender equality between males and females, while a GPI that varies between zero and one signifies gender inequality which disadvantage females. Thus, the coefficient of GPI will be negative if there is gender inequality, and positive if otherwise.

EU Food Safety Regulations Data

The main explanatory variable is the EU food safety regulations imposed on agricultural products between 1995 and 2012. We measure EU food safety regulations using sanitary and phyto-sanitary (SPS) measures and technical barriers trade (TBT) measures that were notified by the EU to the WTO on all agricultural products. SPS measures are food regulations levied on food, drink and feed in order to ensure food safety, plant and animal health and prevent pests, diseases and food hazards. SPS also includes conformity assessment to such food regulations. TBT refers to technical requirements of a products such as its production process, labelling, packaging, etcetera. It also covers the assessment of the products’ conformity to technical specifications other than those that are SPS-related (WTO 2015). While SPS and TBT measures have been regulating trade relations between trading partners prior to 1995, such measures started to be notified to the WTO in 1995 by its members countries, and notified SPS and TBT measures start from 1995 in the WTO database, necessitating the start of our analysis from 1995. More importantly, non-tariff measures such as SPS and TBT became more relevant after 1995, following the Uruguay

Round which resulted into the reduction of tariff and the growth in the number of notified non-tariff measures (Arita et al. 2017; Santeramo and Lamonaca 2019).

Food safety standards can be a mix of qualitative and quantitative requirements. Two approaches known as the inventory approach frequently used to quantify these standards and other NTMs are the frequency and coverage ratio (Fontagné et al. 2005; Disdier et al. 2008). More recently, the inventory approach has been extended to include the prevalence score in addition to the frequency and coverage ratios (Gourdon et al. 2014). By definition, the prevalence score counts the total number of food safety measures or NTMs that applies to a specific product at a given time. A *frequent approach* entails a calculation of the presence or absence of the food safety standards and gives the percentage of products affected by the measure in a given year. The *coverage ratio* accounts for the share of exports or imports affected by the food safety measures at a particular point in time. This study uses the coverage ratio approach focusing on the food safety measures notified by the EU on all agricultural products in each given year.

The categories of food safety regulations notified to the WTO are usually divided into SPS and TBT measures. Nevertheless, concerns about these measures are also notified to the WTO by its member countries. According to Orefice (2017), such non-tariff measures are latent barriers to trade when tariff protections are high. However, when tariff protection is lower, such non-tariff measures become barriers to trade and WTO member countries can raise a concern about such non-tariff measures to the WTO. Consequently, when SPS and TBT measures are perceived as barriers to trade, *specific trade concerns* about such measures can be activated and notified to the WTO by member states (Orefice 2017). Activating and notifying specific concerns enable them to voice their grievances about the stringency of SPS and TBT measures. Generally, raising specific concerns about SPS and TBT measures allows the WTO to mediate and ensure that the measures do not create unnecessary barriers to member countries' trade, growth and employment.

Thus, our measure is constructed, first, by counting the total number of SPS and TBT measures notified by the EU to the WTO in each year on all agricultural products. A food safety notification is defined to be in force in a year if it was notified in that year or published prior to the year considered, but still exists and has not been withdrawn. Hence, the notifications are cumulatively added up in so far as they have not been withdrawn by the EU. Second, we also constructed a frequency measure of all the specific concerns notified by all third countries in relation to the EU's SPS and TBT measures in the agricultural sector. Similarly, a specific concern is said to be in force if it was notified in that year or published prior to the year considered, but it is still being deliberated upon at the WTO, minus resolved concerns.

Food safety measures notifications can be both bilateral (targeted at specific country or countries) or multilateral (notified against exports of all third countries). Nevertheless, our focus is on multilateral SPS and TBT measures as bilateral measures notified by the EU to the WTO were significantly very low. However, since the same multilateral food safety regulations are imposed by the EU on all third country exports, we, therefore, introduce variability into the EU measures by constructing a trade-weighted measure of food safety which is given as follows:

$$EUS_{ijt} = SPS_TBT_{ijt} w_{ijt}, \quad (2)$$

where EUS_{ijt} denotes the EU standards at time t ; SPS_TBT_{ijt} is the count of food regulations imposed by country j (the EU) on country i exports at time t ; w_{ijt} is the weight of the bilateral import value of all agricultural products (the product affected by standards) in world imports of agricultural products. More specifically, w_{ijt} is given as

$$w_{ijt} = IM_{ijt} / IM_t \quad (3)$$

IM_{ijt} is the share of bilateral agricultural import values from country i to j at time t , and IM_t is the world agricultural imports at the same time t . The w_{ijt} is also known as the import coverage ratio, which is a popular way of calculating trade-weighted standard measure in the literature (see Disdier et al. 2008; de Frahan and Vancau-teren 2006; Bao and Qui 2010). While the first part of the measure (SPS_TBT_{ijt}) gives the incidence of EU food safety standards, the second part (w_{ijt}) measures the coverage ratio and captures the extent of trade covered by the standards. More specifically, the coverage ratio of standard in any country i in a year is the share of the affected product bilateral import values from country i to j in the total world imports of the product. Thus, our measure of standards introduces variability across exporters and time.

Other Paramount Variables

The first range of control variables includes *agricultural value added* which shows the aggregate output in the agricultural sector and a country's ability to create employment opportunities. Thus, increase in agricultural value added is expected to directly affect employment. Aside its economic structure, the degree of a country's integration into the global market would also influence its employment of women relative to men. We control this by using a variable capturing *regional/preferential trade agreement/arrangement* (RTA) with the EU. Countries which have RTA with the EU would enjoy some preferential benefits that will bring in more trade, consequently, generating more employment. Many EU agreements recognize and promote labour rights including its gender ramifications. This study identifies three distinct RTAs. These are the generalized system of preference (GPS), the free trade agreements (FTA) and the more recent economic partnership agreements (EPA).

The inclusion of these agreements in our model is based on 2 reasons. One, many of these EU agreements include clauses or provisions obliging the promotion of gender equality among the signatory countries. Second, many of these agreements are forms of trade liberalization measures with employment generation (for men and women) as one of the key objectives. Thus, such trade agreements as trade policy measures would likely impact on both employment and gender equality in employment, which justify their inclusion in our model. In general, promoting gender equality is at the heart of many EU trade agreements. Nevertheless, these agreements differ in terms of their provision on gender equality.

First, many of the FTAs¹ usually have explicit or non-explicit clauses on promoting gender equality or women's rights. Many of the FTAs included in this study are more specific on promoting gender equality and contain explicit clauses/chapters/titles requiring equal treatment between men and women (e.g. EU-Chile, EU-Macedonia, EU-Montenegro, EU-Palestine (West Bank and Gaza)). Nevertheless, some FTAs do not specifically include clauses to promote gender equality, however, most require the respect of the rights or role of women. For instance, some set of FTAs have clauses seeking to promote the role of women in social and economic development (e.g. EU-Algeria, EU-Egypt, EU-Mexico, EU-Morocco).

