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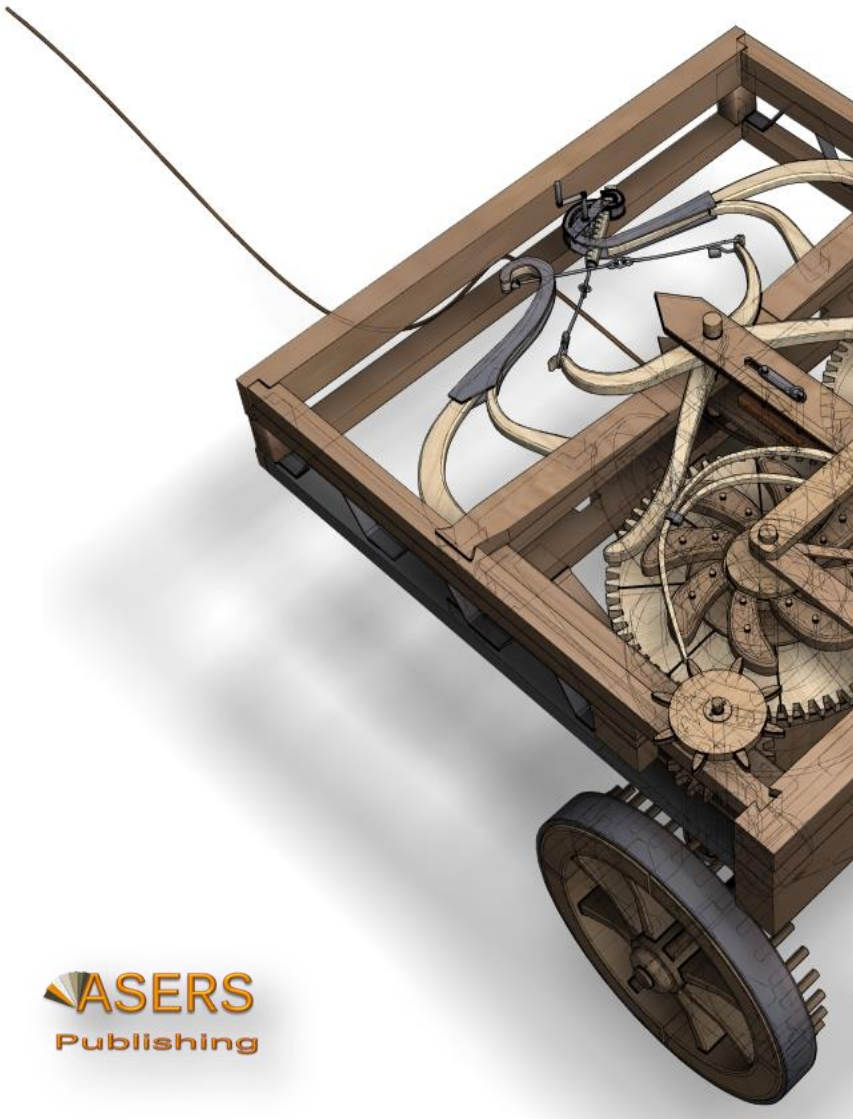

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# *Contents:*



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## Volume V, Issue 2(10), Winter 2014

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# REGIONAL DEVELOPMENT AND RENEWABLE ENERGY ENTERPRISES. A PORTER'S DIAMOND ANALYSIS

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**Abstract:**
*The purpose of this paper is twofold. On the one hand, it aims to highlight the significant role of regional parameters when analyzing the competitive advantage of renewable energy enterprises in Greece by applying Porter's diamond model, and at the same time to implement the aforementioned model in the case of solar energy enterprises. The paper suggests that analysis should be spread to lower levels than the national one, because renewable energy production companies, either at the stage of installation or at the stage of operation, are fully affected by local conditions. Measuring or analyzing competiveness of this kind of enterprises is not always easy because there are essential differences in comparison with other types of industrial activity. In this paper, specific regional data are also incorporated in the analysis of the diamond model conditions, which affect competitiveness.*

**Keywords:** regional, renewable energy, Porter, enterprises.

**JEL Classification:** O13; O18; R1

## 1. Introduction

The exploitation of renewable energy sources is a crucial matter for the improvement of the energy mix towards a sustainable economy, nationally, regionally, and locally. Key part of Greece's energy sector is the electricity production from lignite. The energy mix as presented for 2010 was 52% lignite, 20% Natural Gas, 12% Hydro, 12% Imports-Exports, 4.30% Oil and 4.30% Renewable Energy Sources (RES).

Electricity demand in Greece is expected to increase by 3.5% annually from 2010 to 2020. According to Greece's Energy Regulatory Authority (RAE), 6,000 MW of additional capacity will be needed by 2015. From 2010 to 2020 the growth of electricity demand is estimated at 3.5% annually.

In the first semester of 2011, the total installed capacity of RES stood at 2,022.2 MW, 75% of which came from wind energy production, 11.5% from solar, and the remaining 13.5% from biomass and hydro-electric production units.

According to the Greek government, the country's target is to produce electrical energy from RES at a 40% share of the total electrical power by 2020. Greece's net imports of electricity in 2009 was 4,367 GWh compared to 164 GWh in 1999. Electricity prices in Greek households and industry during the second semester of 2010 were among the lowest in the European Union. Electricity prices in EUR/100KWh for households was 12.1 with all taxes included when at the same time in Germany it was 24.4, in Belgium 19.7, in Italy 19.2 and in

Portugal 16.7. VAT and other taxes is 2.5 Eur/100KWh. The price in industry excluding all recoverable taxes is 10.3 EUR/100 KWh, non-recoverable tax is 1.5 EUR/100KWh. The Electricity price for an industry excluding all recoverable taxes ranges near the European average. At the same time, non recoverable taxes are higher than the European average. Only Germany (2.8), Italy (3.2), the Netherlands (1.8) and Austria (1.7) have higher prices of non-recoverable taxes than Greece.

Project HELIOS aims to provide the countries of central Europe with energy from solar energy. Greece will produce and export 10GW in a cost-effective way. The European Union and its organizations such as the European Network of Transmission System Operators have defined Greece as a priority country for solar energy production (European Union 2011; Greek Ministry for Environment, Energy and Climate Change 2011a, 2011b).

According to the European Photovoltaic Industry Association (2012), Greece is faced with three scenarios:

- Irradiation driven scenario: 20.600 MV;
- Current spatial distribution scenario: 16.000 MV;
- Consumption-driven scenario: 16.000MV.

The pholtovaique barometer of Eurobserv'ER (2011) ranks Greece at the 8th place of the photovoltaic power per inhabitant European Union -wide.

Greece could handle its economic crisis by exploiting its comparative advantage in renewable energy production and especially solar energy production. In a recent study, the energy sector has been presented as one of the most dynamic sectors which can lead Greece out of the crisis.[1] Although, the energy mix needs adjustments in order the cost to remain low, the EC2020 targets for renewable energies must be achieved. The renewable energy targets of complying with the EU aspirations are to reach the RES electricity, that is 16.97 TWh for 2015 and 27.27 TWh for 2020. Ernst and Young (2012) rank Greece in the 11th position, of solar index, globally[2]. The perspectives and the competiveness of enterprises which produce energy through renewable sources in Greece must be analyzed in depth.

Hence, the purpose of this paper is to examine solar energy production enterprises through a twofold interpenetrated framework. Thus, on the one hand, the aim is to highlight the significant role of regional parameters when analyzing the competitive advantage of renewable energy enterprises in Greece by applying Porter's diamond model, and on the other hand to implement the aforementioned model in the case of solar energy enterprises taking into account all possible regional parameters. Besides, as Porter (2008) mentions: "the enduring competitive advantages in global economy are often heavily local, arising from concentrations of highly specialized skills and knowledge"

In the next section, the theoretical discussion and the literature review are developed. Section three focuses on applying Porter's model. In section 4 the paper provides outcomes and policy remarks.

## 2. Theoretical discussion

Electricity production from renewable sources contains remotely the notion "local" or "regional". In contrast with fossil fuels which can be transferred as an energy source from one area to another for industrial process, electricity from renewable energy has local or regional characteristics depending on non-removable weather and/or physical conditions. Renewable energy production (solar, wind, hydroelectric, etc.) can be categorized under resource dependent industry in Porter's (2003) triple sortation of economic activity in regional economies, along with namely local industries and traded industries. Resource dependent industries, according to Porter, compete with other industries in domestic and international locations.

