Chapter 1

INTRODUCTION

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1.1 Motivation

Two mega trends have shaped world markets during the past quarter century. One is globalisation the other is the rapid spread of digital information and communication technologies (ICT).

Globalisation is a worldwide phenomenon which emerged from the increasingly intensive interactions of cultures, countries, markets, organisations, and people, all embedded in a common global natural environment [Leamer 2007]. There is wide agreement that the intensification of international trade has been one of the key drivers of the current era of globalisation [Bhagwati 2004, Leamer 2007, Wolf 2004]. World trade, in turn, was stimulated by decreasing tariffs, as well as falling transport and transaction costs. The reductions in transport and transaction costs both were induced by significant technology changes, the container revolution has reduced transport cost, and information technology and the modern supply chain have reduced transaction cost. Taken together, these changes have led to unpredicted growth in world trade which, according to UN Comtrade more than doubled from 6.5 trillion US$ in 2000 to 16.2 trillion US$ in 2008 [UN Comtrade 2012].

During the current era of globalisation, which began sometime around the beginning of the third quarter of the last century [Martell 2007], digital communication technology has changed dramatically. Whereas the telephone and telex machines dominated long distance communication in the 1970s, email on the internet, the web, and now the smartphone have revolutionised long distance communication. The organisation and coordination of global supply chains is unthinkable without the use of modern digital information and communication technologies.

Although globalisation and the spread of digital IT may be regarded as separate issues, they may actually be interlinked. In particular, we may ask whether ICT

has encouraged globalisation, just as globalisation has encouraged the rapid spread of ICT. An obvious link between the two mega trends may be international trade and a small batch of empirical studies has investigated the impact of ICT on international trade. The main results of these studies, which will be reviewed in a later section in more detail, are: (i) ICT-diffusion stimulates a country's exports; (ii) the export-stimulating impact is larger for heterogeneous than for homogenous goods; (iii) the internet stimulates exports from developing countries but not from developed countries; (iv) mobile phones stimulate international trade in all countries, (v) there is no consensus among the studies on the differences in impact of ICT on imports and exports.

This study analyses the impact of different information and communication technologies on international trade using the example of agricultural and food products, or agri-food products for short. This group of products which comprises products or product groups used for agricultural, or horticultural purposes as well as groceries was chosen because of their specific characteristics compared with other industrial goods, such as perishability, seasonality and heterogeneity. Moreover, the countries involved in international trade in agri-food products are diverse and we can expect large differences in ICT penetration.

The main research question is:

- What impact does ICT have on the trade value of internationally traded agri-food products?

This question can be split into:

- What impact do specific ICT elements - mobile phones, fixed-line phones and internet - have on the trade value of international traded agri-food products?
- Does the impact of ICT on trade depend on specific agri-food products?

For the empirical analysis twenty different agri-food products or product groups have been selected. Based on criteria suggested by Rauch (1999) all twenty agri-food products were classified into homogeneous and heterogeneous ones. In addition, agri-food products were distinguished between primary bulk commodities, produce and horticulture, and processed goods using criteria proposed by Regmi et al. (2005).

Gravity models are the 'work horses' for empirical trade analyses [Rauch 1999]. They have become standard tools of trade analysis and they are known to provide robust results. For that reason, gravity models have also been used in this study. Gravity models explain the value or volume of trade between two countries as a function of the 'economic mass', in whatever way measured, and the distance between those countries. Usually, gravity models also include explanatory variable other than size and distance, such as whether or not the countries are sharing a common border or a common history. Some of such variables are also included in our gravity models. More importantly, however, we include in our gravity models variables that represent the penetration of ICT in the countries. Thus, our gravity models allow for testing the impact of ICT on international trade in agri-food products.

Even though they are a well-established, standard method of trade analysis the details of empirically estimating gravity models are still debated. Earlier studies estimate the parameters of gravity models with ordinary least squares (OLS) methods. Due to estimation problems with zero-trade values in the OLS approach, Santos Silva and Tenreyo (2006) have suggested the use of Poisson regression models instead of double-log models. After some criticism of Poisson regression estimation, Burger et al. (2009) suggested to use binomial models instead of Poisson or OLS regression for the estimation of gravity models. This study does not aspire to contribute to the development of estimation methods for gravity models. Rather, proven methods discussed in the research literature are applied for empirically estimating the influence of ICT on agri-food trade.