Second, EPA have explicit clauses on promoting decent work for both men and women that are in line with the fundamental principle of the International Labour Organisation (ILO) conventions. EPA are a set of more recent agreements by the EU. They are more specific in regard to the promotion of gender equality as they include explicit chapters on obliging signatory members to ensure the provision of *decent work* for all—both men and women. The agreement obliged signatory countries to respect UN declaration on full employment and decent work for all as well as ILO core labour standards as contained in the 1998 ILO declaration on fundamental principles and rights at work. Among the set of trade agreements considered, it is the only one based on *decent work for all* which is based on one of the UN's sustainable development goals (goal number 8). According to ILO, decent work is based on 4 pillars covering access to full and productive employment, social protection, promoting of social dialogue, safeguarding rights at work, with gender as a cross-cutting theme. EPA also includes provisions obliging signatory members to comply with ILO core fundamental conventions regarding fundamental principles and rights at work including those on equal remuneration and elimination of discrimination in employment occupation.

Third, the unilateral privileges such as GSP which has been in force since 1971 also include some implicit gender dimension (European Parliament 2019). The EU uses GSP to promote human rights and core labour standards among the signatory countries. Thus, GSP includes clauses on human right and labour right conditionalities. It also has provision for the withdrawal of benefits or preferences in cases of serious violations of the core ILO labour right convention - among which include equal remuneration for men and women workers for work of equal value and the convention on elimination of discrimination - or serious violation of the United Nations (UN) core human rights conventions one of which includes the convention of the elimination of all forms of discrimination against women.

Furthermore, we include a control for macroeconomic environment which we proxy by inflation rate. Inflation will affect the rate of economic activities and is

¹ Only the EU-Azerbaijan, EU-Turkey and interim EU-Serbia and EU-Bosnia and Herzegovina FTAs do not have any specific clauses or provision requiring the promotion of gender equality between signatory countries agreements, and do not mention the obligation to promote or respect women's rights.

also expected to affect male and female differently and might contribute to widening gender inequality due to the proposition that during economic downturn, women are more vulnerable to employment loss in the agricultural sector, given that many of them are in the first place hired to cut costs (Fontana and Paciello 2009; Chan 2013).

Other control variables are those that directly affect women and their availability for employment. This includes country-level time-saving infrastructure which affects females' care burden and responsibilities, and thus their availability for employment. Women's unpaid care burden brings about considerable time poverty and mobility constraint which prevent them from taking up gainful employment. Thus, the time-saving infrastructure is measured using two variables. These are the percentage of the population which has access to improved sanitation facilities, and the percentage that has access to improved water source. The effects of these two variables are expected to have significant positive impacts on women's employment.

Furthermore, the existing gender structure and women characteristics would have effect on women's access to employment. For instance, women capabilities measured by the level of *educational attainment* will affect their ability to participate in and benefit from gainful and quality employment. Finally, there is concern that the observed trends in agricultural employment might not be due to the influence of food safety standards but rather to each country's agricultural policies, employment policies or economy-wide policies. Thus, we have included a variable to capture governments' effectiveness in the economy as this might have impacts on gender relations in the agricultural sector and on total employment. Therefore, based on the above definitions, we specify a regression equation as follows:

$$\begin{aligned} GPI_{it} = & \beta_0 + \beta_1 \ln Agric_Value_Added_{it} + \beta_2 \ln EUS_{ijt} + \beta_3 \ln Concerns_{ijt} \\ & + \beta_4 FTA_{ijt} + \beta_5 EPA_{ijt} + \beta_6 GSP_{ijt} + \beta_7 Inflation_{it} + \beta_8 Sanitation_{it} \\ & + \beta_9 Water_{it} + \beta_{10} Primary_{it} + \beta_{11} Secondary_{it} + \beta_{12} Tertiary_{it} \\ & + \beta_{13} Government_Effectiveness_{it} + \delta_t + \epsilon_{ijt} \end{aligned} \quad (4)$$

where i , j and t are the exporting country, importing countries (the EU) and time, respectively. The dependent variable, GPI , is gender parity index in agricultural employment measured as the ratio of the number of females to the number of males employed in the agricultural sector for people aged 15–64. Alternatively, we have also used the logarithm of the total number of persons employed in the agricultural sector, aged 15–64; the logarithm of the number of females employed in the agricultural sector, aged 15–64; and the logarithm of the number of males employed in the sector aged, 15–64, as our dependent variables. *Agric_Value_Added* is the agricultural value added measured in current US dollars. *EUS* denotes the European Union food safety regulations on all agricultural products, which can be otherwise called the SPS and TBT measures, and it is the main variable of interest in this study. *Concerns* are specific concerns raised by exporting countries about the stringency of EU SPS and TBT standards over time. *GSP*, *FTA* and *EPA* are the RTA variables. We capture the influence of each of these RTAs using 3 separate dummy variables which are given as one if an exporting country has a FTA agreement with the EU, zero otherwise; one if an exporting country has an EPA agreement with the EU, zero

otherwise; and one if an exporting country has a GSP agreement with the EU, zero otherwise. A list of countries in RTAs with the EU that are included in the dataset are provided in Table 6 in the appendix section. *Inflation* denotes inflation measured in annual percentage, and captured as GDP deflator. *Sanitation* captures the percentage of a country's total population that has access to improved sanitation facilities and *Water* denotes percentage of the total population with access to improved water sources. These variables are proxy for the availability of time-saving infrastructure for women. *Primary*, *Secondary* and *Tertiary* are controls for gender gaps in education with *Primary* defined as the ratio of female to male primary school enrolment, while *Secondary* and *Tertiary* are the ratios of female to male secondary and tertiary school enrolment, respectively. Lastly, *Government_Effectiveness* is a variable controlling for government effectiveness to formulate and implement policies that would promote employment and gender equality in the agricultural sector employment. The variable ranges from -2.5 to 2.5 , with points closer to -2.5 signifying weak governance performance and those close to 2.5 signifying strong governance performance—higher values signify higher government's effectiveness. Finally, δ_t is a dummy variable controlling for time-fixed effects, while ϵ_{ijt} is the error term.