Focusing on rural region, OECD (2011) maintains that rural regions will gain a high percentage of the investments in renewable energy sources because rural areas fulfill the conditions of both available space and renewable energy sources. Energy efficiency and renewable energy may boost the local and regional growth, so it must be taken into consideration by local or national authorities (European Union, 2011b; European Parliament, 2012). Commission staff working document "Regions 2020" (Commission of European Communities, 2008) points that some regions may benefit from the production of renewable energies.

The attainment of local and regional development through the spread of renewable energy with the cooperation of local governance is also described by Radzi and Droege (2012). The governance model could be modified in order renewable energy sources to induce gains (Wiseman, 2011). Ratliff and Smith (2005) by

[1] See McKinsey report "Greece 10 years ahead" (2012).

[2] The index consider: Power offtake attractiveness (19%), Tax climate (11%), Grant or soft loan availability (9%), Market growth potential (18.5%), Current installed base (8%), Resource quality (19%), Project size (15.5%).

analyzing the external cost created by non-renewable energy, stress that the European countries successfully raised the cost of non-renewable energy production in order to internalize externalities. Furthermore, renewable energy could compete with the non-renewable sources on the energy market, in a cost-competitive way. The work by Platt and Judy (2011) presents the Regional Renewable Energy Procurement Project (R-REP) which is projected to produce 50 megawatts of power. The R-REP will generate more than 600 jobs and 200$ million in economic activity. The project will spur regional economy.

Likewise, Allan, Mcgregor, and Swales (2011) advocate that Scotland's economic development in peripheral areas could be intensified through the growth of renewable technology. Laurentis (2012) describes the renewable energy development of Wales not only in electricity production, but also in renewable energy technology. The region accounts for 769 companies, 13.700 employees, 467million or 4% of the UK's exports of this sector. The study suggests that regions can play a significant role in creating new demands for renewable energy systems and this can be achieved by creating new institutions, facilitating planning control, providing skills and business support. Barbiroli (2011) has also extensively analyzed the costs and advantages of a transition towards green and sustainable economies. He recognizes that low cost for traditional energy production cannot lead to alternative eco-compatible production. The transition to sustainability demands amendments in production procedure and in consumption schemes (Hoffmann, 2007). Renewable energy can produce more gains than conventional energy production (Bull and Bilman 2000). The gains from renewable energy installations will firstly enhance the local communities and regions.

Every region can produce renewable energy by exploiting its comparative advantage in natural resources, and as a result, installation can be constructed potentially in every region. Regions vary in terms of renewable resources, energy requirements, production methods, and consumption schemes (Feder, 2004). Every region has its own sources for renewable energy production and this can contribute to the development and the energy security at national level Bull and Bilman(2000).

Porter's model has been used by many researchers and academics. In renewable energy sector it is not broadly used. Dogl, Holtbrugge, and Schuster (2012), implemented Porter's diamond model to analyze German energy companies in China and India, while Zhao, Hu, and Zuo (2009) applied the diamond model on wind power energy performance in China. Demir *et al.* (2010) were occupied with Porter's factor conditions of wind energy industry of Turkey. Brooksbank and Pichernell (1999) argue that Porter's original diamond is an appropriate tool to analyze regional competitiveness. As Malecki (2012) mentions, Porter's model has been used in localities, regions and countries. Porter (1990) believes that a comparative advantage is created and sustained through a highly localized process. In Barcley's (2008) work about regional competiveness, it is advocated that Porter's diamond concept is used in regional competitive advantage.

## 3. Application of Porter's model and data analysis

According to Porter, the competitive advantage is determined by four main components, one for each corner of the diamond, the Factor Conditions, the Demand Conditions, the Related Supporting Industries and the Strategy, Structures and Rivarly. Natural resources, human resources, capital and infrastructure are used in this research in order to measure the factor conditions. The factor conditions determine significantly Porter's diamond model, as they are effectively its input parameters. Local demand, international demand and the size of the market refer to demand conditions. Strategy, structure and rivalry refer to the entrepreneurial competition, the institutional framework of entrepreneurship and the entrepreneurial strategies. The linkage to firms and suppliers in relevant areas and the existence of clusters determine the context of related and supporting industries. There are also 2 complementary factors, Chance and the Government (Figure 1).

### *3.1 Factor conditions*

#### 3.1.1 Human Recourses

From the beginning of the economic crisis, the labor cost of Greece decreased by 12.8%, when at the same time, the unemployment rates remain high. In Greece, there is a pool of high skilled personnel and low skilled workers with significant job experience. Between the first quarter of 2010 and the third quarter of 2011 total labor costs in the economy as a whole have decreased by 14.3% in nominal terms. In the energy sector the labor cost decreased by 24.7% (NILHR, 2011). This reduction is expected to boost competitiveness in all sectors. The labor cost of Greece, after the reductions which occurred in 2012, is one of the lowest in Europe and it is expected to equalize with that of the Balkan countries (Labour Institute of the Greek General Confederation, 2012).

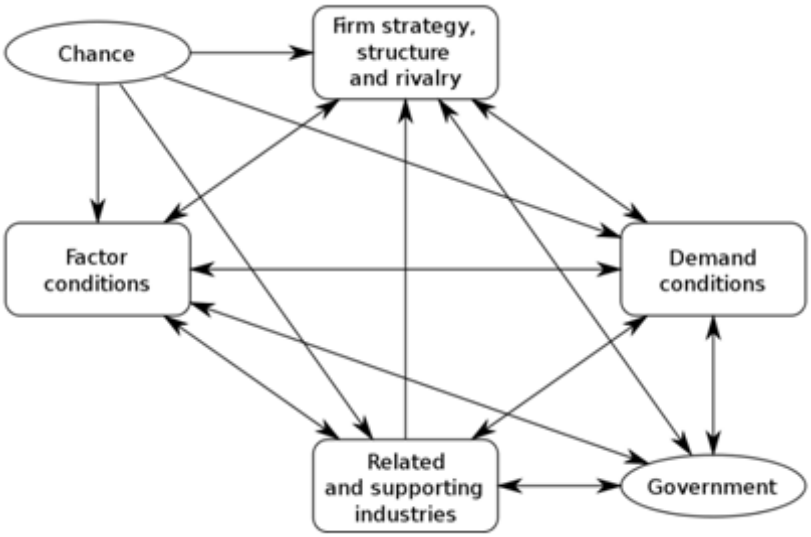


**Figure 1:** Porter's diamond model
**Source:** Porter (1998)

Greece's skilled employment rate of economic activity related to electricity, gas, steam and air conditioning supply, declined from 1.29 to 0.9 during 2008-2011. As far as the same European economic activity is concerned, its average is not far above Greece's for the same period, as presented in Table 1. According to this Table, Greece is presented to be advantageous over Portugal, Spain, Cyprus, while it exhibits performance close to the one of France and Malta.

**Table 1**: Specialization in electricity, gas, steam and air conditioning supply

| Country | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| **Euro area (17 countries)** | **1,0** | **1,0** | **1,0** | **1,0** |
| Belgium | 1,2 | 1,0 | 1,0 | 0,9 |
| Denmark | 0,9 | 0,8 | 0,8 | 0,9 |
| Germany (including former GDR from 1991) | 1,3 | 1,3 | 1,3 | 1,3 |
| **Greece** | **1,26** | **1,0** | **0,9** | **0,9** |
| Spain | 0,6 | 0,6 | 0,6 | 0,6 |
| France | 1,0 | 1,2 | 1,2 | 1,1 |
| Italy | 0,8 | 0,8 | 0,7 | 0,8 |
| Cyprus | 1,1 | 1,3 | 0,6 | 0,6 |
| Austria | 0,9 | 0,9 | 1,0 | 1,1 |
| Portugal | 0,8 | 0,7 | 0,5 | 0,6 |
| Slovenia | 1,6 | 1,2 | 1,1 | 1,4 |
| Slovakia | 2,0 | 1,9 | 1,7 | 1,6 |
| Estonia | 2,0 | 1,8 | 2,3 | 2,0 |
| Finland | 0,9 | 1,0 | 0,9 | 0,8 |
| Malta | 2,0 | 1,6 | 1,4 | 1,6 |
| Netherlands | 0,7 | 0,6 | 0,6 | 0,6 |
| Luxembourg | 0,9 | 0,8 | 0,6 | 0,6 |

*Source*: Eurostat (2011)

Engineers, guards, machine operators, builders, real estate agents, layers, financial agents, insurance consultants, environmentalists and other specialists are needed in order to complete the installation and operate a renewable energy solar park. The high technological demands in solar recourses require the business staff to be highly qualified (Dogl, Holtbrugge and Schuster, 2012).

There is a highly qualified working force in all regions of Greece but in Central Macedonia and Attiki the percentage of those who are employed and of those being unemployed is even higher than in other regions.