The empirical analysis uses panel data from 1995 to 2009, compiled by different data sources, mainly UN Comtrade, the World Bank, and the International Telecommunication Union (ITU).

The study includes a quality check of UN Comtrade's trade data. The quality of export trade data were tested with Benford's law. The test examines whether the frequency distribution of the first digit in a data set differs from the theoretical distribution given by Benford's law. Testing the quality of data provided by well-established statistical organisation is not common practice. However, as the costs of conducting quality checks have rapidly decreased with the progress of computers and databases, we felt that the benefits of avoiding the risk of the rubbish-in rubbish-out syndrome may be well worth the additional effort.

1.2 Outline of the dissertation

The dissertation is composed of seven main chapters. Chapter 2 summarises the context of international trade in agri-food products - globalisation, trade and ICT. Chapter 2 closes with an overview of the usage and penetration rates of fixed and mobile telephones and the internet.

Chapter 3 specifies gravity models for empirical bilateral trade analysis. The basic principles and the main steps in the development of the microeconomic foundation of gravity models are presented. Moreover, the connections between gravity models and the well-established trade theories of Ricardo, Heckscher-Ohlin and the New Trade Theories are discussed. The chapter closes with a review of applied gravity models of agri-food products, the influence of ICT on trade, and of studies which analyse this impact.

Chapter 4 is concerned with the selection and description of the variables and countries that we have included in our gravity models. The chapter starts with the selection of agri-food products and their classification into heterogeneous and homogenous goods according to criteria suggested by Rauch (1999) and their classification into processing categories according to Regmi et al. (2005). For each of the selected products we also report trends in their world markets. We then present our selection of countries and we introduce explanatory variables of our gravity models. The country variables are of two kinds: country characteristics of individual countries, such as economic mass, population size, ICT variables, or being a landlocked country, and country pair characteristics, such as having a common border, a common language, or simply the distance between two countries.

Panel data analysis and estimation methods are introduced in chapter 5. The Hausman test is presented which is used to choose the appropriate model of fixed effects (FE) models or random effects (RE) models. The well-established log-log estimation specification is discussed together with newer estimation specifications, such as the Poisson regression and the negative binomial regression, which have been introduced to overcome estimation problems associated with zero-trade values.

Prior to the estimation of the gravity models, a quality check of the trade data based on Benford's law has been performed. Results of the quality check are

reported in Chapter 6 where we also report all other test and estimation results. The discussion of results and the research approach follows in Chapter 7. English and German summaries complete this dissertation.

Chapter 2

GLOBALISATION, TRADE AND ICT

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2.1 Aspects of globalisation

Globalisation is a phenomenon which emerged from the increasingly intensive interactions of markets, cultures, governments, organisations, and people, all embedded in a common global natural environment [Leamer 2007]. Evidence of globalisation are increasing foreign direct investments, global financial markets, increase in global business corporations, increased amount of multinational enterprises but also international capital transfer, worldwide trade, international passenger transportation and cross-border communications.

In the following the term globalisation is defined, eras of globalisation are introduced and important drivers of globalisation, especially reduced trade costs, are discussed.

2.1.1 Globalisation defined

Globalisation is a widely used popular term, which includes several aspects and which has been defined in various ways. The Organisation for Economic Co-operation and Development (OECD) defines globalisation as "*the increased flow of knowledge, resources, goods and services among nations*" [OECD 2010]. Leamer (2007) defines globalisation as follows: "*Globalization is the increased international mobility of goods, people, contracts (including financial claims) and thoughts (facts, ideas, and beliefs).*" According to Hummels (2007) globalisation "*refers to increases in the degree of integration between national economies. Integration encompasses all of the ways national economies are connected in international markets, including trade in goods, services and ideas; international movements of the factors of production; and coordination of public policies.*" [Hummels 2007].