Estimation Techniques and Addressing Endogeneity

We had used two estimation techniques for the analysis: the standard panel fixed effects model and two-stage least square (2SLS). The fixed effect model uses the Breusch and Pagan Lagrange multiplier (LM) test for the null hypothesis that the variance across countries is zero. The test result failed to reject the null hypothesis that there is no within-unit correlation thereby confirming the fixed effects model as more appropriate. Endogeneity may be an issue in this study, which may result either from reverse causality or omitted variable bias that could impact on both gender inequality and growth. For instance, the literature on gender and growth nexus has shown extensively that the degree of gender inequality may affect growth variables; and that latter the variable may also affect the degree of gender inequality (Seguino 2000; Klasen and Lamanna 2009; Bandara 2015). Using panel data could minimize this problem when country fixed or regional fixed effects are included to control for unobserved characteristics of the countries or regions. For this reason, we argue that the endogeneity problem would be negligible but cannot, however, be completely ruled out. Thus, we employed an instrumental approach to correct for potential endogeneity problem. We employed the 2SLS instrumental variable approach. Our challenge is to find valid instruments that would be correlated with the endogenous variable (agricultural value added), but uncorrelated with the error term. To address this concern, we instrumented agricultural value added with two variables: these are total labour force and labour force participation rate as a percentage of total population aged 16 to 64. The intuition is that they affect the level of economic activities in the agricultural sector but they themselves do not directly contribute to gender inequality. Following standard instrumental variable estimation approach, we tested the validity of our instruments using the Sargan test of overriding restriction to ascertain if one or more of our instruments is valid. In all regression, the test did not reject the null hypothesis that our instruments are valid.

Table 1 Summary statistics

Variable	Obs	Mean	SD	Min	Max
Gender parity index	905	0.45	0.32	0	1.61
Relative gender gap	905	0.55	0.32	−0.61	1
Log of total agricultural employment	905	6.12	2.59	−1.61	12.24
Log of female agricultural employment	896	4.66	2.85	−5.81	11.29
Log of male agricultural employment	905	5.78	2.54	−2.30	11.76
SPS and TBT measures	905	4.90	0.81	3.09	5.85
Log of SPS and TBT specific concerns	849	4.87	1.70	−1.41	8.16
Log of agricultural value added	861	21.52	1.92	15.91	26.45
Regional trade agreement: FTA	905	0.12	0.33	0	1
EPA	905	0.19	0.14	0	1
GSP	905	0.89	0.31	0	1
Inflation (%)	889	9.01	15.13	−26.30	273.95
Total labour force ('000)	888	15,019.75	36,123.57	64.53	472,000
Labour Force Participation Rate	888	65.83	9.16	38.90	90.80
Access to improved sanitation facilities (%)	868	76.97	19.77	9.10	100
Access to improved water sources (%)	871	89.27	9.84	36.50	100
Female to male primary school enrolment	714	97.21	5.21	55.84	114.14
Female to male secondary school enrolment	621	101.96	12.25	36.53	149.93
Female to male tertiary school enrolment	533	1.23	0.63	0.282	6.76
Government effectiveness	902	−0.06	0.67	−1.77	2.03

Thus, with 2SLS, our first-stage regression model becomes

$$\begin{aligned}
 \ln Agric_Value_Added_{it} = & \beta_0 + \beta_1 Lab_{it} + \beta_2 Labrate_{it} + \beta_3 \ln EUS_{ijt} + \beta_4 \ln Concerns_{ijt} \\
 & + \beta_5 FTA_{ijt} + \beta_6 EPA_{ijt} + \beta_7 GSP_{ijt} + \beta_8 Inflation_{it} \\
 & + \beta_9 Sanitation_{it} + \beta_{10} Water_{it} + \beta_{11} Primary_{it} + \beta_{12} Secondary_{it} \\
 & + \beta_{13} Tertiary_{it} + \beta_{14} Government_Effectiveness_{it} + \delta_t + \mu_{ijt}
 \end{aligned} \quad (5)$$

In Eq. (5), all variables are as earlier defined. However, *Lab* is the total labour force in given country *i* at time *t*, and *Labrate* is the participation rate of labour for a given country *i* at time *t*, which is expressed as a percentage of total population aged 16 to 64.

Data and Sources

This study uses an unbalanced panel data of 90 developing countries from 1995 to 2012, and our sample of countries covers 6 regions. A list of sampled countries is included in Table 7 in the Appendix section. The selection of countries is based on employment data availability at the gender level at least for two years to enable a panel analysis. Data on agricultural employment disaggregated by gender were

sourced from the 8th edition of the International Labour Organisation (ILO) Key and Indicators of the Labour Market (KILM) database. SPS and TBT measures on agricultural products were from the WTO's Integrated Trade Intelligence Portal (I-TIP) database and data used in constructing the regional trade agreement dummies were sourced from WTO. Data on inflation, agricultural value-added as a percentage of GDP, the percentage of population having access to improved sanitation facilities and improved water sources were sourced from the World Bank's World Development Indicators. Data on total educational attainment which was measured by ratio of female to male primary school enrolment and ratio of female to male gross secondary and tertiary school enrolment were all sourced from UNESCO database. Data on government effectiveness were from the World Bank's Worldwide Governance Indicators (WGI). A description of the summary statistics of all the variables included in this analysis is reported in Table 1.

Results and Discussion

Table 2 gives the results from both the fixed effects (FE) and 2SLS estimation techniques. Column 1 presents the results from the first stage regression for all the regression models and are displayed in columns 3, 5 and 7. All models have similar first stage results given that their first-stage model is based on the same variables as specified in Eq. (5). Columns 2 and 3 present the results of the models with total agricultural employment as the dependent variable, while the other columns report the results disaggregated by gender. In the case of the first stage regression as reported in column 1, the instruments used—both total labour force and labour force participation rate—were statistically significant in the first-stage regression model, signifying their correlation with the endogenous variable.

In addition, in respect to each regression model, the test for endogeneity is statically significant at 5%, thus, we reject the null hypothesis of zero endogeneity between agricultural value added and the dependent variables, which justify our usage of the 2SLS. In addition, the Sargan–Hansen test results which is a test of overidentification restrictions is not statistically significant in all the models, thus, we cannot reject the null hypothesis that the instruments are valid. Furthermore, in all models, we also reported the Cragg–Donald Wald F statistics which is the test of weak identification, and its associated Stock and Yogo² (2005) critical values. Based on our test results, we reject the null hypothesis that the instruments used are weak as the calculated Cragg–Donald Wald F statistics is greater than the critical value for all models.

We see that the results of the fixed effects model differ only marginally from those of the 2SLS for many of the variables, however, the former model is interpreted given its ability to correct for endogeneity whose presence is detected based on the endogeneity tests reported at the lower part of Table 2.

² Stock and Yogo (2005) provide critical values for the Cragg–Donald F statistics.