### *3.1.2 Physical recourses*

According to Ernst &Young (2012), high levels of solar irradiation make Greece an attractive solar market. In the Presentation of Greece's project Helios (Greek Ministry of Environment, Energy and Climate Change, 2011) at the 26Th European Photovoltaic Solar Energy Conference and Exhibition, the ability of Greece to produce solar energy was highlighted: "Greece enjoys 300 days of sunshine a year and almost 50% more sun radiation than Germany, the global leader in solar PV".

However, as locality in RES plays a crucial role, regions of south Greece present higher sun radiation than regions of north Greece. Thus, south Greece's attractiveness in solar energy production investments is significantly higher. The average annual solar radiation is 1.800 kWh; consequently Greece's potential solar energy could be exploited by other European member states, either for economic purposes or in order to attain their goals within the scope of Europe 2020.

### *3.1.3 Infrastructure*

Greece's network needs upgrading in order to meet the demands of RES. Extensive investments in grids and generating capacity are required (IEA, 2011). Investments in capacity are needed so as to attain renewable energy goals, while simultaneously, there could be an economic turnover to the regions of their installation. (Allan, Mcgregor and Swales, 2011)

The energy market in Greece is not liberated and the only provider is the Public Enterprise of Electricity. Consequently, the needed investments in networks are not economically efficient for private initiatives within the current regulatory framework. Lately, the capacity of networks has been minimized due to investments in RES.

As presented in Table 3, there are regions where network capacity for RES is zero or marginal. Besides the high irradiation, not all regions accomplish the conditions for investments because of the network capacity. Electricity network system is composed by an interconnected mainland system and non-interconnected islands. The interconnected mainland system in many regions as in West Macedonia and West Greece has been covered.

**Table 3:** Final possibility existing network considering all known requests for RES stations (operating or connection offer or under consideration)

| REGIONS | Maximum margin only for PV (MW) | Sub region capacity |
|---|---|---|
| East Makedonia-Thraki | 75 | Evros (20) Kavala (55) |
| Central Makedonia | 179 | East Thesalonniki(57), West Thesalloniki(32), Pieria(5), Xalkidiki(85) |
| West Makedonia | 0 | |
| Ipeiros | 0 | |
| Thessalia | 0 | |
| West Greece | 0 | |
| Central Greece | 0 | |
| Attiki | 51 | |
| Peloponnesus | 44 | Korinthos (44) |

*Source*: Public Enterprise of Electricity (2012), modified by authors.

Land availability plays an essential role as in Greece the land is splitted (IOBE, 2010) and there are also quite a few million acres of sustainable uncultivated land.

**Table 2:** Quality of human resources in Greek regions

| | Percentage of employed by region as to the total of employees of each region holding a doctoral, master, university graduates. Graduates of higher technological schools | | | | | Percentage of unemployed by region as to the total of unemployed of each region holding a doctoral, master, university graduates. Graduates of higher technological schools | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2008 | 2009 | 2010 | 2011 | 2012 |
| East Makedonia-Thraki | 27,85% | 28,18% | 28,66% | 34,10% | 30,03% | 21,19% | 25,26% | 22,46% | 21,43% | 22,73% |
| Central Makedonia | 35,78% | 36,44% | 38,67% | 39,30% | 41,30% | 36,31% | 36,82% | 34,66% | 37,28% | 34,87% |
| West Makedonia | 26,87% | 27,94% | 29,84% | 30,43% | 31,83% | 24,69% | 22,54% | 24,93% | 28,65% | 36,40% |
| Ipeiros | 27,21% | 27,22% | 27,14% | 31,85% | 32,20% | 32,77% | 34,48% | 33,76% | 35,02% | 28,33% |
| Thessalia | 30,77% | 34,15% | 33,01% | 31,76% | 33,24% | 44,85% | 35,85% | 37,29% | 32,42% | 35,22% |
| Ionia Islands | 19,55% | 20,04% | 25,40% | 26,77% | 24,47% | 13,38% | 21,79% | 28,79% | 16,20% | 16,64% |
| West Greece | 27,95% | 27,07% | 28,09% | 30,03% | 28,92% | 36,01% | 21,35% | 30,99% | 30,32% | 30,42% |
| Central Greece | 23,48% | 24,31% | 24,16% | 25,52% | 28,22% | 27,55% | 25,47% | 26,78% | 26,77% | 27,03% |
| Attiki | 46,59% | 47,21% | 49,59% | 49,90% | 54,29% | 47,05% | 39,18% | 41,71% | 41,24% | 39,97% |
| Peloponnisos | 23,24% | 20,57% | 21,92% | 24,02% | 22,57% | 25,80% | 24,63% | 26,08% | 29,29% | 29,01% |
| North Aegean | 31,63% | 36,26% | 28,88% | 29,65% | 33,05% | 18,16% | 32,55% | 32,70% | 29,58% | 24,29% |
| South Aegean | 22,86% | 22,64% | 21,40% | 26,13% | 32,69% | 17,67% | 14,97% | 14,72% | 30,34% | 22,27% |
| Kriti | 29,60% | 26,88% | 26,49% | 27,29% | 29,44% | 36,71% | 31,24% | 29,60% | 29,53% | 29,79% |

*Source*: Eurostat (2012)

### *3.1.4 Capital*

The financial availability is a fundamental factor for cautious investors (Ernst and Young, 2012). Barret (2011) points that EIB in 2011 financed with loans of € 5.5 billion renewable energy projects and with € 1.4 billion TEN-E projects.

**Table 4:** EIB's renewable energy financing in Europe 2007-2011(EURm)

| Renewable Energy | EURm |
|---|---|
| Solar photovoltaic | 2,216.03 (16%) |
| Hydroelectric | 2,558.6 (19%) |
| Offshore Wind | 3,231.17 (24%) |
| Onshore Wind | 4,043.85 (30%) |
| Geothermal | 547.5 (4%) |
| Biofuel/Biomasse | 374.78 (3%) |
| Solar thermal energy | 591.22 (4%) |

*Source*: Barret(2011)

In the context of promoting and encouraging investments in RES from the EU, there are co-funded sources as the Intelligent Energy Europe (IEE) programme and the Rural Development Fund (EAFRD). There are also other funding programmes such as the Joint Assistance to Support Projects in European Regions (JASPERS), the Joint European Resources for Micro to Medium Enterprises (JEREMIE) and the Joint European Support for Sustainable Investment in City Areas (JESSICA). The ERDF funding in this sector is low, especially in support of energy grid investments (European Parliament, 2012), while the EARDF could provide financial sources towards such initiatives (European Union, 2011a).

### *3.2 Strategy and structures*

Greece's National Plan for RES is based on 20/20/20 regulation of Europe 2020. Greece's targets in this sector are expected to be far above Europe 2020 (European Commission, 2010) sets. The main target is to cover its energy needs and sell energy to other countries through programs like HELIOS. The revenues will contribute to sovereign dept. payout. Huge solar parks are also constructed by the Public Enterprise of Electricity in order to reduce gradually its dependence on lignite.

Liberating energy market of obstacles and statism will contribute to the modernization of structures. The current structures are not friendly for investments from private initiative.

The growth of renewable energy is costly in relation to non-renewable, so for strategic reasons, the investments in solar energy production in Greece attractively subsidized during the previous years. There are regions where the percentage of the subsidies was higher than in others so as regions with low income to attract investments.

Through a feed in tariff policy in solar energy production after 2009, Greece tried to encourage investments. Greece's solar sector and producers enjoyed higher rates, from 0,35 euro to 0,4 euro per kilowatt hour (kWh), from 2010 to February 2012 compared to Germany where for the same period the rate ranged between 0.21 euro to 0,29 euro/kWh (Ernst & Young, 2012).

**Table 5:** Feed-in-tariffs for photovoltaics from 2009 to 2020

| Year | Month | Mainland | | Non-Interconnected Islands |
|---|---|---|---|---|
| | | >100kW | 10<=100kW | |
| 2009 | February | 400,00 | 450,00 | 450,00 |
| 2009 | August | 400,00 | 450,00 | 450,00 |
| 2010 | February | 400,00 | 450,00 | 450,00 |
| 2010 | August | 392,04 | 441,05 | 441,05 |
| 2011 | February | 372,83 | 419,43 | 419,43 |

| Year | Month | Mainland | | Non-Interconnected Islands |
|---|---|---|---|---|
| 2011 | August | 351,01 | 394,88 | 394,89 |
| 2012 | February | 333,81 | 375,53 | 375,54 |
| 2012 | August | 314,27 | 353,56 | 353,55 |
| 2013 | February | 298,87 | 336,23 | 336,23 |
| 2013 | August | 261,38 | 316,55 | 316,55 |
| 2014 | February | 268,94 | 302,56 | 302,56 |
| 2014 | August | 260,97 | 293,59 | 293,59 |
| For each n year as of year 2015 | | 1.3 ASMCn-1 | 1.4 ASMCn-1 | 1.4 ASMCn-1 |
| ASMCn-1: Average System Marginal Cost during the previous year (n-1) | | | | |

*Source*: Greek Ministry for Environment, Energy and Climate Change (2010)

### *3.3 Demand conditions*

According to Europe 2020 all European Union countries must achieve the target of 20% energy production from renewable energy sources. All the member states of the EU, but also other countries like the USA, China, Russia are trying to reduce energy dependence from non-renewable sources and increase the renewable energy production.

