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New features, forgotten costs and counterfactual gains of the international trading system

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Abstract

We critically survey the literature dealing with some of the significant changes that have recently occurred in international trade flows and policies. The aim is to offer a 'road map' through large swathes of literature and inform the profession of recent developments that can assist us as we seek to analyse agricultural markets and policies. In the first part, we analyse the increasing importance of global value chains and highlight the systemic structure of trade relations. In the second part, we run through the most recent literature that assesses the impacts of trade liberalisation. On the one hand, increasing attention has been paid to the trade adjustment costs; on the other hand, the new (new) trade theory has provided valuable insights in order to better estimate gains from trade.

Keywords: international trade, trade policy, global value chains, quantitative trade models

JEL classification: F10, F12, F13

1. Introduction

More than 25 years have passed since the publication of 'Between Scylla and Charibdys: Agricultural economists' navigation around protectionism and free trade' (De Benedictis, De Filippis and Salvatici, 1991). We have been sailing in rough seas and the landscape is quite different from the past. Since 1991, when the last round of General Agreement on Tariffs and Trade negotiations was not yet concluded, trading patterns have altered as shifts have been observed in the importance of production centres, access to markets and size of transportation costs (Hummels, 2007; Anania, 2015).

At the same time, there have been significant developments in both agricultural markets and agricultural policies worldwide. After the 1980s, the rates of distortion to agricultural prices diminished in both high-income and developing

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countries. The heavy taxation of agriculture in developing countries was phased out and the high domestic prices for farmers in high-income countries were brought more into line with international prices as trade measures were replaced by more-direct forms of income support (Tokgoz, Laborde and Majeed, 2016).[1] The European Union (EU) is a good case in point. Since the mid-1990s, along with the subsequent reforms of the Common Agricultural Policy (CAP) and the gradual decoupling of direct payments, decisions regarding agricultural trade policies have progressively been disentangled from those regarding domestic policies (Matthews, Salvatici and Scoppola, 2017).

Results suggest that countries' efforts to attain the benefits of trade have resulted in an intertwined network that is increasingly dense, reciprocal and clustered. World trade has increased dramatically during the last four decades, facilitated among other factors by the reduction of policy barriers, transportation and communication costs. The international trade of goods and services grew about 380 per cent from 1994 to 2014, from about US$5 trillion to US$24 trillion, whereas the share of trade of goods and services in global gross domestic product (GDP) rose from about 20 per cent in the 1980s to over 30 per cent in 2013 (Cepeda *et al.*, 2017). More recently, however, there has been a significant slowdown in world trade growth: the jury is still out on to what extent this reflects underlying long-term structural shifts in the world economy (Hoekman, 2015). Finally, and perhaps surprisingly, the focus on firms is a relatively new development since the economic literature on trade focused mainly on country and industry characteristics to predict the pattern and implications of trade.

The main objective of this article is twofold. First, we review some key aspects of these significant changes and present a series of empirical results that emphasise the importance of proper account for various trade data and policy issues. Next, we review recent theoretical developments in the international trade literature and discuss theoretical and empirical challenges to assess trade liberalisation impacts. Given the broad scope of issues that will be touched upon, we cannot pretend to be exhaustive; our aim is more to offer a 'road map' through large swathes of literature and provide information on recent developments in terms of new data and methodologies that can assist us as we seek to analyse agricultural markets and policies. Those seeking a detailed discussion of specific issues should refer to literature reviews dealing with each specific topic.

More specifically, in Section 2, we explore the emergence of global value chains (GVCs), with the increased splitting of production across countries and the consequent expansion of international trade flows. We will not deal

1 There are multiple methodologies utilised and different data sets employed in the literature and by international organisations (IOs) to measure distortions to agricultural incentives: the World Bank computed the Nominal Rates of Protection (NRP) and Nominal Rate of Assistance (NRA) database (http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:21960058~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html); the OECD has continuing efforts with the Producer Support Estimate (PSE) database that has been expanded to non-OECD countries (http://www.oecd.org/agriculture/agricultural-policies/producerandconsumersupportestimatesdatabase.htm). More recently, FAO-MAFAP has focused on Africa and is now expanding to Asia (http://www.fao.org/in-action/mafap/home/en/).

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with the topic of GVCs in general, but we will examine specifically how the GVC paradigm has been recently applied and linked to the study of international trade and trade policy. To this aim, we first review micro- and macro-GVC analyses that focus on agriculture and food sectors, and provide some original insights into the GVC participation of EU countries in this sector by using global input–output and trade in value-added data (Section 2.1). Then, since the expansion of GVCs has strongly increased economic interdependence between countries, we put the emphasis on the systemic nature of trade by examining network analysis, as a method recently applied to investigate trade interconnection at global and sectoral level (Section 2.2). Finally, we address the implications of this increasing integration in terms of trade policy measurement (Section 2.3).

Section 3 focuses on the challenges faced when evaluating the impacts of trade policies. Traditional arguments in favour of free trade based on dry statistics that point out aggregate net benefits fail to account for structural change in economies as trade liberalisation proceeds. There are short-run costs of redeploying an economy's resources out of sectors that shrink due to international competition. In the real world, due to several market failures, costs and inefficiencies can be protracted and fall harshly on some. Moreover, trade liberalisation yields sharp distributional effects: income losses by certain groups of producers or worker categories are the flip side of the gains from trade. Indeed, recent research has put the emphasis on these adverse distributional effects. We run through the literature that investigates adjustment costs and highlight some hidden and/or new costs that are emerging (Section 3.1).

On the other hand, new models have pointed out additional channels for gains from trade. However, the theoretical literature focuses on stylised settings that cannot easily be applied to the data. Since we never observe markets that are both closed and open at the same time, the fundamental challenge in identifying a programme or policy's impact lies in predicting how local firms or markets would behave under counterfactual scenarios in which they suddenly become more or less integrated with the rest of the world. In Section 3.2, we review new quantitative trade models (NQTMs) rich enough to speak to first-order features of the data, such as heterogeneous firms. We also draw attention to some caveats in terms of policy simulation design.

Section 4 concludes arguing that agricultural-specific aspects of international regulatory cooperation, trade facilitation and GVCs are increasingly worth our attention in a scenario where political backlash against globalisation has materialised. To this end, we draw some lessons from the previous sections regarding critical issues and areas of future research which may help to enhance the supply response of our profession.

2. The emergence of GVCs

2.1. Trade patterns

In recent decades, international trade has grown faster than global production thanks to a mix of technological change and business innovation, policy

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reforms and the integration of new emerging economies into the world economy (Irwin, 2002), although a slowdown in this trend has been recorded after the 2008–2009 global crisis. This rising integration has brought with it a disintegration of the production process, mainly in manufacturing activities, with a consequent growth in intermediate trade: about 60 per cent of current global trade consists of trade in intermediate goods and services which are then incorporated at different stages of production (UNCTAD, 2013a).

In what follows, we specifically analyse how the GVC – i.e. the full range of activities carried out by firms and workers in inter-firm global networks to bring a product from its conception to end use and beyond (Gereffi and Fernandez-Stark, 2011) – paradigm has been recently applied and linked to the study of international trade and trade policy. The topic has entered the academic literature on trade only recently (Antràs *et al.*, 2012; Baldwin, 2012, 2014; Baldwin and Venables, 2013; Costinot, Donaldson and Smith, 2013; Stehrer, 2013; Baldwin and Nicoud, 2014; Koopman, Wang and Wei, 2014; Timmer *et al.*, 2014; Baldwin and Lopez-Gonzalez, 2015) as scholars have pointed out that the nature of international trade has changed 'from trade in goods to trade in tasks' (Grossman and Rossi-Hansberg, 2008) or 'from selling things to making things' (Baldwin, 2011). Even small countries with limited capacities or resources have a chance to participate in GVCs and benefit from global trade as pointed out by recent contributions that focus on the relationships between competitiveness, trade, growth and development (Minten, Randrianarison and Swinnen, 2009; Cattaneo *et al.*, 2013; Swinnen and Vandeplas, 2014; Swinnen, 2016).

GVC micro-level analyses

GVCs mainly affect manufacturing but services and agriculture can be influenced as well. Agriculture sectors participate in value chains as the supplier of raw materials used in other production processes, whereas food sectors participate in terms of sourcing inputs from around the globe although across sectors and countries there is considerable variation (Greenville, Kawasaki and Beaujeu, 2017). Studies on agri-food chain are not new (Davis and Goldberg, 1957), and the literature embraces some complementary traditions: commodity chain analysis focuses on worldwide temporal and spatial relations (Hopkins and Wallerstein, 1986); *filière* analysis focuses on national political regulation and institutions (Lauret, 1983), whereas value chain analysis focuses on international business organisation and profitability (Porter, 1990). There have also been several applications of industrial organisation to economic and policy issues in the food and agricultural sector as well as analysis of the interaction between industrial organisation and policy in a trade setting: see among (many) Karp and Jeffrey (1993), Scoppola (2007), McCorriston and Sheldon (2011), and Sexton (2012).

The increasing importance of global agricultural trade registered during the past three decades comes with changes in the way GVCs are organised, with increasing levels of vertical coordination, upgrading of the supply base and

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the increased importance of large multinational food companies (Swinnen and Maertens, 2007; McCullough, Pingali and Stamoulis, 2008). A relatively small number of companies now organise the global supply of food and link small producers in developed or developing countries to consumers all over the world (Gereffi and Lee, 2009). This is generally referred to as agro-food GVCs (Humphrey and Memedovic, 2006; Liapis and Tsigas, 2014; Greenville, Beaujeu and Kawasaki, 2016; Balié *et al.*, 2017).