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All these three definitions of globalisation include the aspect of trade of goods. Romano (2006) amplifies in his definition of globalisation the trade aspect as "*the extension of the market and its deepening as a result of reduction of the transaction costs of trading internationally*". This dissertation is focused of trade as a central aspect of globalisation in particular, it concentrates on agri-food trade. Other aspects of globalisation, such as culture, capital transfers, or international travel and migration are ignored in this study.

The contribution to globalisation of individual components of international trade costs is a topic of active discussion. Some authors, such as Bhagwati (2004), argue that liberalisation policies are the most important drivers for globalisation. Others emphasise the relevance of progress in transportation [e.g. Hummels 2007]. Almost all authors who are concerned with economic globalisation, however, highlight the contributions of IT and communication on globalisation [e.g. Cairncross 1997, Romano 2006, von Braun and Diaz Bonilla 2008]. The role of IT and globalisation is described in more detail in section 2.3.

2.1.2 Waves of globalisation

Some studies, which are dealing with globalisation identify different waves or eras of globalisation. WTO (2009) distinguishes between two waves of globalisation. A third wave is occasionally discussed for instance by Martell (2007)[1]. Only few of the studies give a clear time line about the beginning and the end of the different globalisation waves [Baldwin and Martin 1999, Martell 2007, WTO 2009].

In broad terms the first wave of globalisation was mainly technology driven and was more or less coextensive with the rise of industrialisation. During the second wave political issues such as trade liberalisation, decolonisation and decreasing tariffs boosted international trade and globalisation. The appearance and spreading of digital information technology, in particular the internet and its associated technologies, and their use for international communication heralded the current wave of globalisation [Baldwin and Martin 1999, Hummels 2006,

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[1] For more detailed information about the three waves of globalisation in particular about method, economy, politics and history see: Martell 2007.

Hummels 2007, Martell 2007, WTO 2009] which began shortly before the turn of the millennium. This dissertation is concerned with the current wave of globalisation.

2.1.3 Intensified trade

Since the end of the Second World War various efforts have been made to reduce trade barriers, especially tariffs. These policies were first negotiated, coordinated and supervised under the auspices of the General Agreement on Tariffs and Trade (GATT) and later of the World Trade Organization [BMZ n. d, WTO GATT years n. d, WTO Who we are n. d.].

Trade liberalisation certainly has contributed towards the enormous growth of world trade during the past 20 year. In 1988 the value of all exports was 1.7 trillion US$; only 10 years later the value of world exports had grown more than threefold to 5.2 trillion US$ and another 10 years later, in 2008, world exports had again nearly tripled to reach 15.3 trillion US$. Due to the world financial crises the value of world exports have, however, decreased to 12 trillion US$ in 2009 [based on UN Comtrade data].

2.1.4 Reduced trade costs

Rising trade volumes on global markets can have several causes, for instance increased supply, increased demand or decreasing trade costs. Explanations of globalisation of world markets are mostly based on falling costs of international trade [e.g. Bhagwati 2004, WTO 2009]. Trade costs are defined here as the costs of transferring property in a good and the good itself from a seller to its buyer. In the context of international trade these costs include (i) trade policy related costs, such as tariffs and the costs for overcoming non-tariff trade barriers, (ii) transport costs which comprise freight expense and time costs, and (iii) transaction costs which are the costs of information and communication, contract enforcement, and costs of settling disputes. Some authors add local distribution costs as a fourth item to international trade costs [Anderson and van Wincoop 2004, Emlinger et al. 2008, WTO 2009]. We do, however, not include this item in our definition of trade costs.

Trade is believed to be stimulated by trade cost reductions of any kind, be it reductions in policy related costs, transport costs, or transactions costs and we

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highlight some trade cost reductions that have occurred during the current era of globalisation.

2.1.4.1   Transport costs

Transport costs fell rapidly during the last 50 years. Due to investments in transport infrastructure, better capacity use and technical progress, freight costs almost halved since the mid-1970s [World Bank 2009a p. 175].