All the scenarios presented in the National Renewable Energy Action Plan (Greek Ministry for Environment, Energy and Climate Change, 2010) during the period 2010-2020 show a raise in electricity production from renewable energy in Greece.

**Table 6:** The possible scenarios of National Renewable Energy Plan 2010-2020

| | 2010 | | | 2015 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Reference | Compliance | Accelerated economic recovery | Reference | Compliance | Accelerated economic recovery | Reference | Compliance | Accelerated economic recovery |
| Electricity generation(TWh) | 58,86 | 58,86 | 58,86 | 64,13 | 61,47 | 62,09 | 2,18 | 8,46 | 2,48 |
| % RES in electricity generation | 13% | 13% | 13% | 22% | 28% | 29% | 8% | 0% | 1% |
| RES installed capacity(GW) | 4,11 | 4,11 | 4,11 | 7,13 | 8,66 | 9,33 | 9,91 | 3,27 | 4,72 |
| Biomass/Biogas | 0,06 | 0,06 | 0,06 | 0,05 | 0,12 | 0,12 | 0,05 | 0,25 | 0,25 |
| Hydro(excluding pumping) | 2,54 | 2,54 | 2,54 | 2,89 | 2,92 | 2,91 | 2,91 | 2,95 | 2,95 |
| Wind | 1,33 | 1,33 | 1,33 | 3,78 | 4,3 | 4,74 | 6,25 | 7,5 | 8,25 |
| **Solar PV** | **0,18** | **0,18** | **0,18** | **0,41** | **1,27** | **1,51** | **0,7** | **2,2** | **2,9** |
| CSP | 0,00 | 0,00 | 0,00 | 0,00 | 0,03 | 0,03 | 0,00 | 0,25 | 0,25 |
| Geothermal | 0,00 | 0,00 | 0,00 | 0,00 | 0,02 | 0,02 | 0,01 | 0,12 | 0,12 |

*Source*: Greek Ministry for Environment, Energy and Climate Change (2010)

Greece's electricity consumption during the previous 15 years was continuously growing (Table 7). Only the last two years due to the economic crisis did the consumption decrease slightly. The domestic demand is of

decisive importance for the enterprise competiveness. According to McKinsey (2012) report regarding Greece: "Compared to other Southern markets and Germany, electricity consumption in the residential and commercial segments is up to 40% higher and fuel consumption for transportation is up to 10% higher".

**Table 7:** Greece's electricity consumption

| YEAR | ELECTRICITY CONSUMPTION (kwh) |
|---|---|
| 1998 | 44.766.000.000,00 |
| 1999 | 46.451.000.000,00 |
| 2000 | 49.559.000.000,00 |
| 2001 | 51.260.000.000,00 |
| 2002 | 53.525.000.000,00 |
| 2003 | 55.638.000.000,00 |
| 2004 | 56.967.000.000,00 |
| 2005 | 58.202.000.000,00 |
| 2006 | 59.891.000.000,00 |
| 2007 | 62.991.000.000,00 |
| 2008 | 64.309.000.000,00 |
| 2009 | 62.509.000.000,00 |
| 2010 | 59.315.000.000,00 |
| 2011 | 59.848.000.000,00 |

*Source*: World Bank
http://data.worldbank.org/indicator/EG.USE.ELEC.KH

### *3.4 Related supporting industries*

In renewable energy production, there are many related supporting industries which are encountered in a wide range of economic activities. Industries constructing photovoltaic panels have been developed in Greece within the last years for two main reasons. Firstly, the domestic demand has increased, and as a result, many international companies transfer production units in Greece. Secondly, Greece's skilled workers and the strategic position of Greece are offered for exports in the Balkan region, North Africa and West Asia. Real estate companies support solar energy sector by detecting land that is available and satisfies the appropriate physical conditions. This is essential because in Greece land property is splitted. The constructing sector, such as engineering companies, is required during the installation process. Financial and insurance companies offer specialized products and services to investors. The only supplier at the moment is the Public Enterprise of Electricity and the distribution channels belong to HTSO-Hellenic Transmission System Operator which is its subsidiary company. All contracts of selling solar energy, which have duration of 20 years, are signed through HTSO.

### *3.5 Government*

Greece's government plays an important role due to its statism and interventionism. The current regulatory framework presents shortfalls and is not applicable due to the bureaucracy. Despite the efforts to simplify the license procedures followed by the public services, the situation is still non-friendly for investors. The law 3581/2010 managed partly to set a renewable energy market. The priority that was given to farmers' applications, after political pressures on the government of Greece and the inability to examine the applications in time, delayed big investments in solar parks. The previous year the emergency taxes came up to 40% in order the Greek government to obtain revenues to accomplish its fiscal target. From August 2012 the procedure of administrating licenses for the installation of solar parks has temporarily been inhibited because the targets set by the Ministry of Environment until the year 2014 have been fulfilled.

### *3.6 Change*

Physical phenomena and natural disasters may cause vulnerability in energy production from renewable energy sources. Climate change will affect the weather conditions in many regions within the next years, therefore structures in RES should weigh up climate change as an instrumental variable. As presented in Region 2020 (Commission of European Communities, 2008), the impact of climate change on the EU regions in the energy sector is crucial. In addition, all regions of Greece show high vulnerability to climate change and energy in medium term.

## Conclusion

Greece's energy market reformation will contribute to the country's economic competiveness. Recourse efficiency may boost the economy (European Commission, 2011). Despite the comparative advantage which is created by the human recourses and the high irradiation, factors such as the infrastructure, the capital and the government also affect significantly the diamond model in the case of solar energy enterprises in Greece.

The infrastructure and the needed upgrading investments tend to hinder the widespread exploitation of renewable energy sources. Regional and sub-regional capacity of the existing network is a considerable variable for investments. The lack of credibility and the problems in the bank sector inhibit further development.

The government, as Porter (1990) mentions, plays an important role in influencing the diamond. In countries like Greece, where statism remains high and the constant interventions in energy market cause distortions, the role of the government became much more crucial. IEA (2009) maintains that the reduction of Greece's statism may advance the national economy. The additional taxation in high solar energy production enterprises, in conjunction with producer's payment delays from the system provider caused defaulted loan installments.

National competiveness of Greece in solar energy production, as indicated in several researches, is high due to physical recourses, knowledge and human resources. Nonetheless, entrepreneurship should be encouraged through friendly policies and by creating an appropriate regulatory framework. Greece should exploit its strategic position in the global map by providing the other European member states with renewable energy. To do so, comparative advantages of regions should be exploited in line with regional entrepreneurship policies.

Regional or local factors play an essential role as they affect either in a positive or a negative way the national competiveness. There is a pool of high qualified and skilled personnel in the regions of Attiki, Central Makedonia and West Makedonia. However, there is network capacity for investments in renewable energy production only in Attiki and Central Makedonia. The irradiation in the regions of north Greece (Central Makedonia, Thraki, West Makedonia) is lower than in south Greece (Attiki, Peloponnisos), therefore, competiveness at a national level especially in renewable energy firms depends, to a great extent, on locality.

The regional and sub-regional reformation in 2010 created new local policy targets about energy planning. Huge solar parks and other renewable energy projects such as the hydroelectric production are not always welcome from local communities as the internal stakeholders balances change. Regional strategies should underpin entrepreneurship competiveness and eliminate unnecessary obstacles (Huggins and Williams, 2010).

What emerges from the above analysis is that regional/local factors should be analyzed thoroughly when Porter's model is applied on renewable energy firms.