Much empirical evidence on agri-food GVCs is largely focused on capturing the impact on national economies through an analysis of case studies on the globally integrated value chain at the product level. These studies underline how the development of agri-food chains can be an important opportunity to increase rural income, reduce rural poverty and foster pro-poor growth (Maertens and Swinnen, 2009b; Minten, Randrianarison and Swinnen, 2009; Reardon *et al.*, 2009; Rao and Qaim, 2011; Rao, Brummer and Qaim, 2012). A large number of micro-studies analyse modalities through which emerging and developing countries can enter into agri-food value chains, underling both the importance and relative implications of tools such as contract farming with exporters or overseas buyers and standards (see, among others, Reardon *et al.*, 2001; Swinnen and Maertens, 2007; Asfaw, Mithoefer and Waibel, 2009; Maertens and Swinnen, 2009a; Miyata, Minot and Hu, 2009; Subervie and Vagneron, 2013; Beghin, Disdier and Marette, 2015; Swinnen, 2016). Some of these studies find that smallholders are also included in modern agricultural value chains, not only in developed economies but also in developing countries in Africa and Asia (Henson, Masakure and Boselie, 2005; Gulati *et al.*, 2007; Minten, Randrianarison and Swinnen, 2009; Kersting and Wollni, 2012; Handschuch, Wollni and Villalobos, 2013).

Notwithstanding these positive findings, most of these micro-analyses underline that getting access to, involvement and participation in a GVC is not an easy task. Increasing standards in international markets may exclude smallholders and family farms from value chains (Dolan and Humphrey, 2000; Unnevehr, 2000; Reardon and Berdegué, 2002; Gibbon, 2003; Weatherspoon and Reardon, 2003; Berdegué *et al.*, 2005; Jaffee and Masakure, 2005; Dries *et al.*, 2009; Ouma, 2010; Belton, Haque and Little, 2011; Bamber and Fernandez-Stark, 2014). Small farmers may be unable to comply with stringent requirements due to a lack of technical and financial capacity (Reardon *et al.*, 2001) which may induce traders and processing firms to reduce sourcing from small suppliers. Also, transaction costs for monitoring compliance with standards may be very high in the case of sourcing from smallholders (Swinnen, 2016). Such requirements can represent significant barriers to market access (Lee, Gereffi and Beauvais, 2012) which make them prohibitive for many small and medium-sized producers.

In many developing countries, other obstacles can threaten competitiveness such as weak regulatory institutions, poorly designed and implemented sanitary and phytosanitary regulations, inadequate transportation, power and water infrastructure, and the absence of important value chain actors (Markelova *et al.*, 2009; Hazell *et al.*, 2010). Consequently, small- and medium-sized producers are generally not well positioned to respond to changes in market structures and

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risk being marginalised (Dolan and Humphrey, 2004; Maertens and Swinnen, 2009a; Lee, Gereffi and Beauvais, 2012). In summary, the empirical evidence yields a mixed picture on the capability of countries – and specifically small farmers – to join agri-food value chains and exploit their economic benefits.

GVC Macro level analyses. Trade in value added and GVC involvement: the case of the EU agriculture and food sectors

From a macro-point of view, a new and growing literature has emerged which aims to describe the competitiveness of a country and/or its industries by looking at their production of value added as well as their level of integration into GVCs. Inter-country input–output tables and a full matrix of bilateral trade flows are now used to determine the trade in value added data and calculate new indicators.[2] The concept of trade in value added highlights the fact that both domestic and foreign value added (FVA) are combined to produce exports which may be later embodied in other products or consumed as final goods and services (Amador and Cabral, 2016).

The availability of new data and indicators has dramatically improved our current knowledge of the economic fragmentation process and the structure of global interlinkages across countries. By decomposing gross trade flows into added value components (Koopman *et al.*, 2011; Wang, Wei and Zhu, 2013; Koopman, Wang and Wei, 2014), it is now possible to get a measure of real involvement of countries and sectors in the international fragmentation of production (see, among others, Hummels, Ishii and Yi, 2001; Yi, 2003; Miroudot and Ragoussis, 2009; Daudin, Rifflart and Schweisguth, 2011; Johnson and Noguera, 2012; OECD-WTO, 2012; Backer and Miroudot, 2013; Wang, Wei and Zhu, 2013; Koopman, Wang and Wei, 2014; Timmer *et al.*, 2015). Most of the existing works are aggregate analyses or are centred on the manufacturing sector. This is mainly due to the larger availability of data at the aggregate level or related to the manufacturing sector compared to other sectors.

There have been some recent attempts (Backer and Miroudot, 2013; Liapis and Tsigas, 2014; Greenville, Beaujeu and Kawasaki, 2016; Greenville, Kawasaki and Beaujeu, 2017) to provide evidence about the extent to which the agriculture and food sectors are increasingly structured around GVCs. We propose here an analysis that provides a more detailed assessment of both the agriculture and food sectors[3] for 1995, 2007 and 2011 using data from World Input–Output Database (WIOD) (see Timmer, 2012, for details) to compare the Italian case with one of the largest EU exporters, France and Belgium as a smaller economy. Following Wang, Wei and Zhu (2013), we decompose the value added embodied in national gross exports of a country

2 Among these initiatives: the World Input–Output Database (WIOD) developed by the University of Groningen; the TiVA database developed by OECD–WTO; the Global Trade Analysis Project (GTAP); the Asian International Input–Output Tables developed by the Institute of Developing Economies–Japan External Trade Organization (IDE-JETRO).

3 We refer specifically to the agriculture, hunting, forestry and fishing sector (ISIC code rev. 3: A, B) and food, beverages and tobacco sector (ISIC code rev. 3: 15,16).

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into four main components: (i) the domestic value-added (DVA) embodied both in final goods and intermediate exports; (ii) the FVA used in the production of a country's exports which is the value added contained in intermediate inputs imported from abroad, exported in the form of final or intermediate goods measuring the extent of involvement in GVC for relatively downstream industries; (iii) the returned value added (RDV) that reflects the portion of DVA that is initially exported but ultimately returned home by being embedded in the imports from other countries and consumed at home and; (iv) the 'pure double-counted terms', arising from intermediate goods that cross borders multiple times (PDC). Looking at the value added decomposition of gross exports in Agriculture and Food (Table 1) for the selected EU member countries (EU averages have also been provided), we find evidence of (i) a higher level of DVA for agriculture (over 75 per cent on average in 2011); (ii) an increasing level of fragmentation in agri-food production highlighted by a decreasing weight of DVA and a parallel increase in FVA and PDC, both on average and for the three selected European exporters. This means that, notwithstanding the fact that the agri-food sector still registers a relevant domestic contribution in terms of value-added, a growing share of European exports – in food but also in agriculture – embodies value added derived from foreign countries' inputs.

Moving on to analyse who are the main suppliers of FVA for European countries' exports in the agri-food sector (Table 2), we find that in 2011 a significant percentage of FVA in agricultural exports – ranging from 42 per cent in the case of Belgium to 63.4 per cent of Italy (corresponding to ~11 and 8 per cent of gross exports respectively) – came from extra-EU countries, with an increasing role played by some emerging countries (mainly China and Russia). This is a new trend since in 1995 EU partners supplied half of the FVA of exports in the agricultural sector, from about 53 per cent in the case of Italy to 71.4 per cent for Belgium. The same trend is also registered in the food sector.

Other interesting insights come from looking at the indirect value added (IVA) that is the DVA in intermediate goods re-exported by the direct importer to other foreign countries (Table 3). IVA is commonly considered a proxy for the participation of a country in international production networks since it contains the exporter's value added that passes through the direct importer for a (or some) stage(s) of production before reaching third countries in the form of intermediate or final goods (Koopman *et al.*, 2011). France and Belgium have a high IVA share in agriculture, higher than the EU average. In the case of the EU, the agriculture sector presents a higher and increasing percentage of IVA compared to the food sector (about 15 per cent on average against 3.4 per cent in 2011). Accordingly, EU countries are significantly involved in agricultural GVCs by providing a growing value added in intermediates exports used in third countries' production: EU countries' agriculture sectors participate in value chains mainly as suppliers of raw materials used in other production processes, whereas the food sectors participate in terms of sourcing inputs.