Infrastructure investments and breakthroughs in transport technologies have caused transport costs to fall. Under certain conditions increases in trade volume that have been induced by lower transport costs may further lower transport costs because of economies of scale in the transport sector [World Bank 2009a p. 19]. A 10 percent increase in transport costs can reduce trade volume up to 20 percent. For intermediate goods a small change in transport costs has significant effects on trade flows [World Bank 2009a p. 171].

For instance, China and on a lower scale Chile strongly benefit from low transport costs [World Bank 2009a p. 185]. Transport costs fall faster in regions where the demand of transport service is high. Reduced transport costs attenuate some of the adverse effects of distance on trade and they may allow producers to realise economies of scale in production [World Bank 2009a p. 184].

2.1.4.1.1   Roads and railways

Road transport costs fell by about 40 percent over the last thirty years in spite of high energy and wage costs [World Bank 2009a p. 175]. Nevertheless, road transport costs vary among regions, quality of roads and charges for road use. The deregulation of the trucking industry, as it happened in the USA, lowered cost most, the next largest cost reducer being reduced vehicle costs. Railway transport costs fell less than road costs because of uneven technical progress across countries; moreover, state-owned railway enterprises were slow to reduce costs [World Bank 2009a pp. 175].

2.1.4.1.2   Shipping

One of the main contributors of declining shipping costs was the introduction of standardised containers [UNCTAD Secretariat 2010]. Standardised containers

save costs because loading and unloading of cargo other than oil and bulk cargo is done more efficiently and more quickly with containers. According to a World Bank report (2009a) loading loose cargo cost nearly 6 US$ per ton in 1956. After the introduction of containers, these loading costs fell to less than 0.20 US$ per ton [World Bank 2009a p. 179]. Changes in port logistics, institutional changes and technical progress enhance all kinds of ship transportation, be it tram or liner shipping. Ocean shipment rates differ by routes and commodities, which mainly reflect cost differences in harbor technologies, ship types and storage opportunities. For instance, prices for shipping a TEU-container from the USA to China cost about 400 US$ while the cost was 800 US$ for shipping a container to India and about 1300 US$ for shipping a container to Sierra Leone in 2007 [World Bank 2007 pp. 98]. In 2007, 18 million containers were used on nearly 200 million trips [World Bank 2009a p. 172]. Figure 1 shows the main global shipping routes and the largest container ports[2].
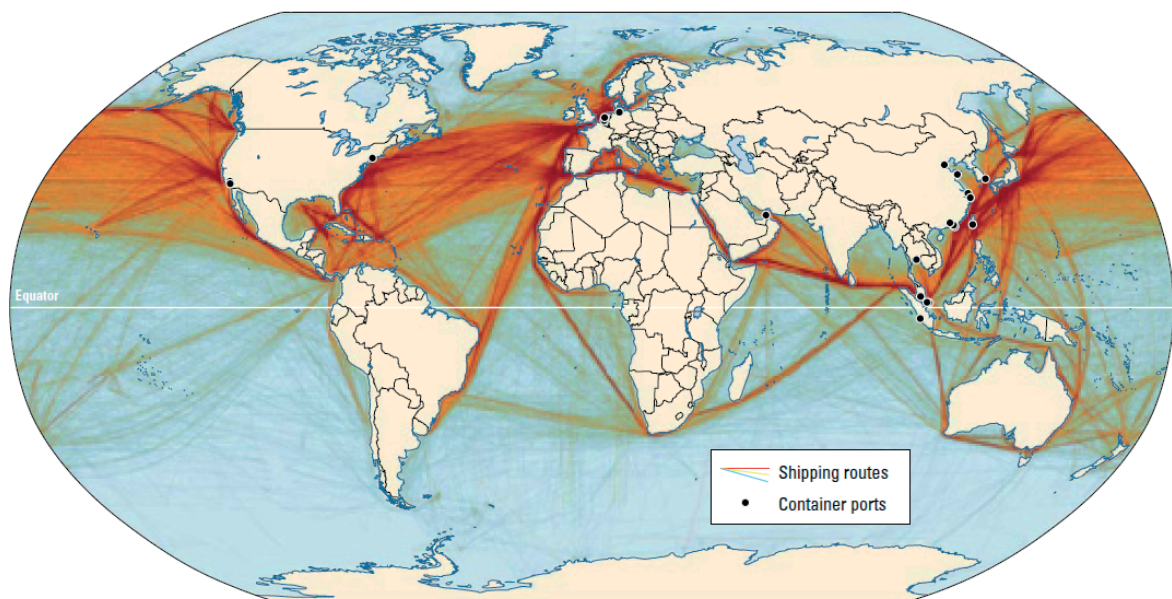