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# HOW BIG ARE THE EMPLOYMENT EFFECTS OF MICROLOANS? EVIDENCE FROM A CASE STUDY IN LATVIA

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**Abstract:**

*Microloans to small and medium-sized enterprises have become popular in many countries. However, evidence on the economic and social impact of microfinance is scarce. In an attempt to partly fill this gap, this paper looks at a case study and analyzes the economic impacts of the microloan programme of the Latvian development bank Hipoteku Banka. In our analysis, we focus on the following questions: Did the microloan programme increase employment within the supported firms? And was it able to contribute to the economic development of rural areas and the decrease of economic inequalities across regions? We find that the firms that were granted a loan from Hipoteku Banka on average considerably increased their employment during the loan period, as well as the microloan programme made a successful contribution to the economic development of rural regions in Latvia.*

**Keywords:** microloan, employment, Latvia.

**JEL Classification:** G21, E24

## 1. Introduction

Nowadays microloans to small and medium-sized enterprises have become popular in many countries of Central and Eastern Europe. However, evidence on the impact of microfinance on variables such as employment and future financial access of the supported enterprises is scarce. In an attempt to partly fill this gap, this paper looks at a case study and analyzes the economic and social impacts of the activities of the Latvian development bank Hipoteku Banka.

While microloans are an established tool in pursuit of the goal of poverty reduction in economically low developed countries, microfinance has also become more popular in economically more developed countries such as the countries in Central and Eastern Europe. By providing microloans to businesses with limited access to bank financing, one intends to promote the establishment of small and medium-sized enterprises. Especially, self-employment and the associated creation of micro-enterprises are seen as a way to help unemployed people to escape poverty. This objective is especially pertinent for Latvia, where the economic crisis in 2008 and 2009 was very severe and has cast many people into unemployment and poverty. Thus, increased access to financial services may not only have positive effects on the individual firm level, but can also be expected to contribute to macroeconomic growth and to lower unemployment. While financial development measured by overall loans or

deposits in an economy has long been recognized as an important determinant of macroeconomic development (see the seminal contribution by King and Levine (1993)), the importance of the degree of inequality in the access to finance has recently gained more attention (see Beck *et al*. (2009) and Guiso *et al*. (2004) for important empirical contributions and e.g. Baldi (2013) for a theoretical analysis).

Microloans can be one way to improve financial access for small businesses. This implies that microloans should not constitute an end in itself, but rather a way to fill a gap in cases where small enterprises find it hard to get access to traditional forms of finance. Commercial banks are often reluctant to grant small loans, because bankers perceive such loans as being associated with high risk and overhead costs, while providing low returns (see Armandáriz and Morduch (2010) and Cull *et al*. (2009a)). As a result, access to finance is particularly difficult for such small businesses. To fill this gap, microfinance institutions grant loans to businesses that may not be able to provide the collateral usually demanded by commercial banks. These microloans are meant to allow small enterprises to expand their planning horizon and to increase their investments. Proponents of microfinance also occasionally refer to de Soto (2000), who emphasized the importance of giving people the opportunity to use their skills and property for productive purposes.

However, as e.g. pointed out by Banerjee and Duflo (2009), reliable evidence on the effects of microfinance is scarce. There also exists a literature questioning the economic and social impact of microloans (see e.g Bateman (2010)). Critics argue that microloans distort the functioning of the free market. In particular, small businesses benefiting from microloans may crowd out existing enterprises which do not have the same favorable financing conditions. It is also argued that impact studies tend to suffer from the so-called survivor bias, which refers to the tendency of impact studies to focus on success stories and neglect those firms which have left the market. In addition, some researchers find that the positive effect of microcredit is achieved only in the short term. In the long term, the use of active microcredit instrument provides an unfavorable development trajectory (Bateman, Chang, 2013).

This paper aims at providing further empirical evidence on the economic effects of microloans using as a case study the activities of the development bank Hipoteku Banka in Latvia. We analyze the microloan programme of this bank between 2009 and 2011. In our analysis, we focus on the following questions: Did the microloan programme increase employment within the supported firms? And was it able to contribute to the economic development of rural areas and the decrease of inequalities across regions? We analyse a dataset provided by the Hipoteku Banka and compare the results with economic indicators of Latvia and its regions. Using these indicators, we try to partially compensate for the absence of a control group. We find that the firms granted a loan from Hipoteku Banka on average considerably increased their employment during the loan period. While one cannot clearly identify the specific effect of the microloan programme on this employment increase, the rise in average employment is nevertheless a clear sign that Hipoteku Banka supported serious micro-enterprises and on average helped the enterprises through its loans to succeed. The regional spread of the loans has been rather even across the rural regions of the country and there have not been considerable differences in the performance of the supported firms across regions. Thus, one can conclude that the microloan programme made a successful contribution to the economic development of rural areas.

This paper is organized as follows. Section 2 gives an overview of microfinance for small enterprises in Central and Eastern European countries and describes the activities of Hipoteku Banka. Section 3 gives an overview of the economic environment in Latvia and its regions during the years in which the microloan programme was implemented. The developments in the Latvian economy will be very useful in order to compensate for the absence of a control group when assessing the economic impact of the microloan programme. In section 4, the results of the economic impact analysis of the Hipoteku Banka are shown and discussed. Finally, section 5 presents the conclusion.

## 2. Microloans for small enterprises in Central and Eastern Europe – a short overview

### *2.1. Microloans in Central and Eastern Europe.*

In Central and Eastern European countries, microloans are used to promote self-employment and the development of small enterprises (for a useful overview, see CGAP and MIX (2010)). Especially in the current economic environment characterized by stagnation or weak growth, microcredits are seen as a useful tool to encourage new businesses and help soften the impacts of the financial and economic crisis (see e.g. European Commission (2010) and Eriksson *et al*. (2011)).

In most countries, microcredits are targeted to small enterprises employing less than 10 people, and to unemployed people who plan to start their own businesses, but do not have access to traditional banking services. Microloans in Europe are usually defined as loans of up to € 25'000, which is considerably higher than

loans for the poor in economically less developed countries. However, in countries of Central and Eastern Europe, the loan amount is often smaller and rarely exceeds €10'000. The first microloan institutions in Central and Eastern European were established in the early 1990's. Currently, programmes promoted by the European Commission are the most important providers of microloans in Central and Eastern Europe. Microloans can be particularly important for rural areas. Examples of targeted business activities are self-employed entrepreneurs, small farmers, local retailers as well as small manufacturing firms and service providers.

Microloan activities have growth rapidly in the countries of Central and Eastern Europe. However, this increase in the number of microloans has often not been accompanied by impact studies confirming the economic and social contribution of microloans. The cost of the impact studies as well as the difficulty of obtaining reliable data on the impact of microfinance has in many cases led to a lack of systematic evaluation of the performance of microfinance institutions. Improving our understanding of the impacts of microfinance institutions becomes particularly important when discussing the question of microfinance regulation and how the currently implemented tighter regulations of the financial sector should be applied to microfinance institutions (see Cull *et al*. (2009b), BIS (2010) and Vento (2011)).

*Microloans in Latvia: Short Experience Overview.*

Microfinance services in Latvia is distributed relatively weak, and as one of the main obstacles the insufficient number of institutions providing microloan services and limited financial support from government for such activities could be mentioned, as well as potential clients often show rather weak interest. Microloans in Latvia have not yet considered an essential support tool for business promotion (BNS 2011). Mostly in Latvia other forms of support measures for medium and small enterprises were promoted, such as tax cuts, bureaucratic procedures facilitation, simplification of accounting report, the share capital reduction, stakeholder training and others. (Ministru Kabinets, 2009).

As shown by studies of the European Microfinance Network about microfinance sector in the European Union since 2004 to 2011, in surveys from Latvia participated only three active micro-lending institutions (Bendig, Unterberg, Sarpong, 2012), which indicates that the microcredit sector is weakly distributed in Latvia.

For the goal of developing the microfinance sector in Latvia, the experience of microfinance institutions in Eastern Europe would be possible to use. The activities in the field of microfinance in Eastern Europe is characterized by: the orderly legal framework in the field of microfinance, a close cooperation with development and employment agencies, as well as with microfinance institutions in other countries (searches for the potential clients), close co-operation with commercial banks, active marketing policy, effective selection mechanisms (Brown, 2013). However, despite the sector's long-standing and relatively successful experience, the microfinance sector in Eastern Europe experienced a severe downturn after the financial crisis despite the fact that the microfinance sector by itself is considered as a relatively stable against to changes of economic cycles. Effects of transient stage of economics, as well as the structure of loans are mentioned like main reasons for this situation (Loncar, Novac, Cicmil, 2013).

Right now the Latvian experience in microloans is based on programs such as: the ALTUM program with cofinance from the European Union's structural funds (2006-2008), the initiative of the European Investment Fund JASMINE (2008-2013), initiative of the European Comission the microcredit instrument "Progress" (2010-2013) and the Latvian-Swiss Cooperation Programme (2011-2015), as well as collaboration between business incubators and the Hipoteku Banka.