Table 2 Effects of SPS and TBT measures on agricultural employment disaggregated by gender

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FE	FE	2SLS	FE	2SLS	FE	2SLS
	Total employment			Female employment		Male employment	
	Agricultural value added						
Agricultural value added		0.820*** (0.032)	1.019*** (0.055)	0.807*** (0.042)	1.051*** (0.083)	0.834*** (0.030)	1.024*** (0.044)
SPS and TBT Measures	0.156 (0.091)	-0.022 (0.087)	-0.074 (0.078)	-0.253** (0.115)	-0.317*** (0.105)	0.041 (0.078)	-0.009 (0.072)
SPS and TBT Concerns	-0.124*** (0.040)	-0.011 (0.033)	0.022 (0.034)	0.107** (0.041)	0.147*** (0.045)	-0.043 (0.032)	-0.012 (0.031)
FTA	0.514*** (0.140)	-0.009 (0.075)	-0.085 (0.097)	-0.267** (0.098)	-0.359** (0.129)	0.062 (0.074)	-0.010 (0.091)
EPA	-2.098*** (0.211)	-0.127 (0.152)	0.357* (0.174)	-0.134 (0.184)	0.457* (0.260)	-0.025 (0.142)	0.437** (0.153)
GSP	0.338 (0.195)	0.494*** (0.052)	0.391*** (0.076)	0.120 (0.081)	-0.005 (0.100)	0.619*** (0.057)	0.521*** (0.082)
Inflation	0.020*** (0.006)	0.003 (0.009)	-0.002 (0.010)	0.009 (0.011)	0.003 (0.012)	-0.000 (0.009)	-0.005 (0.010)
Access to Sanitation	0.037*** (0.010)	-0.014*** (0.003)	-0.015*** (0.003)	-0.015*** (0.005)	-0.017*** (0.005)	-0.014*** (0.003)	-0.015*** (0.003)
Access to Water Facilities	-0.002 (0.015)	-0.036*** (0.006)	-0.042*** (0.006)	-0.054*** (0.009)	-0.061*** (0.011)	-0.028*** (0.006)	-0.033*** (0.005)
Ratio of Female to Male Primary Schooling	-0.099*** (0.015)	0.076*** (0.018)	0.089*** (0.019)	0.147*** (0.023)	0.163*** (0.026)	0.048** (0.019)	0.060*** (0.018)
Ratio of Female to Male Secondary Schooling	0.027*** (0.008)	-0.019** (0.009)	-0.022** (0.009)	-0.038*** (0.009)	-0.042*** (0.008)	-0.011 (0.009)	-0.014 (0.009)
Ratio of Female to Male Tertiary Schooling	-1.616*** (0.008)	-0.701*** (0.009)	-0.290* (0.009)	-0.861*** (0.009)	-0.359* (0.008)	-0.620*** (0.009)	-0.228 (0.009)

Table 2 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FE	FE	2SLS	FE	2SLS	FE	2SLS
	Total employment			Female employment		Male employment	
	Agricultural value added						
Government Effectiveness	(0.156) 0.063 (0.105)	(0.151) -0.316*** (0.060)	(0.158) -0.353*** (0.068)	(0.149) -0.297*** (0.072)	(0.192) -0.343*** (0.081)	(0.163) -0.327*** (0.059)	(0.155) -0.363*** (0.066)
Labour force participation	2.47e-08*** (0.000)						
Total labour	0.024*** (0.005)						
Constant	25.347*** (1.643)	-11.908*** (1.492)	-16.835*** (2.169)	-15.096*** (2.327)	-21.105*** (3.169)	-11.655*** (1.330)	-16.349*** (1.901)
Endogeneity Test Statistics			13.506*** (0.0002)		14.142*** (0.0002)		13.198*** (0.0003)
Sargan-Hansen statistics			0.531 (0.466)		0.044 (0.835)		0.891 (0.345)
Cragg-Donald Wald F Statistics§			90.027 (19.93)		90.027 (19.93)		90.027 (19.93)
Number of observations	363	363	363	363	363	363	363

Standard errors of the regression coefficients are in brackets

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. p values are provided in brackets for the endogeneity and Sargan-Hansen test statistics. The probability value (p value) associated with the endogeneity test statistics indicates that the null hypothesis of exogeneity is rejected. The Sargan-Hansen test of overidentifying overriding restrictions, the significance of the Sargan-Hansen statistics indicates that we cannot reject the null hypothesis that the instruments are valid. The Cragg-Donald Wald F statistics is a test for overidentification and the test reports Stock-Yogo critical values ranging from 10 to 25% maximal IV Stock-Yogo. The Cragg-Donald statistics indicates that the instruments are not weak

§Stock-Yogo critical value is in bracket, and the 10% maximal IV size is reported

In columns 3, 5 and 7, compared to the results of the fixed effects models in columns 2, 4 and 6, we could see that the estimated coefficients of agricultural value added are only a bit larger after controlling for endogeneity, implying that increase in the value added in the sector does significantly generate employment in the sector. Similar results hold for the other columns when the fixed effects models were used.

Crucial to this study are the trade policies variables. The estimates of food standards are negative and this holds across all estimation techniques. However, it is only significant in the case of female employment as shown in column 5. The associated coefficient (-0.317) indicates that the imposition of SPS and TBT measures by the EU on agricultural exports significantly decrease women agricultural employment, disadvantaging women. In other words, a 10% increase in these EU measures would decrease their employment by 3.17%. The results might be attributable to the huge costs of complying with such SPS and TBT measures. These costs can be enormous for developing countries that often lack the technical and financial capacity to bear such standards (Czubala et al. 2009; Kareem et al. 2017), consequently, excluding them from the global markets. These results might also be attributed to the constraint faced by women relating to their inadequate technical expertise to comply with such EU measures which make many of them to be unable to access and compete in export markets compared to their male counterparts (Fontana and Paciello 2009). In addition, compared to men, women find it difficult to comply with standards as they seldom receive on-the-job technical training due to gender segregation in training with a preference for men (Kabeer 2012).

However, third countries' notifications of their grievances and concerns about EU's SPS and TBT measures turn out positive and statistically significant but only for the females as shown in column 5. In fact, voicing out grievances and stating concerns about stringent SPS and TBT measures that third countries see as unnecessarily stringent and constituting barriers to their export can stimulate an increase in employment. A 1% increase in notification on concerns about EU's standards increases women agricultural employment by 0.147%. This was the case of EU overly stringent aflatoxin regulations and beef hormone standards in the 1990s that propelled many countries to raise concerns about such measures which consequently made the EU to lower such standards through the intervention of WTO. Such concerns consequently removed the unnecessary obstacles caused by the measures and open more trade and generated more employment, which was also affirmed by Henson and Jaffee (2008). There is, however, some difference in the way these 'concerns' affect gender; raising such concerns is more beneficial in increasing women's employment, but the effect is not statistically significant for men.

Apart from these, trade agreements with the EU have significantly positive aggregate employment effects only in the cases of EPA and GPS (column 3). In relation to gender differences, however, women are more affected than men in the agricultural sector as countries in FTAs with the EU have an employment decrease of 43.2% [i.e. $\exp(0.359) - 1$]*100], relative to the case of males where the effect is negative but statistically indistinguishable from zero. In addition, men seem to benefit in the case of GSP while the effect is not different from zero for their women counterparts in the sector. Thus, with the exception of EPA which is slightly more beneficial for women than men, signing a RTA with the EU has been more beneficial for men.