Figure 1: Intensity of shipping routes during Oct. 2004 to Sep. 2005

[World Bank 2009a p. 172]

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[2] see also: Table 4

Nevertheless, vessel capacity is limited by harbour infrastructure and by the width and depth of shipping lanes. For example, the depth of Suez Canal and the Straits of Malacca limit the size of passing ships [World Bank 2009a p. 178].

2.1.4.1.3 Air transport

Airplanes transport is much faster than transport via ships. After 1972 the technological process slowed. Prices for air transport had been fallen between 2 and 4 percent per annum between 1972 and 1983. Air transport costs were about 0.30 US$ per ton and kilometre in 2000. After 2001 prices rose slightly especially in the US because of higher security costs. In 2006 nearly 35 percent of the value of merchandise trade was shipped by air. Air transport is still reserved for high-value products, including high-value perishable agricultural and horticultural products or for products with extremely short product cycles, such as fashion items [World Bank 2009a p. 176].

2.1.4.2 Time costs of transport

As tariffs and transport costs decreased, time costs became more relevant in international trade [WTO 2009]. Time costs are the costs of transit time, including the time required for border processing procedures; and for also 'behind-the-border-elements' such as time required for complying with regulations and warehousing [World Bank 2009a p. 189]. Time costs vary between the means of transport and are affected by the infrastructure of the exporting and importing countries as well as by their level of bureaucracy.

Shipping a container by sea from Europe to the USA takes between 2 and 3 weeks, about 5 weeks from the USA to Asia, and less than one day for either trip if shipped as air-cargo [World Bank 2009a p. 179]. Time costs are mostly opportunity costs and therefore difficult to quantify. Nevertheless, some estimates have been provided. According to the World Bank (2009a) export enterprises are willing to pay one percent of a good's value per day to avoid time losses. Hummels (2007) suggests that each additional day which a merchandise good spends in transit is equivalent to a tariff rate of 0.8 percent. For obvious reasons, time costs may be substantially higher for perishable agri-food products [Hummels 2007] and for goods in highly integrated supply chains [WTO 2009 pp. 85].

There is substantial variation in the time it takes to move goods across borders. Moving goods across borders is particularly time consuming in Sub-Sahara Africa and in Central Asia where most of the countries are landlocked. The World Bank (2009a) reports time costs for crossing borders for OECD-countries of 10 days on average, but 89 days for Kazakhstan and for Zimbabwe. Twelve export documents are required when merchandise crosses borders in Kazakhstan and nine in Zimbabwe [World Bank 2009a p. 189].