Development of the microcredit sector in Latvia can be considered as rather slow but purposeful with active use of the opportunities to attract external financial resources and foreign experience. In the framework of the programms ALTUM and JASMINE the goal to create an environment (knowledgeable entrepreneurs and micro-lenders), in which a microfinance sector could successfully develop, is achieved, while in the framework of the programms "Progress" and the Latvian-Swiss Cooperation this environment is filled with really working companies through the provision of financial flows.

Studies suggest that microcredit institutions attract more customers and earn higher profits in countries with low access to traditional financing, so that they satisfy the query where banks cannot do it (Vanroose, D'Espallier, 2012). This fact may in part explain why the Latvian microcredit sector is relatively poorly developed. During the period from 2004 till the global economic downturn in Latvia a very sharp increase in loans in the traditional sector was observed. Development of micro-credit sector and increase of the service's popularity in Latvia gradually began from time, when banks due to severe impacts from global economic downturn defined rigorous restrictions in traditional bank lending that are still significantly reduces the access of companies to financial resources. However, the micro-credit institutions help poor people in countries with well-developed financial system, thereby contributing to increased competition between micro-credit and traditional sectors. This

competition could weaken the execution of mission of microcredit institutions (Vanroose, D'Espallier, 2013). Therefore it is important to correctly define the range of clients and supported industries.

### *2.2. A Short history of the Latvian development Bank Hipoteku Banka*

The Hipoteku Banka was founded in 1995 and has since then provided a sizable number of loans and financial consulting to small and medium-sized enterprises. After Latvia joined the European Union in 2004, a special unit - the Promotional Programmes Office ALTUM - was created within the Hipoteku Banka in order to separate the publicly funded microloan activities from the commercial activities of the bank. In the midst of the severe economic crisis in Latvia, the Latvian government decided in 2009 to fully transform the Hipoteku Banka into a development bank. Since then, the Hipoteku Banka has focused on providing microloans and financial consulting to microbusinesses and self-employed people. These activities are meant to contribute to the economic recovery and to combat the massive unemployment in Latvia. The Hipoteku Banka focuses its support on small entrepreneurs in rural and economically less developed areas. Businesses in the area of Riga, by far the economically most developed region in Latvia, were first excluded from the programme, but were also allowed to apply beginning in December 2010.

### *2.3. The data and methodology of research*

The aim of the research is to evaluate whether the microloan programme increases employment within the supported firms and thus contributed to economic development and decreased the high regional differences

The data from Hipoteku Banka for the period of time since 2009 till 2011 and data from Central Statistical Bureau of Latvia from 2008 till 2011 for this purpose were used. For each firm, data is available on job creation as well as the number of jobs in the beginning and the end of period studied. In addition, the localization and the sector of economic activity of each firm are known. This allows us to calculate the number of jobs created per region and per sector of economic activity.

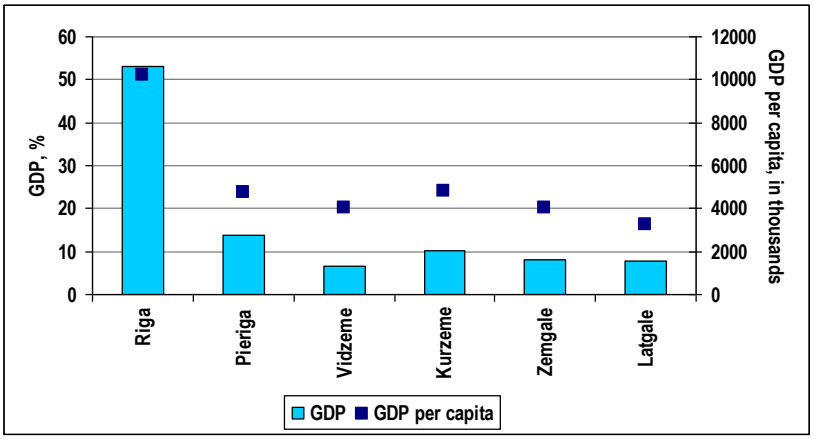
The calculation of the Location Quotient (LQ) (Florida University, 2013) was based on data about regional employment by kind of economic activity, as well as on data about microloans. Results of LQ calculations provide information about regional specialization and thus indicate whether microloan programme contributes to the changes in situation or supports sectors of regional specialization.

## 3. Description of the economic environment in Latvia from 2009-2011

### *3.1. Regional distribution of the economy*

This section provides a statistical characterization of the Latvian economy, during global economic downturn, which affected the Latvian economy very strong and worsened financial accessibility and employment level.

Understanding the economic situation during the microloan programme is essential, when it comes to interpreting the impact results of the microloan programme carried out in section 4. The economic data of Latvia and its regions will allow us to compare the development of the firms in the microloan programme with developments going on in the Latvian economy.




*Source*: Central Statistical Bureau of Latvia

**Figure 1**. GDP and GDP per Capita across Regions in Latvia in 2010, in %, in Lats

First, it is interesting to have a closer look at the economic structure of Latvia, which is divided into fifth regions: Riga, Vidzeme, Kurzeme, Zemgale and Latgale. As can be seen in Figure 1 Latvia is experiencing unequal economic development of regions. Riga is the clear leader, which provides more than half of the country's GDP. The level of GDP is lower than in Riga across other regions, which are more rural and economically less developed than Riga. The importance of the region of Riga in the Latvian economy can be even better seen in Figure 1. GDP per capita is by far the highest in the region of Riga. The other regions are economically less developed and their GDP per capita is below the Latvian average. In these regions, GDP per capita is rather similar.

Table 1 indicates that nearly half of the population lives in the region of Riga, where two-thirds of the Latvian GDP is concentrated. The rest of the population is relatively evenly distributed over the other four regions. However, despite the differences in terms of population in Latvian regions, the amount of economically active and employed population between regions is more or less equivalent. The concentration of the labor force indicates on differences between regions. Riga specializes on "Transportation, storage, information and communication" sector, while the remaining regions on "Agriculture, forestry and fishing sector", where produced value added is lower. It is also one of the reasons why the differences in GDP and hence in economic development between Riga and other regions are so high.

**Table 1**. Regional economic distribution of the Latvian population in 2010 in %

| Region | Population | Economically active population | Employed popuplation | Employment concentration by economic activity | |
|---|---|---|---|---|---|
| | | | | LQ* max | LQ*min |
| Riga Region | 48.8 | 69.4 | 54.7 | 1.42 in (H, J) sector | 0.08 in (A) sector |
| Vidzeme region | 10.4 | 60.8 | 52.0 | 1.99 in (A) sector | 0.56 in (H, J) sector |
| Kurzeme region | 13.3 | 63.4 | 53.8 | 1.60 in (A) sector | 0.74 in (H, J) sector |
| Zemgale region | 12.4 | 64.6 | 50.7 | 1.74 in (A) sector | 0.74 In (H, J) sector |
| Latgale region | 15.1 | 60.9 | 49.7 | 1.46 in (A) sector | 0.76 in (F) sectors |

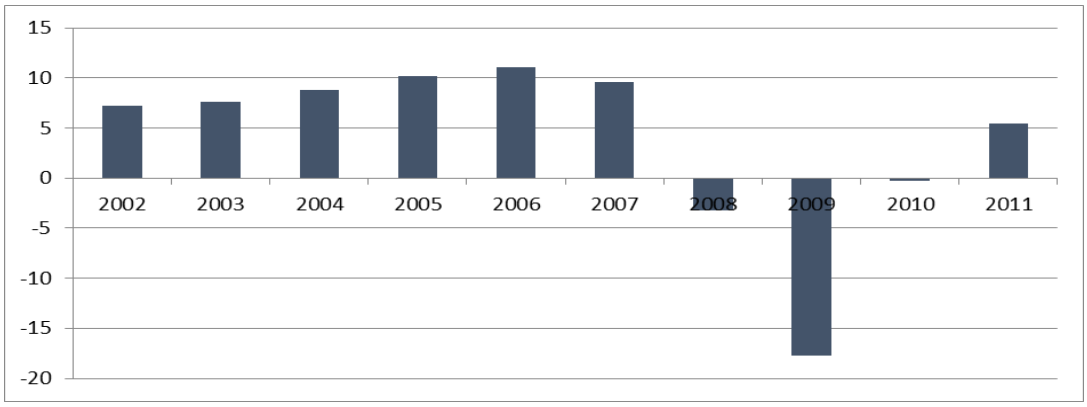
*Source*: Central Statistical Bureau of Latvia and own calculations by Central Statistical Bureau of Latvia

Note: (A) sector: Agriculture, forestry and fishing; (H, J) sector: Transportation, storage, information and communication; (F) sector: Construction

From the analysis of the economic structure of Latvia in Figure 1 and Table 1, one can conclude that the similarities across these rural areas make a comparison of the impacts of microloans appropriate across these regions.