However, both men and women benefit from EPA but women seem to only slightly benefit more than men in the case of EPA 57.9% [i.e. $\exp(0.457) - 1 \times 100$], relative to men whose employment gain is 54.8% [i.e. $\exp(0.437) - 1 \times 100$]. These results are expected particularly as EPA is a much more encompassing trade agreement with provisions obliging signatory countries to respect United Nations' declaration on full employment and decent work for all.

In relation to the coefficient on inflation, this turns out insignificant in the 2SLS models. Furthermore, access to time-saving facilities are expected to free women of domestic duties or ensure their process of domestic duties and thus free them for employment. However, counterintuitively, access to time-saving infrastructure such as sanitation facilities and water decreases total employment as well as female and male employment. These results cast doubt on the quality of these sanitation and water facilities—indicating they might be sub-standards or of low quality as they did not stimulate women's availability for employment.

Turning to the employment effects of schooling and training, the measures of gender equality in education signify that increase in equality in schooling at the primary level significantly increases agricultural employment, with the effect higher for females than males. However, at the higher school levels, women are particularly affected—as a widening of the gap between female to male enrolled in secondary and tertiary schools reduces their availability for labour, with no significant effect on men, signifying that females with secondary and tertiary education are less likely to enter the agricultural employment sector. Our results indicate the near gender equality achieved at the primary school significantly favours women in terms of increased employment. However, the existing gender inequality at the secondary and primary school levels disproportionately disadvantage them.

Lastly, our measure of government domestic policies' effectiveness on the agricultural sector shows that the present state of governance in the countries considered significantly reduce total agricultural employment as well as female and male employment. This might indicate poor governance quality as well as the lack of policies and commitment to policies that promote women in the agricultural sector.

Implication for Gender Inequality

Having established that women are at a disadvantaged position in the agricultural labour market, to better understand the extent of the inequality, we proceed to investigating the extent to which the factors that affect gender gaps are contributing to (de)feminization. Table 3 presents the results of the model with the dependent variable measured as the ratio of female to male in agricultural employment (GPI), controlling for other factors that affect the gender gap. The results from the fixed effects model and those of the 2SLS are presented. We did not present the first-stage regression of the 2SLS estimator which turns out to be similar to those obtained in column 1 of Table 2 as the reduced form (first stage of the 2SLS) is based on the same variables as given in Eq. 5. However, the postestimation tests are reported at the bottom of the table. Based on the endogeneity test, we could not reject the null hypothesis of exogeneity as our test statistics is not statistically significant at the conventional

Table 3 Impacts of EU SPS and TBT measures and specific concerns on gender inequality

	(1) Gender Parity Index FE	(2) Gender Parity Index 2SLS
Agricultural value added	−0.027*** (0.009)	−0.017 (0.018)
SPS and TBT measures	−0.085*** (0.024)	−0.087*** (0.020)
SPS and TBT concerns	0.043*** (0.010)	0.044*** (0.009)
FTA	−0.094*** (0.032)	−0.098*** (0.030)
EPA	−0.212*** (0.037)	−0.187*** (0.048)
GPS	−0.167*** (0.037)	−0.172*** (0.041)
Inflation	0.005*** (0.002)	0.005** (0.002)
Access to sanitation	−0.0001 (0.001)	−0.0002 (0.001)
Access to water facilities	−0.012*** (0.003)	−0.013*** (0.003)
Ratio of Female to Male Primary Schooling	0.044*** (0.007)	0.045*** (0.008)
Ratio of Female to Male Secondary Schooling	−0.011*** (0.002)	−0.011*** (0.002)
Ratio of female to male tertiary schooling	−0.140*** (0.048)	−0.119* (0.060)
Government effectiveness	0.021 (0.014)	0.019 (0.014)
Constant	−0.437 (0.641)	−0.688 (0.759)
Endogeneity test statistics (<i>p</i> value)		0.676 (0.411)
Sargan–Hansen statistics (<i>p</i> value)		1.995 (0.158)
Cragg–Donald wald F statistics [§]		90.027 (19.93)
Number of Observations	363	363

Standard errors of the regression coefficients are in brackets

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. *p* values are provided in brackets for the endogeneity and Sargan–Hansen test statistics. The probability value (*p* value) associated with the endogeneity test statistics indicates that we cannot reject the null hypothesis of exogeneity. The Sargan–Hansen test of overidentifying overriding restrictions, the significance of the Sargan–Hansen statistics indicates that we cannot reject the null hypothesis that the instruments are valid. The Cragg–Donald Wald *F* statistics is a test for overidentification and the test reports Stock–Yogo critical values ranging from 10 to 25% maximal IV

Table 3 (continued)

 Stock–Yogo. The Cragg–Donald statistics indicates that the instruments are not weak

 §Stock–Yogo critical value is in bracket, and the 10% maximal IV size is reported

levels. Thus, we rely more on the results of the fixed effect model which is also similar to the 2SLS in terms of magnitude and significance except for the coefficient on agricultural value added which is only significant in the fixed effects model.

In column 1, the result of the fixed model shows that value addition in the agricultural sector does not bring about significant employment effects for females as the coefficient is negative but statistically significant. This implies that increase in the value added in the sector disadvantage women as more males than females are employed. Crucial to this study are the variables of trade policies. The estimates of food standard measures are negative and significant indicating that the imposition of SPS and TBT measures by the EU on agricultural exports are indeed not gender neutral. The result shows that increased international trade barriers contribute to the defeminization of women in the agricultural sector. This result is as expected as women relative to men have less technical education to comply with technical standards. The situation is also exacerbated due to their relative lack of financial assets or financial access to pay for standards certification and other technicalities, which can be very costly, particularly, for smallholder farmer (Czubala et al. 2009; Kareem 2016a) most of whom are women in many developing countries.

Furthermore, third countries' notifications of their grievances and concerns about SPS and TBT regulations turn out positive and statistically significant. In fact, expressing their concerns about stringent EU food regulations that constituted barriers to their exports tend to enhance women employment relative to men, thereby contributing to gender equality which favours women.

In relation to trade agreements, relative to countries without no agreements, countries with trade agreement have significantly reduction in female employment relative to males—indicating that women are less likely to benefit from trade liberalization policies. In essence, relative to countries with no such agreement, countries with trade agreement have gender employment gap favouring men over women as shown by the negative coefficients on the three RTAs. This resulted into a widening of the employment gap by 0.094, 0.212 and 0.167 in the cases of FTA, EPA and GSP, respectively, which disadvantaged women.

Employment (Table 2 column 5) also widens the gender employment gap (Table 3, column 1). However, only EPA increases female employment (Table 2, column 5), nevertheless, it widens the gender gap, disadvantaging women (Table 3, column 1). We concurred that out of the three set of trade agreements, EPA has the most gender employment effect but the worse gender-promoting effect.