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Table 1. Value added decomposition of gross exports in Agriculture and Food – EU 27 and selected countries[4]

		Agriculture, hunting, forestry and fishing					Food, beverages and tobacco				
		Gross exports	DVA	FVA	RDV	PDC	Gross exports	DVA	FVA	RDV	PDC
Area/countries	Year	In millions of US$	In % of gross exports				In millions of US$	In % of gross exports			
EU 27	1995	63,182	82.2	13.8	0.6	3.3	172,761	77.2	21.6	0.1	1.1
	2007	109,320	76.8	17.5	0.7	5.0	334,841	72.9	25.5	0.2	1.5
	2011	128,761	75.5	18.1	0.7	5.6	418,342	71.7	26.7	0.2	1.5
Belgium	1995	2,926	70.4	23.1	1.1	5.4	14,782	64.0	33.7	0.3	2.1
	2007	5,051	67.2	23.0	1.1	8.8	24,569	62.2	35.4	0.1	2.2
	2011	6,171	61.4	27.1	1.0	10.5	30,309	56.5	41.0	0.1	2.4
France	1995	14,624	85.6	9.5	2.4	2.5	28,366	86.3	12.9	0.3	0.5
	2007	19,451	82.2	12.4	1.7	3.6	45,511	83.9	15.0	0.3	0.7
	2011	26,612	79.4	14.5	1.7	4.4	55,408	80.6	18.0	0.4	1.0
Italy	1995	4,170	92.1	7.1	0.3	0.4	11,518	84.8	14.7	0.1	0.3
	2007	7,178	88.0	10.1	0.6	1.3	25,830	81.2	18.2	0.1	0.5
	2011	8,432	84.9	12.7	0.6	1.8	33,226	79.0	20.3	0.1	0.5

Source: Authors' calculations based on the WIOD, 2013 release.

4 Croatia became the 28th EU member on 1 July 2013.

Table 2. Main source countries of FVA in some selected EU countries exports

Sector	Agriculture, hunting, forestry and fishing									Food, beverages and tobacco								
Year	1995			2007			2011			1995			2007			2011		
	Rank	In % of gross exports	In % of FVA share	Rank	In % of gross exports	In % of FVA share	Rank	In % of gross exports	In % of FVA share	Rank	In % of gross exports	In % of FVA share	Rank	In % of gross exports	In % of FVA share	Rank	In % of gross exports	In % of FVA share
Belgium																		
FVA share of gross exports		**23.1**			**23.0**			**27.1**		FVA share of gross exports		**33.7**			**35.4**			**41.0**	
Tot. EU suppliers		16.5	**71.4**		14.8	**64.6**		15.7	**58.0**	Tot. EU suppliers		23.6	**70.2**		23.1	**65.3**		24.0	**58.6**
France	(3)	3.4		(3)	2.5		(3)	3.0		France	(3)	6.2		(3)	4.8		(1)	5.5	
Germany	(1)	4.4		(1)	3.8		(1)	3.6		Germany	(2)	5.3		(2)	5.1		(3)	5.0	
The Netherlands	(2)	3.7		(2)	3.2		(2)	3.5		The Netherlands	(1)	5.6		(1)	5.3		(2)	5.4	
Tot. extra EU suppliers		6.6	**28.6**		8.1	**35.4**		11.4	**42.0**	Tot. extra EU suppliers		10.1	**29.8**		12.3	**34.7**		17.0	**41.4**
China	(8)	0.2		(3)	0.6		(3)	1.2		Brazil	(4)	0.6		(3)	1.0		(3)	1.3	
Russia	(5)	0.2		(2)	0.8		(2)	1.3		China	(5)	0.2		(2)	0.9		(2)	2.0	
USA	(1)	2.1		(1)	1.5		(1)	2.4		USA	(1)	2.8		(1)	2.1		(1)	3.0	
France																		
FVA share of gross exports		**9.5**			**12.4**			**14.5**		FVA share of gross exports		**12.9**			**15.0**			**18.0**	
Tot. EU suppliers		5.5	**57.7**		6.3	**50.5**		6.7	**46.4**	Tot. EU suppliers		7.0	**54.3**		7.8	**52.2**		8.4	**46.5**
Germany	(1)	1.7		(1)	1.8		(1)	1.9		Germany	(1)	2.0		(1)	2.0		(1)	2.2	
The Netherlands	(4)	0.7		(3)	0.7		(3)	0.8		Spain	(6)	0.4		(5)	0.8		(2)	1.0	
UK	(3)	0.7		(2)	0.9		(2)	0.8		UK	(4)	0.8		(2)	1.1		(3)	0.9	
Tot. extra EU suppliers		4.0	**42.3**		6.2	**49.5**		7.8	**53.6**	Tot. extra EU suppliers		5.9	**45.7**		7.2	**47.8**		9.6	**53.5**
China	(8)	0.1		(3)	0.4		(3)	0.7		China	(8)	0.1		(3)	0.5		(2)	0.9	
Russia	(3)	0.3		(2)	0.7		(2)	1.0		Russia	(4)	0.3		(2)	0.6		(3)	0.8	
USA	(1)	1.1		(1)	0.9		(1)	1.2		USA	(1)	1.6		(1)	1.2		(1)	1.5	
Italy																		

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FVA share of gross exports		**7.1**			**10.1**			**12.7**		FVA share of gross exports		**14.7**			**18.2**			**20.3**	
Tot. EU suppliers		3.8	**52.7**		4.7	**46.2**		4.7	**36.6**	Tot. EU suppliers		8.2	**55.4**		9.3	**50.9**		8.1	**40.0**
France	(1)	1.0		(2)	1.0		(2)	1.0		France	(3)	2.2		(2)	1.9		(1)	1.8	
Germany	(2)	0.9		(1)	1.1		(1)	1.1		Germany	(2)	1.8		(1)	2.0		(2)	1.8	
The Netherlands	(3)	0.4		(4)	0.4		(3)	0.5		The Netherlands	(4)	0.8		(4)	0.7		(3)	0.7	
Tot. extra EU suppliers		3.4	**47.3**		5.5	**53.8**		8.1	**63.4**	Tot. extra EU suppliers		6.6	**44.6**		8.9	**49.1**		12.2	**60.0**
China	(6)	0.1		(3)	0.3		(3)	0.6		China	(7)	0.3		(3)	0.6		(3)	1.2	
Russia	(2)	0.4		(1)	0.6		(1)	1.7		Russia	(5)	0.6		(2)	0.8		(1)	1.8	
USA	(1)	0.6		(2)	0.5		(2)	0.7		USA	(1)	1.3		(1)	1.1		(2)	1.2	

Source: Authors' calculations based on the WIOD, 2013 release.
Notes: Unit: % of gross export, (*n*) position in the ranking of UE and extra UE foreign suppliers of value added in sectoral exports.

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Table 3. The IVA component of some selected EU countries exports

		Agriculture, hunting, forestry and fishing			Food, beverages and tobacco		
		Gross exports	IVA		Gross exports	IVA	
Area/countries	Year	In millions of US$	In millions of US$	In % of gross exports	In millions of US$	In millions of US$	In % of gross exports
EU 27	1995	2,340	255	10.9	6,399	188	2.9
average	2007	4,049	558	13.8	12,402	408	3.3
	2011	4,769	703	14.7	15,494	520	3.4
Belgium	1995	2,926	335	11.5	14,782	472	3.2
	2007	5,051	858	17.0	24,569	817	3.3
	2011	6,171	969	15.7	30,309	866	2.9
France	1995	14,624	2,150	14.7	28,366	758	2.7
	2007	19,451	3,102	15.9	45,511	1,488	3.3
	2011	26,612	4,278	16.1	55,408	2,014	3.6
Italy	1995	4,170	183	4.4	11,518	177	1.5
	2007	7,178	618	8.6	25,830	468	1.8
	2011	8,432	799	9.5	33,226	611	1.8

Source: Authors' calculations based on the WIOD, 2013 release.

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2.2. Trade networks

The expansion of GVCs has strongly increased economic interdependence between countries. Studying this phenomenon requires new tools for evaluating the linkages among countries that can no longer be adequately appraised by bilateral standard gross trade flows. Consequently, new methods of analysis have been recently developed or applied to investigate the systemic structure of international trade.

Given the specific features of GVCs, network analysis can be usefully applied to study the international flows of value added and countries' involvement within GVCs. This type of analysis allows us to investigate the interdependence of observations and explore the complexity and heterogeneity of actors and links in GVCs, including the different patterns embedded in a supply (demand) (Carvalho, 2014; Santoni and Taglioni, 2015; Amador and Cabral, 2016).

Several aspects of the structural and topological properties of the 'world trade network' have been studied by Serrano and Boguñá (2003), Garlaschelli and Loffredo (2005), Kali and Reyes (2007), Fagiolo, Reyes and Schiavo (2010), De Benedictis and Tajoli (2011), De Benedictis *et al.* (2014), Fan *et al.* (2014), among others. Network metrics have also been applied to examine sectorial networks (see Barigozzi, Fagiolo and Garlaschelli, 2010; De Benedictis and Tajoli, 2010; Akerman and Seim, 2014; Amighini and Gorgoni, 2014). The specificity of networks is that the relation between two nodes (i.e. countries in our case) is not analysed in isolation, but is studied by focusing on its structural dimension, that is, considering the 'effect of others' in the relation between them, i.e. taking into account the set of all possible trade relations with other partners (De Benedictis *et al.*, 2014). The visualisation of the network structure using graphs that contain the structure of nodes linked by edges is hence a useful and informative tool for detecting the presence of multiple interconnections and facilitating the interpretation of network data.