This time costs of goods crossing borders are indicated in Figure 2 by the thickness of the border lines. The figure shows that borders in most African countries impose higher time costs on international trade than European and American countries. Only few countries such as China, Russia, Thailand and India with 'thick' borders belong to the main exporting countries of selected goods in this study.
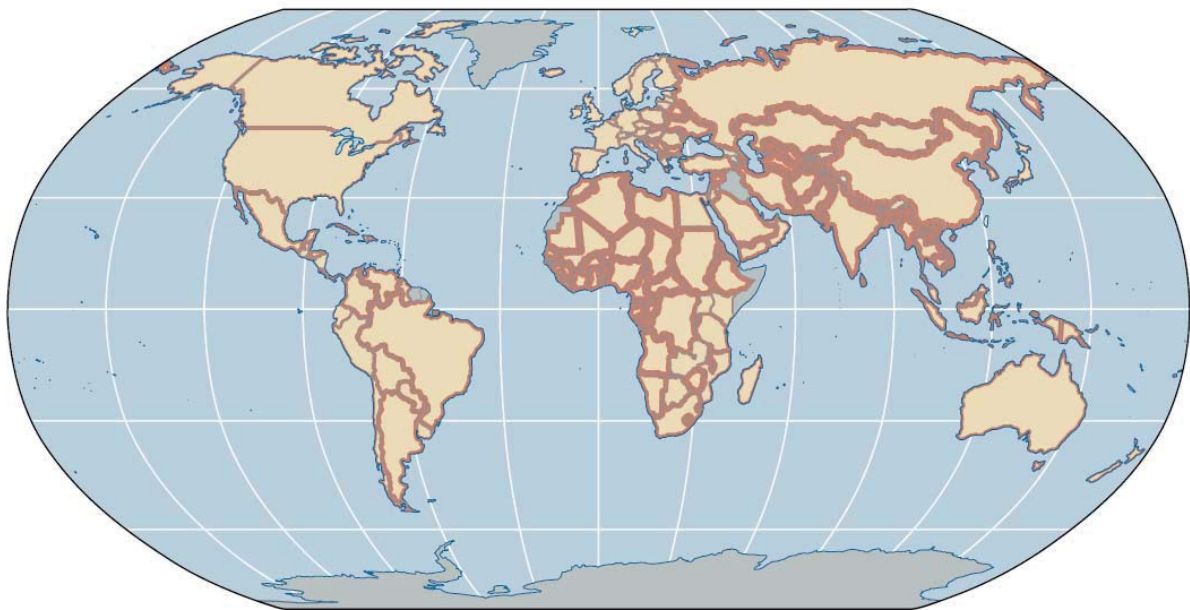

Figure 2: Thicker borders in developing regions

[World Bank 2009a p. 31]

2.1.4.3   Communication and information costs

Transaction costs are to a large degree communication and information costs [Dahlman 1979, Thiemann et al. 2012]. Communication costs have been falling

rapidly. The costs for a 3 minute call from New York City to London have fallen from 300 US$ for in 1931 to a few cents in 2004 (see: Figure 3) [World Bank 2009a p. 18].
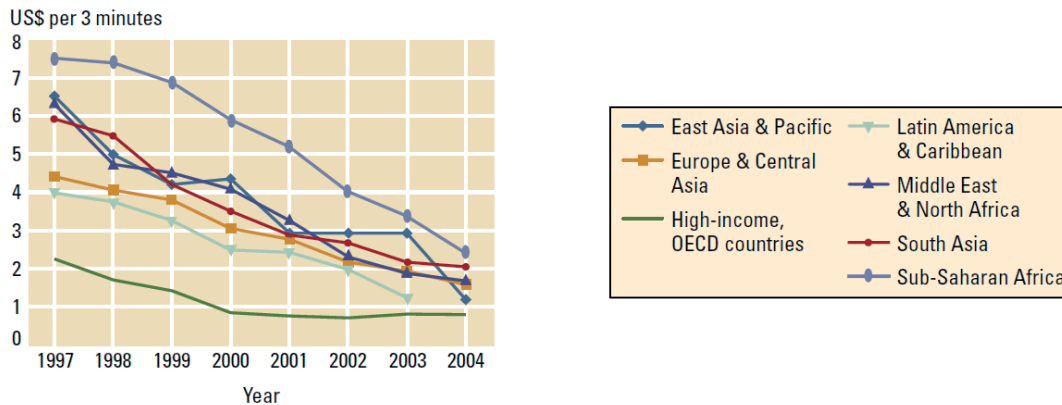

Figure 3: Development of average cost of a 3-min telephone call to the United States between 1997 and 2004

[World Bank 2009a p. 180]

Falling communication costs have contributed to moving some information-intensive activities, such as accounting or call centres to low-cost cities or countries [World Bank 2009a p. 180]. Agricultural production, however, is more location-bound and is therefore less affected by changing information and communication costs than information-processing activities.

Information and communication costs are likely to continue to fall in the foreseeable future because of exponentially falling costs of IT-capacities, computers and digital networks [Kurzweil 2005].