Intuitively, these results show that the progress of trade agreements on achieving gender equality is uneven and that trade and trade policies including trade agreements are not gender neutral, particularly, since trade policies affect women and men differently due to the fact that women face a number of constraints that prevent them from fully benefiting from such trade and trade liberalization measures, among which are their reproductive and domestic duties and entrenched gender norms

which discriminate against them. Besides, the EU gender chapters are not included in the trade agreements' general dispute settlement mechanisms, such mechanisms cannot be used to address the violation of gender provisions in its trade agreements (European Parliament 2019; Monteiro 2018). This might lead to the lack of incentive by signatory countries to implement such provisions given this moral hazard problem.

As earlier discussed, crucial to women's availability for employment is the provision and access to improved sanitation and water both of which are expected to lessen their heavy domestic chores, reduce their time poverty, and increase their mobility. Our results show that the impact of access to sanitation is not different from zero, while a 10% increase in the access to water widens the employment gap disadvantaging women by 0.1%. Although these results are counterintuitive as one would have thought that access to these facilities would have favoured women over men. However, we posited that these two measures have to go hand in hand due to the fact that availability of sanitation facilities without water infrastructure would not improve the condition of women and vice versa. More so, intuitively, these results cast doubt on the quality of the facilities.

Furthermore, the variables controlling for unequal opportunities resulting from the entrenched gender norms and cultures also turn out to be significant in explaining the observed gender differences in employment. The measure of female-to-male schooling also known as the gender parity index in education reveals that the increased female to male in primary schooling has indeed benefited women. Women's share in primary education is positive and significant, narrowing the employment gap between men and women in favour of women. This result is as expected, given the fact that gender parity has been achieved at in primary education (Tejani and Milberg 2010), and this is significantly resulting in relatively more job opportunities for women. In contrast, the coefficients on the ratio of female to male in secondary tertiary school are negative and significantly decline the employment gap in favour of men. The educational gap at the tertiary level signifies that a 10% increase in this gap widens the gender employment gap by 1.4%, disadvantaging women. The observed gender gap at tertiary level reflects the possible women's lack of technical expertise and training needed to comply with SPS and TBT measures, compared to their male counterparts.

Furthermore, increase in inflation benefits women more relative to male, however, the coefficient on government effectiveness variable is not different from zero signifying that government policies to ensure gender equality are not particularly effective in bridging the gender gap.

Countries' Differential Effects

Given that countries have different capacities to comply with standards, hence, the impact of SPS and TBT measures might not be the same across the countries considered. Thus, we estimated the differential effects for each country by interacting country dummies with EU SPS and TBT variables, with country dummies included. The interaction terms give the differential effect for each country.

Table 4 Impact of EU SPS and TBT Measures by Country

Countries	Estimates	Countries	Estimates	Countries	Estimates
Algeria	0.008	Guatemala	-0.752***	Panama	0.002
Antigua and Barbuda	-0.595***	Guyana	-0.595***	Paraguay	-0.006
Argentina	-0.001	Honduras	0.195**	Peru	0.179***
Armenia	1.169	Hong Kong, China	-0.595***	Philippines	0.049***
Azerbaijan	-0.177***	India	-0.075***	Qatar	-0.595***
Bahamas	-0.844***	Indonesia	-0.032*	Russian Federation	0.124**
Bahrain	-0.595***	Iran, Islamic Republic of	0.156**	Saint Lucia	-0.751***
Bangladesh	-0.419***	Iraq	-0.548***	Saudi Arabia	-0.595***
Barbados	0.951***	Jamaica	0.579***	Senegal	-0.485***
Belize	-1.104***	Kazakhstan	1.166***	Serbia	-0.051
Bhutan	0.162*	Korea, Republic of	0.063**	Sierra Leone	-0.595***
Bolivia	-0.507***	Kyrgyz Republic	-0.456***	Singapore	-0.595***
Bosnia and Herzegovina	-0.595***	Lesotho	-0.595***	South Africa	-0.595***
Botswana	-1.244***	Liberia	-0.595***	Sri Lanka	-0.570***
Brazil	-0.595***	Macau, China	-0.595***	Suriname	-0.595***
Cambodia	-0.150**	Macedonia, The former Yugoslav Republic of	0.038***	Syrian Arab Republic	-0.299***
Cameroon	-0.595***	Madagascar	-0.409***	Tanzania, United Republic of	-0.595***
Cayman Islands	-0.595***	Malaysia	-0.018**	Thailand	-0.037**
Chile	0.096***	Maldives	-0.917***	Trinidad and Tobago	-0.595***
Colombia	-0.118***	Mali	-0.595***	Turkey	0.045**
Costa Rica	-0.028**	Mauritius	0.020	United Arab Emirates	-0.595***
Cuba	0.017	Mexico	-0.070**	Uruguay	0.008*
Dominican	-0.595***	Moldova, Republic of	-0.232***	Venezuela, Bolivarian Republic of	-0.021*
Dominican Republic	-0.595***	Mongolia	-0.022	Viet Nam	-0.321***
Ecuador	-0.628***	Montenegro	-0.295***	West Bank and Gaza	0.049***
Egypt	-0.082***	Morocco	0.155***	Yemen	-0.595***

Table 4 (continued)

Countries	Estimates	Countries	Estimates	Countries	Estimates
El Salvador	−0.001	Namibia	−0.595***	Zambia	−0.595***
Ethiopia	0.421***	Nepal	−0.595***	Zimbabwe	−0.595***
Georgia	0.033***	Nicaragua	−0.595***		
Ghana	−0.595***	Oman	−0.711***		
Grenada	−0.595***	Pakistan	0.023		
Endogeneity Test		2.979*			
		(0.084)			
Sargan–Hansen Statistics [§]		–			
Anderson canon. LM statistics		24.475			
		(0.000)			
Cragg–Donald Wald F Statistics ^{§§}		17.333			
		(16.38)			
Number of observations		363			

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. p values are provided in brackets for the endogeneity test statistics. The probability value (p value) associated with the endogeneity test statistics indicates that the null hypothesis of exogeneity is rejected. The Cragg–Donald Wald F statistics is a test for overidentification; the test reports the Stock–Yogo critical values ranging from 10 to 25% maximal IV Stock–Yogo. The Cragg–Donald statistics indicates that the instrument is not weak

[§]The Sargan–Hansen statistics was not reported as the equation is exactly identified

^{§§}Stock–Yogo critical value is in bracket, and the 10% maximal IV size is reported here

Initially using our previous instruments (labour force participation and total labour force), total labour force is insignificant in our first-stage regression when estimating the differential effects. Thus, we proceed by estimating our model using only labour force participation as instrument. The results are reported in Table 4, with the postestimation tests displayed at the bottom of the table. The Sargan test statistics is not significant, thus, the null hypothesis that the instruments are valid could not be rejected. In addition, the Cragg–Donald Wald F Statistics indicates that the instrument is not weak as its critical values are less than the calculated F statistics.