Recently, several works have adopted network analysis to study GVCs. Cerina *et al.* (2015) examine the global, regional and local network properties of the so-called world input–output network and document its evolution over time. They find a strong but asymmetric rise in cross-country connectivity over time, as countries increasingly participate in GVCs. In the same vein, Zhu *et al.* (2015) find that the industry-level GVCs are indeed not chain-like, but are better characterised by tree topology. In a different vein, Ferrarini (2013) uses network visualisation tools based on parts and components product-level data to map vertical trade among countries. The resulting global network of production and vertical trade shows that outside Asia and with the exception of Mexico, developing countries are not yet fully part of the global production networks. More recently, Amador and Cabral (2016) provide a general picture of the characteristics and dynamics of GVCs from a complex network perspective: larger countries play a key role and the regional dimension of GVCs is still dominant, although a global network is progressively emerging. Finally, Cingolani, Iapadre and Tajoli (2016) provide an application of network analysis to examine the impact of trade

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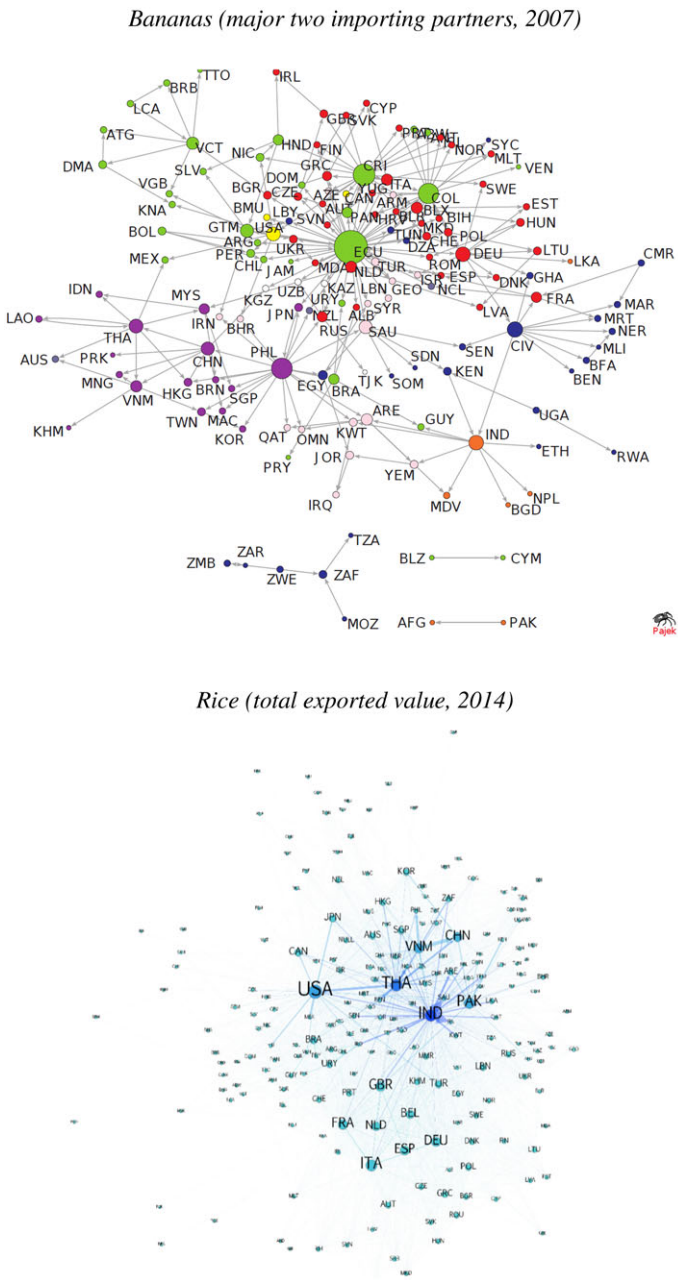

Fig. 1. World sectoral trade networks.
Source: De Benedictis *et al.* (2014); for rice, courtesy of L. Tajoli.
Note: Country labels are the Iso3 country codes. The size of the circle associated to each country is proportional to out-degrees (the number of outgoing trade flows). Data come from the Base pour l'Analyse du Commerce International (BACI) data set operated by Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

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preferences on the topology of global and regional value chains. By applying bilateral trade intensity indices to the matrix of world trade in two industries – textiles and apparel, and electronics – their analysis confirms that (i) stronger preferentiality and selection of trade partners seem to occur for trade in intermediate goods; (ii) regionalisation is still high, especially in electronics, but progressively declining; (iii) there are relevant differences between industries since the organisation of production in the industries and the technological characteristics of the goods matter.

Although there are no studies that focus solely on agri-food GVCs, De Benedictis *et al.* (2014) describe the topological properties of the world trade network by studying several selected products networks. These include networks in bananas and rice (Figure 1).

International trade, both in bananas and rice, appears geographically segmented, with the major role played by Asia, on one side, and Latin America, on the other side, for bananas, and the USA (together with Europe) for rice. Apart from the country-by-country relations, both visualisations show that the sectors are characterised by remarkably polarised networks, where a limited number of countries dominate the market. In the case of bananas, some of the features of the network have been influenced by EU trade preferences granted to the Africa, Caribbean and Pacific countries (Anania, 2015).

A network framework that takes into account the full set of links among countries and their positions in GVCs can shed some light on the structure of the underlying production linkages and contribute to a better assessment of how globalisation affects each national economy and global economy as well. Accordingly, we envisage a larger role for this tool in future agricultural trade analyses.

2.3. Protection indexes

The increasing importance of GVCs has significant policy implications, changing the way policy-makers interpret trade policies and external competitiveness. Taking into account both border and domestic policies, Briones Alonso and Swinnen (2015) develop an extended Nominal Rate Assistance methodology to disentangle the welfare impacts of policies for various interest groups along the value chain. More generally, the rise of GVCs changes the purpose of trade agreements through the way that international prices and the terms of trade are determined, from traditional market-clearing mechanisms to a web of bilateral bargains over the prices of customised inputs in specialised buyer–supplier relationships (Antràs and Staiger, 2012). The idea that the rise in the fragmentation of production across GVCs may be a deterrent against protectionism has also been empirically verified (Gawande, Hoekman and Cui, 2015).

Since global supply chain linkages modify countries' incentives to impose import protection and these linkages are important determinants of trade policy, the recent literature has introduced supply chain linkages into theoretical

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models of protection measurement.[5] It is worth emphasising that the two questions, 'how much protection is given?' and 'what is the impact of protection?' are logically distinct even if the literature answering the former make use of the impact on trade and welfare to aggregate several products and policy instruments into scalar indicators.

A well-known measure of trade protection which takes into account the effects of tariffs both on inputs and outputs is the effective rate of protection (ERP). The concept of the ERP was developed by Corden (1966) to measure the increase in value added in an industry under protection compared with what value added would be under free trade.

The original ERP formulation considers only two steps of production (imported input *directly* used to produce output), and turns out to be inconsistent with the recent changes in patterns of global trade. Diakantoni and Escaith (2014) use Leontief insight and the dimensional information given by international input–output matrices (country/sector of origin/destination) to refine the specification of the ERP, incorporating the *indirect* consumption of intermediate inputs.

Even if the revised version of the ERP is able to exploit the information made available by the multi-regional input–output (see Section 2.1), it does not properly address one of the fundamental obstacles to constructing summary statistics of the overall level of trade restriction in an economy due to the fact that the level of trade restriction in each industry must be appropriately weighted. As a matter of fact, the index does not consider any potential endogeneity between the level of tariffs and the input intensity (e.g. for a prohibitive tariff inputs are not imported and they do not enter in the computation of effective protection), and this may lead, among other things, to an underestimation of the effective protection in cases of 'escalated' tariff structures (Pritchett and Geeta, 1994).

Anderson and Neary (1996) formulate the general model of a small tariff-distorted competitive trading economy and apply dual techniques to model trade policy. In such a setting, the uniform tariff (μ) which, when applied to the set of domestic prices (p), yields the same volume of imports (M) at world prices (p^*) while holding constant the balance of trade function (B), can be expressed as follows:

$$\mu : M[(1+\mu)p^*, B] = M(p, p^*, B)$$

This is the Mercantilist Trade Restrictiveness Index (MTRI) proposed by Anderson and Neary (2003) to measure the extent to which trade distortions impact import volumes.[6]

5 For an alternative approach which introduces supply chain linkages into a workhorse model of tariff setting with political economy, see Blanchard, Bown and Johnson (2016).

6 Even if the MTRI is a general equilibrium index, Bureau and Salvatici (2005) provide a partial equilibrium approximation modelling import demand through a Constant Elasticity of Substitution (CES) functional form whereas Bureau, Fulponi and Salvatici (2000) estimate changes in the protection indexes resulting from different patterns of tariff reductions.

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The uniform tariff equivalent which would maintain the same volume of trade once all existing tariffs were eliminated is an example of *an equivalence* measure since it provides results that are equivalent to the original data in terms of the information we are interested in (Cipollina and Salvatici, 2008). The greatest advantage of this class of measures is that they are unequivocal because their definition is predetermined. These measures are theoretically grounded since weights represent the effects of the tariffs according to a fundamental economic structure.

With the development in the nature of international trade due to the rising of international fragmentation of production, a gap between countries' gross and value added trade flows has emerged (see Section 2.1). As a consequence, an analytical framework that allows us to distinguish the part of intermediate production embodied in bilateral imports that takes place in a third country could be useful.

Antimiani, Fusacchia and Salvatici (2016) recast the definition of the index to distinguish between the three main components of bilateral imports under the assumption that the importing country production structure does not differentiate between goods sold in the domestic or foreign markets:

i. The DVA originated in all sectors of the importing country which is imported back through the exporting country (RDV).
ii. The bilateral foreign value added originated in all sectors of the exporting country (FVAB).
iii. The FVA of third countries which is indirectly imported (FVAI).

the sum of the last two components corresponds to the FVA.