### *3.2. The effects of the severe economic crisis in 2009-2010.*

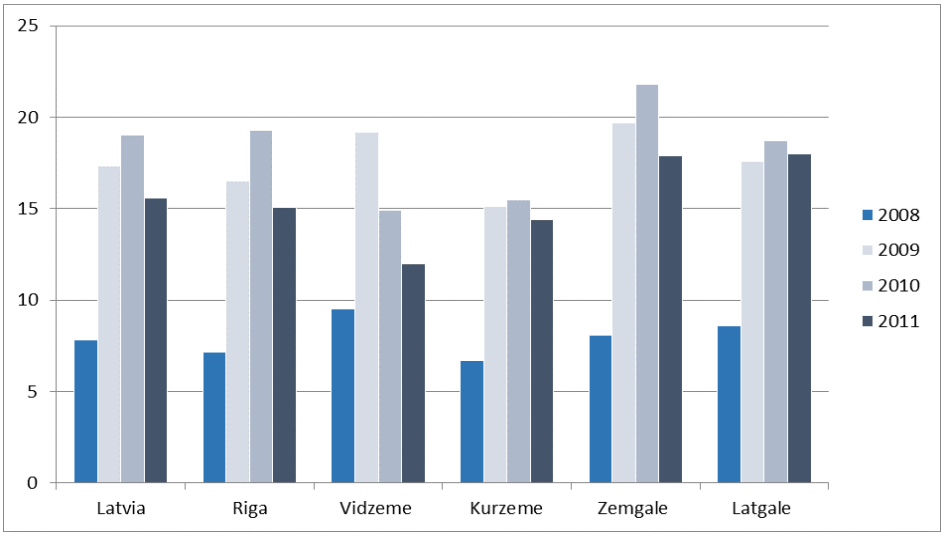
Latvia had to bear the consequences of a large economic crisis during the implementation period of the microloan programme of the Hipoteku Banka. After a long period of high growth rates in the 2000s, the economy became overheated and showed the first signs of weakness towards the end of 2007. Latvia was therefore especially vulnerable when the financial crisis occurred in 2008. As a consequence, a severe economic crisis hit the Latvian economy in 2008 and 2009 (*see* Figure 2), which was associated with fears that Latvia would eventually have to abandon its fixed exchange rate vis-à-vis the euro. Latvia had to obtain financial support from the IMF and the EU, and the Latvian government implemented high spending cuts in order to reduce the budget deficit to sustainable levels. Eventually, a stabilization of the economy and the government budget was achieved during 2010, and the fixed exchange rate vis-à-vis the euro was also able to be maintained. The economy stagnated in 2010 and grew again in 2011.




*Source*: Central Statistical Bureau of Latvia

**Figure 2**. Growth Rate of Real GDP, % change with respect to previous year

At the same time as the economy started to contract, unemployment rose sharply from around 7% to nearly 20% in 2010 (see Figure 3). Regarding unemployment, it is interesting to have a closer look at the regional disparities shown in Figure 3.




*Source*: Central Statistical Bureau of Latvia

**Figure 3**. Regional unemployment rates in Latvia, in %

One can see that in most regions, unemployment still rose in 2010, but fell in Vidzeme and stayed roughly constant in Kurzeme. As a result, these two regions showed the lowest unemployment rates of all Latvian regions in 2010. In 2011, unemployment fell considerably in Latvia with Riga, Vidzeme and Zemgale showing the largest decrease. We are going to refer to these regional disparities in unemployment rates again when discussing the impacts of the microloan programme in section 4.

**Table 2**. Evolution of employment across sectors of activity from 2009 – 2011, changes in %

| Sector of economic activity | Employment Increase |
|---|---|
| Agriculture | 12.8 |
| Manufacturing | -18.4 |
| Whole sale and Retail Trade | -7.1 |
| Transportation | -12.6 |
| Accommodation and Food Services | -6.5 |

| Sector of economic activity | Employment Increase |
|---|---|
| Information and Communication | -11.2 |
| Real Estate Operations | -2.3 |
| Scientific and Technical Activities | 18.5 |
| Arts and Recreation | -17.5 |

*Source*: Central Statistical Bureau of Latvia

Table 2 provides an overview of employment in those sectors of activity which are at the centre of our interest in this paper. One can see that manufacturing, transportation, as well as arts and recreation are among those sectors that show the largest decrease in employment during this period of overall economic contraction. Two sectors, namely agriculture and scientific and technical activities, have seen an increase in employment. This certainly reflects the fact that unemployed people moved to these sectors because they chose self-employment making.

### *3.3. The sectoral and regional structure of the Latvian economy*

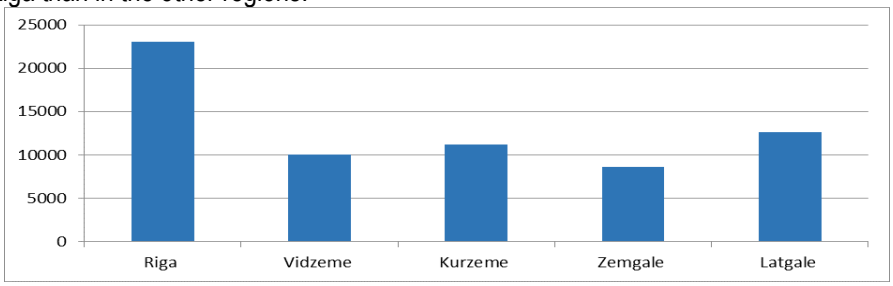
Table 3 shows the sectoral and regional structure of the Latvian economy. We focus on those economic activities where most of the firms in the microloan programme are active. In particular, the differences across the Latvian regions are interesting and will be of importance when analyzing the impacts of the microloan programme. The weight of each sector of economic activity with respect to total output is shown.

**Table 3**. Number of firms according to economic activity in % of total in 2009

| | Latvia | Riga | Vidzeme | Kurzeme | Zemgale | Latgale |
|---|---|---|---|---|---|---|
| Agriculture | 3.8 | 1.6 | 9.7 | 7.0 | 12.3 | 3.8 |
| Manufacturing | 10.8 | 8.9 | 16.4 | 14.8 | 15.4 | 12.0 |
| Wholesale and Retail Trade | 15.3 | 17.1 | 12.5 | 10.6 | 13.0 | 11.8 |
| Transportation | 11.1 | 12.4 | 4.1 | 14.5 | 4.6 | 7.9 |
| Accommodation and Food Services | 1.6 | 1.7 | 1.4 | 1.3 | 1.0 | 1.3 |
| Information and Communication | 4.3 | 5.9 | 1.1 | 1.4 | 1.1 | 1.8 |
| Real Estate Operations | 9.3 | 9.0 | 9.8 | 10.0 | 9.7 | 9.7 |
| Scientific and Technical Activities | 4.8 | 6.3 | 1.7 | 2.4 | 1.6 | 1.4 |
| Arts and Recreation | 1.7 | 1.7 | 1.5 | 1.8 | 1.5 | 1.8 |

*Source*: Central Statistical Bureau of Latvia

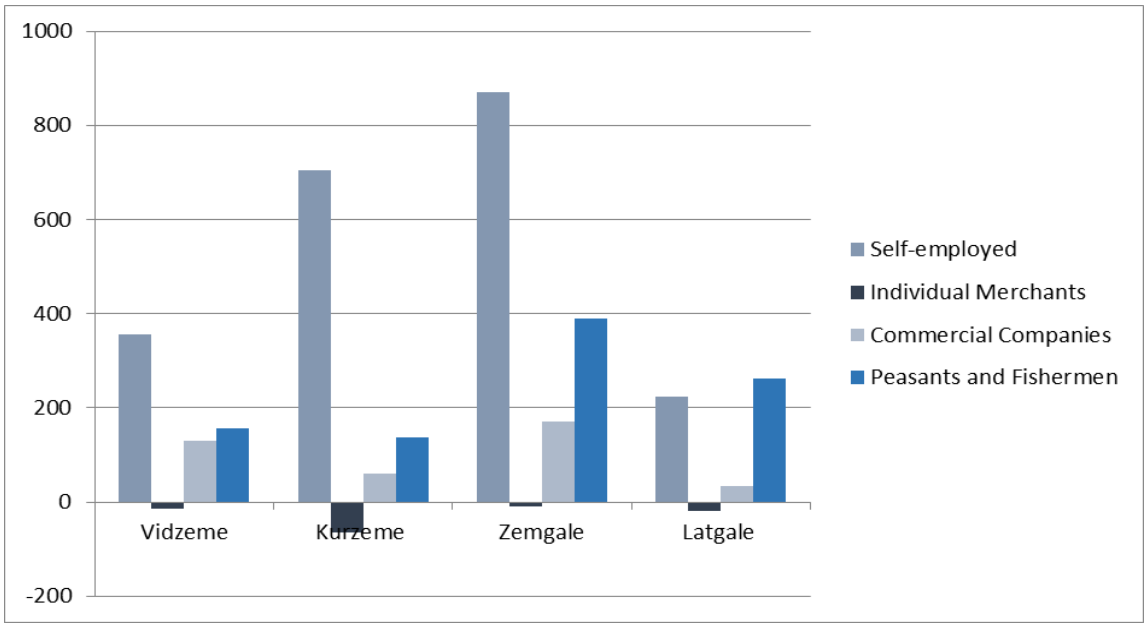
One can again see the differences between Riga and the rest of the country. In particular, Riga depends relatively less on agriculture and manufacturing than the rest of the country, while the services sector is more developed in Riga than in the other regions.