Furthermore, search costs are falling, too. Internet search machines like google simplify the acquisition of new trading partners and information. Search costs in general are supposed to be lower for homogeneous goods and higher for heterogeneous products because of less required information for homogeneous goods, which are traded on an organized exchange and good with a reference price [World Bank 2009a p. 180, Rauch 1999].

<u>Language barriers</u>

Language differences between countries are an obstacle to communication among traders, increase transaction costs, and may inhibit trade. Some language

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barriers are easier to overcome than others, for example when languages are similar like Spanish and Portuguese [Lohmann 2011]. A common language facilitates negotiations and may contribute to strengthening trust when traders can easily communicate with each other. English has contributed much towards lowering language barriers in international trade [Lazaro and Medalla 2004].

2.1.5 IT – a global general purpose technology

Digital information technology has found myriads of unforeseen applications; it has created new industries and profoundly transformed others. For these reasons it is regarded as a general purpose technology (GPT) on par with electricity [Jovanovic and Rousseau 2005]. As their name suggests, GPTs can be used for many purposes. Moreover, GPTs have a high potential for being combined with other technologies to create new technologies [Mokyr 2002]. When this happens, GPTs are used pervasively and the production of the GPT is on a large scale lowering cost of production, which further encourages the use of the GPT. We see the attributes in the evolution of digital computers which used to be extremely expensive specialised machines for number crunching and which have evolved into affordable personal digital assistants [Jovanovic and Rousseau 2005].

The significance of the information revolution for international trade is the dramatically decreasing costs of communication, processing, and storing information and knowledge. The impact of this cost reduction goes far beyond reducing transaction costs. These larger impacts, which include how knowledge is produced and shared [Mokyr 2002], are, however, beyond the scope of this dissertation.

2.1.6 New organisational forms

Globalisation has been associated with three important changes in international trade. First, because transport and transaction cost have considerably declined, the relevant geographic extension of markets has increased for buyers and sellers. This led to the phenomenon of 'global sourcing' [Werner 2010 p. 43]. Second, reduced communication cost allowed firms to implement more information intensive coordination mechanisms. This led to the phenomenon of the global supply chain [Delfmann 1998, Delfmann and Gehring 2003]. These chains often have developed into complex networks but the distinction between

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networks and chain is here unimportant [Mueller et al. 2007]. Finally, improved communication capabilities have allowed firms to acquire suppliers, buyers or competitors abroad, or to invest and manage subsidiaries in foreign countries [Delfmann 1998, Delfmann and Gehring 2003].

2.2 Agri-food trade and globalisation

This section provides an overview of current trends in global agri-food markets, in the organisation of these markets, the tariffs and non-tariff barriers in these markets, and the innovations that facilitate trade in agricultural and food products.

2.2.1 Trends in global agri-food markets

Reardon and Barrett (2000) have identified three important changes in the world economy: (i) globalisation and liberalisation, (ii) organisational and institutional changes, such as vertical coordination and changing property rights, and (iii) technological changes, e.g. transport, drying, storage, information. Von Braun and Díaz-Bonilla (2008) specify these trends with a perspective on global agri-food markets. They perceive (i) a changing environment of innovation and information, (ii) increasing commercialisation of small producers and (iii) consumer-driven agri-food systems. Moreover, they highlight the ICT revolution, especially the exponential increase in mobile phone penetration, and the role of ICT in global market integration.

Growth in international trade, the hallmark of globalisation, has also occurred on world markets for agricultural and food products. Between 1990 and 2002 world agricultural trade has grown approximately twice as fast as world agricultural production [Romano 2006]. Since 2000 the growth of foreign trade of agricultural products has accelerated. The imports of agricultural and food production rose worldwide from about 467 billion US$ in 2000 to about 916 billion US$ in 2007. This corresponds to a growth rate of approximately 10 percent per annum [BMELV 2008].

The intensity of world agricultural trade varies across the regions in the world. Developing countries tend to export and import smaller shares of their agricultural production and food consumption compared to richer, industrialised countries. Furthermore, significant differences among developing countries exist.