We compute the value added equivalent uniform tariffs yielding the same value as each component of the bilateral imports (T_{RDV}, T_{FVAB}, T_{FVAI}) through a modified version of the standard GTAP model (Antimiani, Fusacchia and Salvatici, 2016). This is a multi-region, multi-sector global CGE model, with perfect competition and constant returns to scale technology, designed to assess the inter-regional, economy-wide incidence of economic policies. We use the newly developed GTAP-MRIO database, derived from the reconciliation of trade data with the input–output structure available for each region, built on the GTAP database version 9 (Aguiar, Narayanan and McDougall, 2016). The analysis is performed for six regions – 'EU28' (European Union – 28 countries),[7] 'USA', 'China', 'hics' (high-income countries), 'mics' (middle income countries) and 'lics' (low-income countries) and this allows the IVA protection to be computed for EU and China.[8]

Table 4 presents the bilateral uniform tariffs imposed by the EU on China exports and by China on EU exports as well as the uniform tariff keeping constant gross imports /(T_{MTRI}). The latter values are quite close to the protection measured in terms of the exporter value added as expected since the latter represents the largest share of gross imports. It is worth noting that

7 Croatia is included in the EU even if the database refers to 2011.
8 China protection data are overestimated in the database given that about half of its exports are processing trade with no tariff charged on intermediate imports.

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Table 4. Bilateral uniform tariff equivalents (%)

	EU from China	China from EU
T_{RDV}	3.05	6.20
T_{FVAB}	3.83	6.52
T_{FVAI}: USA	3.28	6.20
T_{FVAI}: hics	2.61	6.30
T_{FVAI}: mics	2.95	6.22
T_{FVAI}: lics	2.76	5.87
T_{MTRI}	3.49	6.46

Source: Authors' calculations based on the GTAP model and GTAP-MRIO database.

Table 5. Sectoral components of bilateral protection (%)

	China tariffs on EU exports			EU tariffs on China exports		
	T_{FVA}	T_{RDV}	TWA (%)	T_{FVA}	T_{RDV}	TWA (%)
Agriculture	0.9	0.3	12.5	0.3	0.0	3.9
Food	2.5	0.8	11.6	3.0	0.7	11.3
Textiles	3.7	5.0	9.9	48.5	38.9	10.4
Wood	0.9	0.3	2.0	0.9	0.7	0.7
Chemicals	11.7	7.7	6.0	9.3	10.1	4.3
Metals	5.9	4.0	3.9	7.5	7.6	3.2
Motor vehicles	33.8	35.0	16.3	3.3	6.3	2.7
Electronic equipment	1.7	4.4	2.0	8.4	11.1	1.1
Machinery	36.6	40.2	6.0	15.1	22.2	2.2
Other	1.9	1.8	15.7	3.6	2.1	1.8

Source: Authors' calculations based on the GTAP model and GTAP-MRIO database.

DVA faces a significant protection level (T_{RDV}) relative to the bilateral direct FVA, meaning that protection heavily impacts upstream domestic firms exporting intermediate inputs processed abroad and then imported back: in the case of China, taxes on imports from EU impact Chinese re-imported value added more than the exporter value added.

Results also show the relevance of considering the whole trade system, since third countries are significantly affected by EU and China bilateral trade policies. The value added originated in low-income countries is subjected to the lowest level of protection: this reflects the low degree of participation in GVCs by developing countries as well as the existence of preferential trade policies.

In Table 5, we assess the weight of various sectors in overall protection in terms of domestic (RDV) and total foreign (FVA = FVAB + FVAI) value added. For each sector, we also indicate the trade weighted average (TWA) tariff.

The weight of the primary sectors is negligible notwithstanding the relatively high tariffs due to the small economic size. Comparing for each sector T_{FVA} with T_{RDV}, the impact of bilateral tariffs on the two value added components

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appears to be quite different. It is worth noting that some of the most relevant sectors – such as motor vehicles, electronic equipment and machinery – have a larger impact on the protection affecting domestic rather than FVA both in China and in the EU.

3. Trade liberalisation impacts

As mentioned in the Introduction, there is increasing, widespread discontent with globalisation and trade. A strong rhetoric against trade liberalisation has gained momentum: 'there is a sense among the broader public that trade experts, economists and politicians have tended to minimise distributional concerns and often put too much emphasis on the gains from trade and too little on the costs of adjustment' (WTO Deputy Director-General Xiaozhun Yi, November 2016). This negative sentiment has also infected scholars, leading some prominent economists to review their position on the gains from trade.[9]

In what follows, we review the most recent literature that attempts to quantify trade liberalisation impacts both in terms of (often forgotten) costs and (necessarily counterfactual) gains.

3.1. Forgotten costs

The increasing importance and competition of some new important players in the global economy, such as China, and the consequent loss of jobs in specific segments of labour market, has revitalised the debate about the costs of trade. In the following, we briefly review some of the most recent literature that attempts to quantify these costs.

Labour market

Most of the analyses carried out in the past aimed at assessing the adjustment costs of trade and exploring their implications for welfare by focusing on labour market outcomes, such as wages and employment status. This literature is extensive and has been reviewed in several surveys (see Feenstra and Hanson, 2003; Harrison, McLaren and McMillan, 2011; Pavcnik, 2012; Helpman, Itskhoki and Redding, 2013; Goldberg, 2015; Goldberg and Pavcnik, 2007 for developing economies). Some authors investigate the link between trade and inequality, referring to concerns that arise from the distributional conflict brought about by trade liberalisation. They try to explain the increase in the wage gap between skilled and unskilled workers (the so-called skill premium) observed in many countries focusing mainly on comparative statics. They show that trade liberalisation is associated with higher wage inequality, at least in the USA and other industrialised countries (see, for instance, Feenstra and Hanson, 1999; Krugman, 2008 for a survey).

9 Criticism of the economics profession's unconditional support for free trade has been expressed, among others, by Dani Rodrik, Daniel Gros, and Joseph Stiglitz (see the recent survey by P. Subacchi on the Project Syndicate Web site https://www.project-syndicate.org/onpoint/free-trade-in-chains?barrier=accessreg).

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Recently, a growing body of research has also focused on trade's differential effects across local markets within a country (see Dix-Carneiro and Kovak, 2014, for an extensive list of citations).

By and large, most of the action in labour markets is explained by technological changes that complemented high-skill workers and reduced labour demand in manufacturing (Goldberg, 2015; Helpman, 2016). However, new arguments linking globalisation to labour markets have emerged: offshoring and changes in the competitive environment. If trade liberalisation reallocates the factor of production towards more skill-intensive firms in all sectors, this implies a generalised wage gap also in countries with a comparative advantage in unskilled intensive sectors in contrast with standard Stolper–Samuelson predictions.

In the 1990s, one could safely assert that trade with low-wage countries could not significantly impact labour markets in developed countries because south-north trade flows represented only a small share of total developed nations' imports and GDP. This is no longer the case: Autor *et al.* (2016a) calculate that about 55 per cent of job losses in USA manufacturing between 2000 and 2007 were caused by rising exposure to Chinese import competition compared with 33 per cent in the 1990–2000 period. Other recent studies provide an increasingly precise assessment of the adjustment costs of trade and explore their implications for welfare. These works show that trade has sharply different effects on real incomes across different groups of agents and find that import competition can worsen workers' labour market conditions because of a higher probability of job displacement and lower wage growth (see, among others, Khandelwal, 2010; Topalova, 2010; Autor and Dorn, 2013; Autor, Dorn and Hanson, 2014, 2015; Crinò and Epifani, 2014; Dauth, Findeisen and Suedekum, 2014; Dix-Carneiro and Kovak, 2014; Faber, 2014; Acemoglu *et al.*, 2016).

Health

Even if a recent review of quantitative studies highlight overall a beneficial association between international trade and population health (Burns Jones and Suhrcke, 2016), this is quite a new trade adjustment cost which has been overlooked and yet is economically important and should be included in a proper assessment of the net welfare gains from trade. Colantone, Crinò and Ogliari (2015) study the effect of import competition on workers' mental distress. Using data that combines individual-level information on the mental health of British workers with industry-level information on import competition between 2000 and 2007, they show that import competition affects even those maintaining their job due to increasing stress and worsening expectations about the future. Another small (but growing) literature focuses on the effects of trade on life expectancy and children mortality (see Levine and Rothman, 2006, using a cross-country analysis; Owen and Wu, 2007, via panel data econometrics; Olper, Curzi and Swinnen, 2015, applying a Synthetic Control Method) and on the diffusion of infectious diseases (Oster,

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2012, on HIV). Along the same lines, a strand of the natural sciences literature investigates the side effects of international trade, represented by the spread of animal or plant disease or the introduction of invasive species that have the potential to adversely affect domestic livestock and agricultural production (see, among others, Dalmazzone, 2000; Vila and Pujadas, 2001; Mumford; 2002; Levine and D'Antonio, 2003; Olson, 2006; Waage *et al.*, 2008; Westphal *et al.*, 2008; Desprez-Loustau, 2009; Hulme, 2009; Marini *et al.* 2011; Chapman *et al.*, 2016; Wu *et al.*, 2017).