Table 4 presents the country-specific results for the countries considered in this study. The results show that there are variations in the way the EU food safety regulations affect these countries. In general, for most of the countries, food safety regulation is negative and statistically significant, which contributed to a gender gap in agricultural employment—disadvantaging women. However, the effect is insignificant for some countries, while some countries benefited from the imposition of EU standards, disproportionately favouring women. These countries are Armenia, Barbados, Bhutan, Chile, Ethiopia, Georgia, Honduras, Iran, Jamaica, Kazakhstan, Korea Republic, Macedonia, Peru, Philippines, Russia Federation, Turkey, Uruguay and West Bank and Gaza. This result suggests that standards are not always trade and employment prohibiting, and agricultural standards can indeed increase trade and employment, especially enhancing women employment. The employment increasing effect occurs if the demand-enhancing effects of complying with the standards dominate the cost effects of making the necessary investment to comply with the standards.

Robustness Checks

We did a few checks to ensure the reliability of the results. Our first paramount concern is to see whether countries with ‘outlier gender parity index’ are the one driving the results, particularly, the results that show that raising concerns about food safety regulations promote gender equality. A second and equally important concern relates to whether the results are driven by the choice of the measure of the dependent variable.

To address the first concern, we have excluded observations with large values of gender inequality index particularly those that signify gender parity in employment (i.e. where the GPI is equal to 1) and those that signify an advantage for women (GPI greater than one). We have done this by dropping observations points where female employment is approximately greater or equal to the male employees. Column 1 of Table 5 reports the first-stage regression, while columns 2 to 4 of Table 5 addressed the first concern by reporting the estimates obtained when the outliers are excluded from the sample, with all models estimated using the 2SLS approach. Remarkably, with the exception of a few variables, these results further highlight our previous conclusion as the results in column 2 are similar to those reported in Table 3 while those in columns 3, 4 and 5 are also similar to those in Tables 2 with respect to the impacts of SPS and TBT measures as well as concerns about these measures. Thus, our basic conclusions in relation to the implications of the two measures of EU food safety standards remain largely unchanged.

Table 5 Robustness checks with alternative sample and construction of another dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
	Agricultural value added	Gender Parity Index	Total Employment	Female	Male	Relative gender GAP
Agricultural value added		0.024* (0.013)	1.037*** (0.060)	1.122*** (0.082)	1.017*** (0.054)	0.318* (0.179)
SPS and TBT measures	0.167 (0.106)	−0.095*** (0.027)	−0.064 (0.086)	−0.328** (0.123)	0.006 (0.078)	−1.568*** (0.326)
SPS and TBT concerns	−0.122*** (0.041)	0.053*** (0.010)	0.000 (0.036)	0.139*** (0.047)	−0.038 (0.034)	0.742*** (0.104)
FTA	0.589*** (0.174)	−0.142*** (0.054)	−0.050 (0.117)	−0.404** (0.166)	0.065 (0.106)	−1.576*** (0.323)
EPA	−2.447*** (0.248)	0.093 (0.058)	0.552*** (0.238)	0.942*** (0.344)	0.489** (0.208)	1.320* (0.678)
GSP*	0.491** (0.206)	0.000 (.)	0.294*** (0.086)	−0.252** (0.112)	0.490*** (0.089)	−1.849*** (0.276)
Inflation	0.022*** (0.006)	0.006* (0.003)	−0.003 (0.009)	0.001 (0.011)	−0.005 (0.009)	0.025 (0.024)
Access to sanitation	0.023** (0.009)	0.002 (0.002)	−0.013*** (0.004)	−0.011 (0.007)	−0.014*** (0.004)	−0.006 (0.019)
Access to water facilities	0.021 (0.014)	−0.018*** (0.004)	−0.054*** (0.010)	−0.082*** (0.016)	−0.042*** (0.008)	−0.089* (0.042)
Ratio of female to male primary schooling	−0.082*** (0.015)	0.033*** (0.007)	0.090*** (0.021)	0.153*** (0.029)	0.067*** (0.019)	0.352*** (0.073)
Ratio of female to male secondary schooling	0.026*** (0.008)	−0.010*** (0.002)	−0.026*** (0.008)	−0.045*** (0.008)	−0.019* (0.009)	−0.095*** (0.024)
Ratio of female to male tertiary schooling	−1.958*** (0.129)	0.073 (0.054)	−0.140 (0.183)	−0.001 (0.220)	−0.174 (0.177)	−0.253 (0.527)
Government effectiveness	0.007 (0.105)	0.039 (0.027)	−0.287*** (0.059)	−0.254*** (0.072)	−0.309*** (0.059)	0.052 (0.160)

Table 5 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
	Agricultural value added	Gender Parity Index	Total Employment	Female	Male	Relative gender GAP
Labour force participation	2.14e-08*** (0.000)	-0.773 (0.712)				
Total labour	0.030*** (0.006)					
Constant	22.647*** (1.518)	-0.773 (0.712)	-16.065*** (2.134)	-20.144*** (3.229)	-15.682*** (1.825)	-19.708*** (6.329)
Endogeneity test		4.068 (0.044)	9.558 (0.002)	10.990 (0.001)	9.046 (0.003)	3.546 (0.060)
Sargan-Hansen statistics		0.013 (0.910)	0.942 (0.332)	0.620 (0.431)	0.906 (0.341)	1.733 (0.188)
Cragg-Donald wald <i>F</i> statistics§		70.849 (19.93)	63.726 (19.93)	63.726 (19.93)	63.726 (19.93)	90.027 (19.93)
Number of observations	281	281	281	281	281	305

Standard errors of the regression coefficients are in brackets

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. *p* values are provided in brackets for the endogeneity and Sargan-Hansen test statistics. The probability value (*p* value) associated with the endogeneity test statistics indicates that the null hypothesis of exogeneity is rejected. The Sargan-Hansen test of overidentifying overriding restrictions, the significance of the Sargan-Hansen statistics indicates that we cannot reject the null hypothesis that the instruments are valid. The Cragg-Donald Wald *F* statistics is a test for overidentification and the test reports Stock-Yogo critical values ranging from 10 to 25% maximal IV Stock-Yogo. The Cragg-Donald statistics indicates that the instruments are not weak

§Stock-Yogo critical value is in bracket, and the 10% maximal IV size is reported
GSP was omitted during the regression analysis as it was constant within panels

The second concern relates to the construction of the gender inequality indicator. We checked the sensitivity of the results to an alternative measure of gender inequality. We constructed a relative gender gap in men-to-women employment with an equally acceptable measure of inequality. Here, the gender inequality gap can be calculated by subtracting the number of males employed in the agricultural sector from the number of females employed in the sector, divided by the number of males employed in the sector. Formally, the formula is given as follows:

$$Relative_Gap_{it} = \frac{F_{it} - M_{it}}{F_{it}}, \quad (6)$$

where ‘*i*’ indicates the individual country and ‘*t*’ is the time, F_{it} and M_{it} are the female and male employees at time *t* in the agricultural sector, respectively. The relative gender gap is interpreted as the advantage or disadvantage positions of females relative to males. Thus, a positive coefficient indicates that females are in a position of advantage relative to men, as more females are employed than men. A negative coefficient indicates that females are in a disadvantage position.