Food security

A heated debate is related to the effect of trade on food security. Trade can affect each of the four dimensions of food security (food availability, access, utilisation and stability) but the interaction of trade with these dimensions is complex and depends on a variety of underlying factors, producing great differences in country experiences and making it difficult to ascertain a generalisable relationship (FAO, 2015). A review by McCorriston *et al.* (2013) on the evidence for links between agricultural trade liberalisation in developing countries and food security finds mixed results: only 10 out of 34 studies reported that food security would decline because of trade. More recently, Magrini *et al.* (2017) use generalised propensity score-matching estimation to assess the impact of agricultural trade measures on food security for a wide sample of countries, showing that both discrimination against agriculture and large support lead to poor performances in the different dimensions of food security.

Poverty and vulnerability

A large body of empirical research has been developed in the past to study the impact of trade on poverty (see inter alia McCulloch, Winters and Cirera, 2001; Bhagwati and Srinivasan, 2002; Dollar and Kraay, 2002, 2004; Winters, 2002; Goldberg and Pavnick, 2007; Hoekman and Olarreaga, 2007; Ravallion and Chen, 2007; Fosu and Mold, 2008). Although the trade literature has emphasised the positive impact of more outward-oriented policies on economic growth, whether trade liberalisation tends to increase growth and hence leads to poverty reduction is a moot point: results vary across all countries or households and are highly sensitive to modelling and assumptions (see Winters, McCulloch and McKay, 2004; Winters and Martuscelli, 2014).

With a few exceptions, this literature has overlooked the possible impacts of the opening up process on households' exposure to risk. In principle, trade can magnify risks by changing the riskiness of existing activities or by changing the emphasis among the different activities households engage in (McCulloch, Winters and Cirera, 2001). Also in this case, empirical evidence is mixed on the issue, scattered in separate fields of analysis, and does not reach a common stance. Newbery and Stiglitz (1984) were the first to highlight the negative welfare impacts of trade in the absence of insurance. This seminal paper has been followed by a systematic exploration of the links between macroeconomic volatility and trade (see, among others, Easterly, Islam and Stiglitz, 2001;

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Giovanni and Levchenko, 2009; Karabay and Mclaren, 2010; Lee, 2014). Only recently and thanks to the availability of new household surveys and panel data, the literature has also started to explore the micro channels among international trade, risk and households' welfare and vulnerability (for a survey, see Montalbano, 2011). Magrini and Montalbano (2012) assess vulnerability from trade in Vietnam by focusing on behavioural heterogeneity in consumption across households clustered by industries characterised by different degrees of trade exposure; Allen and Atkin (2016) explore the second moment effects of trade on Indian farmers using agricultural micro-data over the period 1970–2009 and demonstrate that the interaction between trade and volatility may have important welfare implications when households are risk averse and financial markets incomplete.

Politics

Another relationship has recently caught the attention of an increasing number of scholars: the linkage between trade and politics, more specifically between trade exposure and sustained increases in partisanship (i.e. political polarisation). Autor *et al.* (2016b) analyse whether the exposure of local labour markets to increased foreign competition has altered the ideological composition of the USA Congress. Their aim is testing whether adverse shocks related to international trade or other events cause voters to supplant moderate legislators with more extreme representatives. The authors find a polarised response to economic shocks, showing that the impacts of trade exposure extend beyond USA trade policy initiatives and affect the overall ideological composition of Congress. Also for the USA, Feigenbaum and Hall (2015) investigate the impact of import competition from China on Congress. They find that support for protectionist trade measures is stronger among politicians from more trade-exposed districts. Similarly, Kleinberg and Fordham (2013) and Kuk, Seligsohn and Zhang (2015) find that representatives from congressional districts harder hit by the China trade shock are more likely to support hard foreign-policy legislation against China. Finally, Feler and Senses (2016) analyse the impact of trade-induced income shocks on the size of local government, and the provision of public services in USA. They find that areas with declining labour demand and incomes due to increasing import competition from China experience relative decline in housing prices and business activity that translate into less revenue which reduces the ability of local governments to provide public services. The outcome is greater inequality both in incomes and in the quality of public services across USA jurisdictions. Moving to Europe, Malgouyres (2014) and Dippel, Gold and Heblich (2015) focus on French and German regions and show that these countries have seen larger increases in vote shares for extreme-right parties. In the same vein, Colantone and Stanig (2016) find that localities in Britain that were more exposed to trade with China voted more strongly in favour of leaving the EU. The recent literature (Dal Bo and Dal Bo, 2011; Dube and Vargas, 2011; Ghosh and Robertson, 2012) studying the impact of trade on expropriations can be

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considered related to politics. These papers raise interesting issues regarding the effects of trade on crime as perhaps the most pervasive form of expropriation. In particular, they suggest the possibility that the effects of trade liberalisation on expropriative activity will differ between developed and developing economies. More recently, Ghosh, Robertson and Robitaille (2016) examine whether trade liberalisation has affected the rate of crime and find that trade liberalisation may be positive or negative on crime depending on whether a country is labour or capital-abundant.

The argument is even more sensitive if we also consider labour mobility. Foreign workers may undercut the quality of public institutions in the host countries by eroding trust and social cooperation if public-goods provision at the level of countries or communities is negatively correlated with measures of ethnic, linguistic or cultural heterogeneity – especially if the numbers involved are large. This posits that low productivity is something that spreads from poor countries to rich countries via cultures and institutions carried by migrants, like disease or pollution (Algan and Cahuc, 2014). However, Clemens and Pritchett (2016) propose an empirical assessment showing that dynamically efficient policy would not imply open borders but would imply relaxations on current restrictions.

3.2. Counterfactual gains

New(-new) trade theory and quantitative trade models

Benedictis, De Filippis and Salvatici (1991) surveyed the contributions to the literature on international economics and trade policies in order to identify analytical approaches that are potentially useful for the task faced by agricultural economists. At the time, the essence of the exercise conducted by the models labelled 'new international economics' was to replace, within general equilibrium models, the assumption of perfect competition, constant returns to scale and homogeneous products with the assumption of imperfect competition, increasing returns and heterogeneous products (Krugman, 1987).

Gains from trade associated with the new international economics are due to the increase in the number of varieties available to consumers as well as exploitation of the economies of scale. However, assuming that all firms have the same likelihood of exporting, these models are unable to explain the presence and impact of firms in the global economy according to the following stylised facts:

1. Very few firms export, even in export-oriented industries.
2. Exporting firms are different from non-exporting firms in all sectors.
3. There is heterogeneity even within exporting firms: a few, very successful exporting firms account for most exports.

The 'new(-new)' trade literature (Bernard *et al.*, 2003; Melitz, 2003) developed the micro-foundations of firm behaviour in an international context maintaining the assumption of monopolistic competition and appealing to probability distributions (mostly Pareto or log-normal) that represent

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heterogeneity in the costs of production to describe how firms select into exporting, and aggregate the decisions of firms into country-level trade flows. Whereas in previous models, trade liberalisation would affect only the intensive margin (that is, through the production choices of a fixed number of exporters), lower variable and fixed export costs draw in firms on the margin to export. The changes in the set of firms serving a country since trade liberalisation suggest an additional channel for welfare gains from trade since average productivity by causing the least productive firms to shut down.

The emergence of detailed data sets on plants and firms in a number of countries played a pivotal role in the refocusing of the international trade literature on firm heterogeneity. This has prompted a number of empirical studies that show that import penetration in both final products and intermediate inputs systematically contributes to firm-level productivity growth. These findings also seem to be confirmed for food firms (Olper, Curzi and Raimondi, 2015) though more evidence would be welcome.

Combining assumptions regarding the functional form of trade costs with those for preferences and production technology generates predictions for bilateral trade. The most recent gains from trade literature (Arkolakis, Costinot and Rodriguez-Clare, 2012) show that in the vast class of trade models that satisfy a 'gravity equation',[10] the welfare gains from trade can be computed using only the open economy domestic trade share and the elasticity of trade with respect to variable trade costs. This does not imply, however, that different models necessarily yield the same predictions on the counterfactual changes in expenditure shares caused by any given policy experiment. Neither does it imply that the strong equivalence survives the introduction of additional real-world features such as multiple sectors, tradable intermediate goods and multiple factors of production or assumed firm productivity distributions (Melitz and Redding, 2015).

Elasticity estimation is the Achilles' heel of quantitative trade policy analyses, since most results critically depend on these estimates. A recent (but rapidly growing) literature estimates trade elasticity using firm-level data (e.g. Berthou and Fontagné, 2016). It is also worth mentioning for policy implications that tariffs can be used as a direct price shifter to identify an estimate of the elasticity of substitution among varieties (Cipollina, Laborde and Salvatici, 2017). Moreover, trade elasticities are associated with different structural parameters in different models and this should not be forgotten when arguing that different models are actually isomorphic in terms of their quantitative predictions. For instance, in the Eaton–Kortum model and the Melitz model, trade elasticity will generally depend not only on demand, through the elasticity of substitution governing the intensive margin, but also on supply parameters, governing the extensive margin through productivity dispersion across firms.

10 These models include the Armington-constant elasticity of substitution gravity model of Anderson (1979), the monopolistic competition models of Krugman (1987), the multicountry Ricardian model of Eaton and Kortum (2002) and the heterogeneous firm framework of Melitz (2003).

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Modelling the markets affected by trade policy reform is a sub-field of economics that has become increasingly sophisticated as the power of computing has grown. This in turn has led to a flurry of model building to provide ex ante estimates of the effects of reducing agricultural protectionism, and since agricultural reform was being negotiated in the Uruguay Round alongside trade policy reforms in other sectors, economy-wide models were needed to capture the combined impacts on national and global welfare. Applied general equilibrium (AGE) models, which feature multiple countries or regions, multiple sectors and input–output linkages across sectors in a Walrasian general equilibrium framework, have been the dominant tool for evaluating the impact of trade liberalisation since the 1980s (Hertel *et al.*, 2007).

A distinguishing feature of AGE models is their focus on the input–output structure of economies. Moreover, taking the input–output structure into account is essential for understanding the nature and impact of trade flows since trade in intermediate goods makes up a large fraction of international trade. As mentioned in Section 2.3, the impact of tariffs and other trade barriers is amplified when there is trade in intermediate goods since the trade costs apply both directly to trade in final goods as well as indirectly through their embodied impact on intermediate goods.

While AGE models have retained their prominence in policy work, the theoretical advancement of AGE models has slowed significantly as the academic trade literature has shifted its attention to firm-level data and models that focus on them. After a country undergoes trade liberalisation, a large number of firms start exporting, and a large number of firms shut down production: incorporating such an 'extensive margin' in AGE models would certainly improve their predictive ability (Kehoe, Pujolàs and Rossbach, 2016).

Some progress has been made in understanding how changes in the extensive margin can be mapped into elasticities that allow AGE models to capture these effects. Dixon, Jerie and Rimmer (2016) find that Melitz results computed with a given value of the inter-variety substitution elasticity can be closely approximated in an Armington model built with the same data but with a greater inter-country substitution elasticity value. However, tinkering with standard CGE elasticities to 'simulate' firms heterogeneity lacks consistency.

There is scope to properly integrate recent advances from the theoretical and econometric literature through the so-called NQTMs. Tighter connection between data and theory allows the model to be used to estimate the key structural parameters necessary for counterfactual analysis (assuming, of course, that the structural fundamentals are stable and invariant to the analysed policy interventions) instead of relying on off-the-shelf elasticities. Even if NQTMs provide a sound basis to undertake counterfactuals for policy interventions, they still require calibration where the values of the theoretical parameters need to be set so that the model matches some key moments of the data. This raises the issues of which overidentification checks can be undertaken using moments not used in the calibration or estimation to provide a check on the validity of the model's simulations (Ottaviano, 2014).

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The cost of enriching theoretical models to connect more closely to the data is typically a loss of analytical tractability: 'NQTMs put more emphasis on transparency and less emphasis on realism' (Costinot and Rodriguez-Clare, 2014). However, with the development of tractable quantitative models and efficient computational methods, researchers have become able to handle multiple disaggregated sectors as well as incorporate the production of intermediate goods as in Caliendo *et al.* (2015). NQTMs have thus the potential of being used to supplement traditional AGE analysis thanks to the tight connection between theory and data, appealing micro-theoretical foundations, and enhanced attention to the estimation of structural parameters.

Moving from a positive to a normative point of view, Costinot, Donaldson and Smith (2016) find that optimal import taxes discriminate against the most profitable foreign exporters whereas optimal export taxes are uniform across domestic exporters. On the other hand, if governments are not allowed to impose different taxes on different firms, the selection of heterogeneous firms into exporting tends to dampen the incentives for terms-of-trade manipulation, and in turn, the overall level of trade protection.

A few recent applications of NQTM based on agricultural data are worth mentioning. Tombe (2015) moves from the observation that agricultural trade in poor countries is small and costly, whereas agricultural labour productivity differences are an order of magnitude greater than non-agricultural. With a quantitative multicountry model featuring non-homothetic preferences, multiple interrelated sectors, distorted labour markets and costly trade, he shows that trade costs significantly lower welfare and productivity in poor countries by protecting inefficient domestic producers or crop varieties and increasing agricultural employment to meet subsistence requirements. Overall, agricultural trade costs (where tariffs and border delays play a significant role) account for one-quarter of the aggregate productivity difference between rich and poor countries; trade costs in all sectors account for over two-fifths.

Sotelo (2015) develops a model that relates agricultural incomes and productivity to trade and specialisation and uses it to calculate the equilibrium effect of large-scale infrastructure policies, such as paving existing roads. Using a new data set on Peruvian agriculture, which includes disaggregated information on crop prices, yields and land allocations, he shows that barriers to market access have a negative effect on farmers' productivity but a large-scale infrastructure policy generates winners and losers if crops are substitutable and there are barriers to the movements of factors.

The same approach has been used to simulate non-policy shocks: Costinot, Donaldson and Smith (2016), using a model of trade among 1.7 million fields covering the surface of the earth, find that the impact of climate change on these agricultural markets would amount to a 0.26 per cent reduction in global GDP when trade and production patterns are allowed to adjust but international trade may play only a minor role in alleviating the consequences of climate change.

Finally, agriculture, 'a sector of the economy in which scientific knowledge of how essential inputs such as water, soil and climatic conditions map into

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outputs is uniquely well understood' (Costinot and Donaldson, 2016, p. 1), provides the opportunity to improve on the standard approach to estimating the gains from trade which requires comparing actual data to counterfactual choices simulated through the use of functional form assumptions. Agricultural data allow an alternative empirical strategy that does not rely on identification by functional form since agronomists are able to predict how productive a 'field' would be were it to be used to grow any one of a set of crops. Costinot and Donaldson (2012) use novel agricultural data that describe the productivity in 17 crops of 1.6 million parcels of land in 55 countries around the world to show that the output levels predicted by Ricardo's theory of comparative advantage agree reasonably well with actual data on worldwide agricultural production. In the same vein, Costinot and Donaldson (2016) using a data set consisting of approximately 2,600 USA counties – treated as separate local markets that may be segmented by barriers to trade analogously to countries in a standard trade model – find that the growth of USA agriculture from 1880 to 1997 appears to have been driven in roughly equal parts by improvements in agricultural technology within locations and by economic integration across locations.

Trade policy simulations

During the Uruguay Round, massive computer modelling exercises showed that a new trade deal could yield hundreds of billions of dollars in benefits, much of it going to developing countries. Even in 2003, World Bank economists estimated that an agreement to reduce tariffs could increase global income by as much as $520 billion (Ackerman and Gallagher, 2008). The most recent contributions, though, make significantly smaller estimates of the benefits of liberalisation of merchandise trade. According to Ossa (2016), further tariff negotiations could bring about gains of approximately $40 billion while the USA International Trade Commission projects that output in the agricultural sector will be 0.5 per cent higher in 2032 than in the baseline as a result of the Trans-Pacific Partnership, equivalent to just 3 months of projected growth (Baker, 2016).

The shrinking gains associated with tariff liberalisation have led economists (and policy makers) to state that the real gains go far beyond tariff reduction effects. This convinced modellers to broaden the discussion to include other categories of trade costs whose reduction could bring additional benefits. Because of this decline in tariffs, quantitative trade models have moved away from using tariffs as the object of policy reform and turned towards non-tariff measures (NTMs). Unfortunately, NTM pose particular difficulties to quantitative modelling, traditionally more comfortable with policies directly affecting prices.

We may want to assess the state of the art regarding NTM impact assessment in terms of explicit policy modelling, that is, the possibility to exogenously fix model variables in the same way as they are actually fixed by the

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policy-makers (Anania *et al.*, 2001). However, we would have to acknowledge that is almost never the case. As a consequence, we need to resort to indirect policy modelling based on model-equivalent representations of the policy of interest. Whether these representations are close enough to the actual policy changes is in the eye of the beholder (Cipollina and Salvatici, 2008).

Looking for big numbers from liberalisation, it may be better to focus on factors rather than goods movements: migration, for instance, need not be that large to bring vast gains. Existing estimates suggest that even small reductions in the barriers to labour mobility bring enormous gains: the emigration of less than 5 per cent of the population in poor regions would bring global gains exceeding the gains from total elimination of all policy barriers to merchandise trade and all barriers to capital flows (Clemson, 2011). Rodrik (2016) points out that the 'USA place premium' (i.e. the income gains that would hypothetically accrue to a worker that moved there) for a Pakistani worker is estimated to be around 500 per cent and reminds us that 'if trade deals were strictly about efficiency and growing the size of the overall economic pie, trade negotiators would drop everything else on their agenda and spend their whole time trying to strike a bargain whereby workers from poor countries could participate in the labour markets of the rich countries' (page 7).

Typically, modellers evaluate costs and benefits of an agreement by comparing a counterfactual scenario, which includes the trade policy changes, with a baseline. A lot of emphasis is (obviously) put on modelling the agreement provisions while less attention is given to the assumptions made about what is expected to happen if the agreement does not materialise. Traditional evaluation compares the consequences of liberalisation to the status quo. Therefore, the cost of a failure of the negotiations is just an opportunity cost: the unrealised gains. However, this approach may underestimate what is at stake. A 'business-as-usual' baseline, where nothing happens except for some exogenous drivers in terms of assumed growth for macro and demographic variables, is not necessarily the most realistic one: the status quo is not a long-term perspective for trade policies. Moreover, the same agreement could have very different impacts according to the environment where it takes place: postponing the implementation of the agreement could lead to larger benefits for one or both partners and this implies a (sort of) 'option value'. On the other hand, it could lead to lower benefits and this 'cost of waiting' could also significantly reduce the incentive to sign the agreement for one or both partners.