We thereafter introduced this measure into Eq. (4) as a dependent variable. The results of this robustness check are reported in column 6 of Table 5. As expected, the results are in line with those reported in Tables 3. For instance, the coefficient on SPS and TBT measures is negative and statistically significant, indicating that females are at a disadvantage relative to male in respect to agricultural employment—signifying a relative gender employment gap which disadvantage women. However, the coefficient on SPS and TBT concerns is significantly negative indicating that these concerns favour women relative to men in relation to employment. Hence, the basic message of this study in relation to the impact of food safety regulations remains largely unchanged.

Conclusion

This study investigates the impact of EU’s food safety regulations on gender relations in the agricultural labour market of 90 developing countries between 1995 and 2012. The results indicate that EU’s food regulations decrease aggregate agricultural employment and also significantly disadvantage women relative to men. In addition, gender-specific obstacles and inequality in opportunities such as gender inequality in secondary and tertiary schooling make women less available for gainful employment. However, gender parity achieved in primary education significantly increase women’ share of employment in the agricultural sector. In addition, the present state of the countries’ time-saving infrastructure which lessens females’ domestic care burden, and their availability for employment, such as their access to sanitation facilities infrastructure does not increase women’ share of employment—indicating that the quality of those infrastructure needed to be improved.

Thus, the results have several important implications for policy formulation and implementation. Improving gender equality is at the forefront of achieving economic growth and development. To move up the developmental ladder, women need to be equally represented in all economic activities in an economy. This will ensure that the economy is not underutilizing its economic resources as a gainfully employed woman can be a means to increased economic growth as women who are gainfully employed have better feed children—reducing undernourishment in the country—and they also have an increased probability of sending their children to school. Hence, equity can increase the quality of a country's future labour force. The problem of gender inequality can thus be addressed through policy measures that reduce inequality in opportunities for women and reduce women's time poverty and care burdens.

Comprehensive reforms and long-term commitments to the implementation of sustained and inclusive growth are among panacea for achieving gender parity or a narrowed gender disparity gap. Besides, there is the need for a policy that is targeted towards changing the observed entrenched gender relation in the customs and norms that discriminate against women. Given the fact that gender inequality is being perpetuated due to unequal opportunity for women in areas such as education, it is pertinent for the government to implement a sound and an inclusive educational policy that will enhance economic growth and development. Since gender parity is achieved in primary education with a significant rise in employment for women, this should be extended to higher levels of education such as the secondary school and tertiary institutions so as to narrow the gender disparity gap in employment in favour of women. In addition, investments in high-quality time-saving infrastructure that reduce women domestic care burden should be undertaken to alleviate their time poverty, increase their mobility and free them to participate in gainful employment.

Finally, and crucial to this study is the finding that non-tariff measures such as food safety regulations are not gender neutral. Engaging in sophisticated scientific and technology transfer as well as providing both financial and human development assistance to women farmers are important policy imprint. Deeper trade integration agreements with the EU should include the provision of technological and scientific assistance to the agricultural sector, particularly, to small-scale women farmers and producers which can help them to adhere to EU food regulations and facilitate their continuous employment in agricultural-trade-related activities.

Acknowledgements Fatima Olanike Kareem thanks United Nations University – World Institute for Development Economic Research (UNU-WIDER) where the initial phase of this research was conducted, for its financial support. The financial support of the German Research Foundation (DFG) under the project grant number GRK1666 (GlobalFood) is also gratefully acknowledged.

Compliance with Ethical Standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Appendix

See Tables 6, 7.

Table 6 List of trade agreements included

Agreement types	Members
GSP [§]	Algeria, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Bhutan, Bolivia, Botswana, Brazil, Cambodia, Cameroon, Cayman Islands, Chile, Columbia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Georgia, Ghana, Grenada, Guatemala, Guyana, Honduras, Hong Kong China, India, Indonesia, Iran, Islamic Republic of, Iraq, Jamaica, Kazakhstan, Korea, Republic of, Kyrgyz Republic, Lesotho, Liberia, Macau China, Madagascar, Malaysia, Maldives, Mali, Mauritius, Mexico, Moldova, Republic of, Mongolia, Morocco, Namibia, Nepal, Nicaragua, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Qatar, Russian Federation, Saint Lucia, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Sri Lanka, Suriname, Syrian Arab Republic, Tanzania, United Republic of, Thailand, Trinidad and Tobago, Turkey, United Arab Emirates, Uruguay, Venezuela, Bolivarian Republic of, Viet Nam, West Bank and Gaza, Yemen, Zambia, Zimbabwe
FTA ^{§§}	Algeria (2005), Azerbaijan (1999), Bosnia and Herzegovina (2008), Chile (2003), Egypt (2004), Macedonia (2004), Mexico (2000), Montenegro (2010), Morocco (2000), Serbia (2010), Turkey (1995), West Bank and Gaza (1997)
EPA ^{§§§}	Antigua and Barbuda (2008), Bahamas (2008), Barbados (2008), Dominican Republic (2008), Jamaica (2008), Trinidad and Tobago (2008), Mauritius (2012)

[§]These countries are beneficiary of the EU GSP in the period considered in this study (1995 to 2012). However, some of the countries cease to be beneficiaries—these are Chile from 2007, while Korea Republic, Hong Kong and Singapore cease to be beneficiaries from 1998

^{§§}This also includes Turkey which, however, has a custom union with the EU. The agreement came into force on 31.12.1995, thus, the inclusion in our data starts from 1996

^{§§§}Out of the FTAs, we excluded EPA which we included separately into our regression models. Other countries such as Madagascar and Zimbabwe, etcetera, are also in these agreements but are missing employment data for the time indicated

In the cases of Bosnia and Herzegovina, and Serbia, the dates they became provisionally applied are reported, the agreements became fully institutionalized in 2015 and 2013, respectively

Table 7 List of regions and countries in the dataset

Regions	Members
Importers	EU
East Asia and Pacific	Cambodia, Hong Kong China, Indonesia, Korea Republic, Macau China, Malaysia, Mongolia, Philippines, Thailand, and Viet Nam
Europe (non-EU) and Central Asia	Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyz Republic, Macedonia, Moldova Republic, Montenegro, Russian Federation, Serbia and Turkey
Latin America and the Caribbean	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominica Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Suriname, Trinidad and Tobago, Uruguay and Bolivarian Republic of Venezuela,
Middle East and North Africa	Algeria, Bahrain, Egypt, Islamic Republic of Iran, Iraq, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, West Bank and Gaza and Yemen
South Asia	Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Singapore
Sub-Saharan Africa	Botswana, Cameroon, Ethiopia, Ghana, Lesotho, Liberia, Madagascar, Mali, Mauritius, Namibia, Senegal, Sierra Leone, South Africa, United Republic of Tanzania, Zambia, Zimbabwe

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