Using a global CGE model, Bouët and Laborde (2010) find that in a scenario where applied tariffs of major economies would go up all the way to currently bound tariff rates, world trade would decrease by 7.7 per cent: these increases in duties would reduce world welfare by USD353 billion and would particularly impact agricultural exports (−6.9 per cent), especially for developing countries (−11.5 per cent). Unfortunately, the threat that countries may want to reverse past liberalisation moves is becoming more prominent after Brexit and the 2016 USA Presidential election: the demand for studies

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assessing the costs of protection rather than the benefits from liberalisation is likely to increase in the near future.

Interpretation and communication of model outcomes is a very delicate issue. Sharp differences among the results of simulations resulting from the same policy experiment usually raise questions about the usefulness of modelling exercises. However, the litmus test of the scientific discourse is the capability to explain where different results come from rather than the homogeneity of outcomes.

Common criticisms of simulation results refer to the poor track record in projecting the patterns of trade following past agreements. This history confirms that the impact of factors not included in the model is quite significant. However, the excluded factors would be difficult to model and, in any case, the goal of economic models is not to provide accurate forecasts but counterfactual, *ceteris paribus*, analysis. In this respect, it should not be forgotten that our models can be used to simulate drastically alternative scenarios in addition to (more or less) realistic negotiation outcomes. For instance, Antimiani *et al.* (2013) use the GTAP-E (AGE) model to compute the tariff needed to keep emissions constant. The striking result is that a carbon tariff imposed by the Kyoto agreement Annex 1 countries that completely eliminates carbon leakage does not exist since no import tax can intervene on the increase in Non-Annex countries domestic demand. Another example is provided by the use of a global AGE model to address the question of whether bilateral agreements engender forces that encourage or discourage evolution toward globally freer trade. Antimiani and Salvatici (2015) simulate the impact of several possible bilateral EU agreements and compare the outcomes with a scenario including all bilateral agreements as well as a benchmark global free trade scenario. In the same vein, Waugh and Ravikumar (2016) quantify potential gains from trade (i.e. how much each country can gain by moving from a current world with trade costs to a free trade world) showing that the welfare cost of autarky is similar across countries, but poor countries have greater potential gains from trade.

Finally, the extent of the impact found by economic analyses is dependent on the design of the models. Empirical research has mostly ignored the macroeconomic effects of liberalisation assuming that knowing how trade affects efficiency is sufficient to know how it affects national income. For example, employment-related questions cannot even be asked based on the assumption that the total number of jobs in each country is not changed by trade policy (for an example of modelling with variable employment, see Taylor and von Arnim, 2006). Moreover, in many AGE models, aggregate trade imbalances are imposed as an exogenous parameter to match observed aggregate trade imbalances.[11] On the other hand, following Arkolakis, Costinot and Rodriguez-Clare (2012), in NQTM, purging data from trade

11 It is important to note that while trade imbalances are exogenously imposed, the sectoral and bilateral composition of these trade imbalances arises endogenously.

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imbalances is becoming a standard practice (Costinot and Rodriguez-Clare, 2014). It seems clear that both choices are far from satisfactory.

4. Conclusions

Globalisation is currently under political siege and the benefits of globalisation are now questioned by a growing share of the population which is no longer limited to the small fringe that opposed trade negotiations in Seattle in 1999. Considering Britain's referendum vote to leave the world's biggest trade bloc, the demise of the WTO's Doha Development Round, and growing opposition to regional deals, the increasingly fraught politics of trade becomes apparent.

At the same time, since the beginning of the century, we have been dealing with a new economic landscape characterised by a financial and economic crisis, the rise of emerging economies and the spread of world supply chains. In this work, we have analysed some of the changes that have directly affected the international trading system. Given the scope of the analysis, it was impossible to review and give credit to all related work. However, we have tried to acknowledge the main contributions that have left significant marks on the development of the literature.

We first focused our attention on the link between GVCs and international trade and the relevance of trade in value added for the agri-food sectors (Section 2.1). We then dealt with positive and normative implications due to the (further) integration of the international trading system. As far as the former is concerned, we took into account new tools that can be effectively used to investigate the increasing interdependence of countries and sector at global level such as network analysis (Section 2.2). From a normative point of view, we tackled the implications of the systemic nature of world trade on bilateral preferential policies (Section 2.3).

The increasing and widespread discontent with international trade has led economists if not to review their position regarding the gains from trade, certainly to be more upfront about the downside of trade and to give more attention to the fact that while free-trade deals enrich countries in general, downsides can be severe for industries and regions that lose out. In Section 3.1, we reviewed the literature dealing with the adjustment costs in terms of unemployment, wages, inequality, health, food security, poverty and vulnerability, and political stability. Results confirm that we need policies to redistribute international trade benefits. This is easier said than done since even offering bigger (and better) safety nets may not be enough: people do not want (only) a monetary compensation, they want jobs, decent wages, health and safety, and food security.

Finally, in Section 3.2, we first reviewed the most recent developments in trade theory. Firm decisions to entry into foreign markets can have meaningful impacts on trade and welfare, in ways not captured hitherto in many previous-generation trade models. We addressed the large ongoing efforts to move the discussion from high theory to empirically grounded and policy relevant analysis. In this respect, our message is: 'Don't take applied models

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too seriously'. In practice, this means 'Simulate, don't forecast'. A forecast involves predicting the future values of the endogenous variables in the model, making assumptions on the likely evolution of all its exogenous variables, and we already know that we cannot (exactly) predict all of them. Simulations concern, instead, hypothetical counterfactual scenarios whose investigation is not necessarily wedded to a particular view about the likelihood of the exogenous variables changing in a certain way, and we contend that there is a lot to learn from these exercises.

The international dimension is still (very much) relevant for our profession in a very different environment for international trade in agricultural products compared with the last century. Global trade in food is exposed to multiple and varied disruptive risks due to the use and expansion of biofuels, massive foreign investments in agricultural land, commodity market price volatility while resource constraints and climate change are not only threatening production in the world's breadbasket regions, but are causing many countries around the world to become increasingly dependent on imports of staple commodities such as wheat, coarse grains and rice.

Even if trade policy instruments are no longer intrinsically linked to agricultural policies (as in the case of the traditional CAP), they do provide support to the sector and play a crucial role in influencing world agricultural markets. Moreover, it should not be forgotten that the space for domestic policies has been constrained by international commitments and domestic agricultural policies reforms have to comply with multilateral and bilateral trade agreements. Thus, we do believe that international trade still provides an exciting area for future research and that agricultural economists who work in this field should expect to find a large audience interested in the policy implications of their work.

First, thanks to the easier accessibility of policy data sets (e.g. http://wits.worldbank.org/Default.aspx?lang=en) and to the higher computing power needed to process them, there has been a surge of empirical works studying ex post the implications of firm heterogeneity and trade in value added for the sources and the patterns of trade networks. In this respect, we have provided several examples of impact evaluations using a range of methods from traditional tools, such as the gravity model, to quasi-experimental methods, such as generalised propensity score matching and synthetic control. Though agricultural trade interventions have so far mostly escaped the rising tide of evaluation methods, we share the view that there are many impact evaluation techniques which are sufficiently flexible for use even in the case of trade policies that are not targeted at a defined group of treated individuals (Cadot *et al.*, 2011). We are confident that systematically building impact evaluation into trade policies analysis could lead to better policy design and to a more credible case for freer trade.

Second, thanks again to higher computing power, the calibration and the simulation of statistical models have been increasingly used to investigate ex ante the implications of trade policies in counterfactual scenarios for which data are necessarily unavailable. In this perspective, NQTMs have the

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potential of being used to supplement traditional AGE analysis thanks to the tighter connection between theory and data, their appealing micro-theoretical foundations, and their enhanced attention to the estimation of structural parameters.

Blind faith in globalisation led many (including economists) to overhype it, creating impossible expectations for trade liberalisation. As a result, a backlash against further trade and trade liberalisation is crystallising in a number of advanced economies. Fighting protectionism needs stories, not just data. Economists cannot bore or scare people to death with pie-charts and statistics.

Nonetheless, information on the current impacts of policies remains a critical input in trade policy debates and helps demonstrate that further efforts are still worthwhile. Common calculations or common acceptance of certain technical facts is a necessary though not sufficient condition for a healthy public debate. If agricultural economists want to maintain the role of providing fact-based input into policy debates, we should work on providing more compelling analyses about how trade liberalisation works. Better theoretical and applied models as well as more accurate and comprehensive data will allow for evidence-based policy analysis and provide us greater credibility as honest brokers in this heated debate.

The challenge is to make the best use of new data and models in order to improve the performance of our analyses in accounting for changes in agricultural and food trade patterns after changes in trade policy. Our final piece of advice is 'Don't treat trade policies too casually'. In practice this means: 'Work hard to make a clear and close link between the policies and the model.' This is crucial if our results are to have any hope of a significant impact. More importantly, this is feasible as pointed out by Giovanni a few years ago: 'a great many of the possible solutions to the outstanding problems are already available: it is "merely" a question of using them… Thus, as far as the future of modelling international agricultural markets and trade policies is concerned, we can look forward with reasonable, yet cautious, optimism' (Anania, 2001, p. 30). The navigation around protectionism and free trade continues.

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