*Source*: Central Statistical Bureau of Latvia

**Figure 4.** Number of Small Enterprises across regions in 2009

In Figure 4, we now turn to the regional distribution of small enterprises across Latvia. Since the microloan programme is meant for small businesses, studying the regional distribution of these enterprises across Latvia is interesting for the interpretation of the results in section 4. As for the other economic indicators, one can see that the region of Riga has many more small businesses than other regions in the country. Across the other regions, the number of small businesses is relatively similar. However, one can nevertheless detect some differences showing that Latgale has more small firms than the other rural regions, while Zemgale lagged behind the other regions in 2009.




*Source*: Central Statistical Bureau of Latvia

**Figure 5**. Net increase in the number of enterprises across Latvian Regions in 2010

In Figure 5, the net increase of enterprises across Latvian regions is depicted for 2010. It contains a number of interesting pieces of information that will become relevant in section 5. The most eye-catching feature is that Zemgale saw a considerable increase in the number of firms, especially regarding self-employed people. The situation of the economy in Zemgale, which is characterized by relatively few firms (compare with Figure 4) and the highest unemployment rate in Latvia (compare with Figure 3) seems to have encouraged many people to choose self-employment as a way to escape unemployment and poverty. In contrast, the region of Latgale, which has a relatively high number of small firms (compare with Figure 4), only registered a relatively modest increase in the number of firms in 2010.

### *3.4. Access to finance*

In this section, we have a closer look at the distribution and evolution of loans in Latvia. The following Table 4 shows results from a survey conducted by the *Central Statistical Bureau of Latvia* questioning enterprises about their problems.

**Table 4**. Percentage of firms in the respective category mentioning access to finance as a main problem. Results for 2011

| Size of the Enterprise | % |
|---|---|
| Large Enterprises | 11.30 |
| Medium Enterprises | 14.34 |
| Small Enterprises | 21.51 |

*Source*: Central Statistical Bureau of Latvia

Access to finance was found to be one of the main problems of the firms in the survey. Interestingly, small enterprises mentioned access to loans more often than larger enterprises. This highlights the potential benefits of microloans granted to small enterprises.

**Table 5**. Amount of loans by sector in 2008, in % of total

| Sector | % |
|---|---|
| Agriculture | 4.3 |
| Manufacturing | 14.0 |
| Wholesale and Retail Trade | 12.5 |
| Transportation | 4.9 |
| Accommodation and Food Services | 2.4 |
| Information and Communication | 0.2 |
| Real Estate Operations | 30.9 |
| Arts and Entertainment | 0.3 |
| Other | 30.5 |

*Source*: Central Statistical Bureau of Latvia

Table 5 shows the structure of loans across those economic activities which are at the center of our analysis.

**Table 6**. Change of amount of loans by sector, in %

| Sector | 2009 | 2010 | 2011 |
|---|---|---|---|
| **TOTAL** | ***-1.6*** | ***-10.3*** | ***-9.3*** |
| Agriculture | -3.0 | -8.6 | -0.1 |
| Manufacturing | -1.3 | -13.3 | -7.4 |
| Wholesale and Retail Trade | -4.4 | -15.4 | -10.6 |
| Transportation | 10.2 | 1.1 | -6.9 |
| Information and Communication | 47.6 | 18.8 | -25.3 |
| Accommodation and Food Services | 6.1 | -6.3 | -11.8 |
| Real Estate Operations | 3.2 | -6.2 | -8.6 |
| Arts and Recreation | 17.3 | -8.4 | -5.5 |
| Other | -8.9 | -15.8 | -11.9 |

*Source*: Central Statistical Bureau of Latvia

As a consequence of the economic crisis, the credit supply was strongly reduced as can be seen from Table 6, which shows the evolution of loans for those economic sectors that are at the center of our analysis. One can see that after a slight decrease in 2009, there was a considerable contraction of loans supplied to the economy in the years 2010 and 2011. Considering that the amount of loans had often grown by double digit rates in the years before, the decrease in the loan supply during the economic crisis becomes even more dramatic. In 2010, the sectors hardest hit by the credit crunch were the manufacturing and the retail trade sectors. Also agriculture, and arts and recreation saw a considerable decrease in credit supply. In 2011, the situation improved for agriculture, manufacturing, retail trade as well as for arts and recreation. For the other sectors, however, the situation further deteriorated.

This section gives an overview of the data used and presents the results of the research conducted on the basis of the questions raised in the introduction, namely the regional distribution of the loans and the impact on employment.

### *3.5. Description of the data*

The microloan programme of the Hipoteku Banka studied in this paper lasted from 2009 to 2011 and the dataset comprises 391 supported businesses. Data on initial and final employment in each enterprise, the location of the business and its sector of economic activity are available.

**Table 7**. Number of firms according to economic activity, in % of total

| | Firms in the Microloan Programme* | Firms in the Whole Economy (2009) |
|---|---|---|
| Agriculture | 10.4 | 3.8 |
| Manufacturing | 25.9 | 10.8 |
| Wholesale and Retail Trade | 8.0 | 15.3 |
| Transportation | 5.2 | 11.0 |
| Accommodation and Food Service | 10.4 | 1.6 |
| Information and Communication | 4.7 | 4.4 |
| Real Estate Operations | 9.9 | 9.3 |
| Scientific and Technical Activities | 4.7 | 4.8 |
| Arts and Entertainment | 11.3 | 1.7 |
| Other | 9.4 | 37.5 |

*Note: *The total of firms in the microloan programme consists of the total of supported firms whose sector of activity is known.*

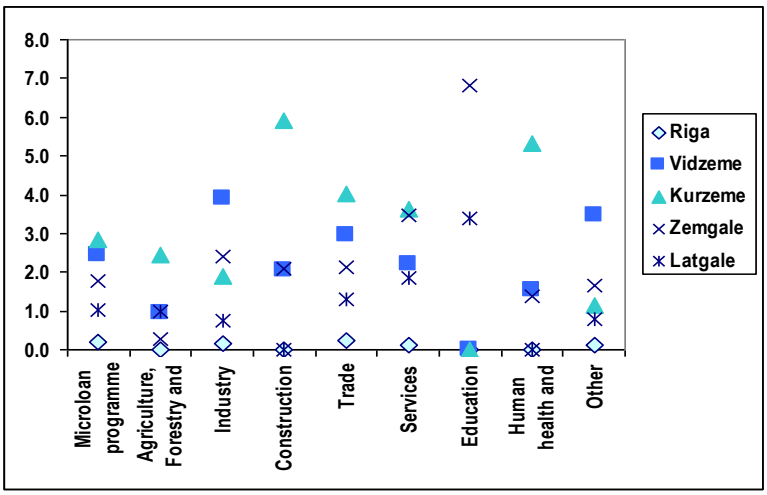
Source*: Own calculations based on data from Hipoteku Banka and the Central Statistical Bureau of Latvia*

Table 7 shows the distribution of the supported enterprises across sectors. For comparison, we also show their corresponding share in the Latvian economy. Only those sectors which show a high share of microloans are depicted. One can see that the enterprises supplied with microloans are active within those sectors that are typical for small enterprises or start-ups. The activities also reflect the focus of the Hipoteku Banka, which is mainly active in rural areas. Hence, a relatively high share of the supported businesses can be found in the agricultural sector. Also, small businesses in manufacturing, the accommodation and food sector, and in arts and entertainment obtain take a higher share in the microloan programme than in the Latvian economy as a whole.

Does microloan programme stimulate development of sectors, which could be named like sectors of region's specialization or promote development in other sectors?

First of all the regional specialization of the microloan programme should be noted. Taking into account calculated LQ values we can indicate that all regions except Riga and Latgale specialize on this microloan programme. This means that the microloan programme is an important instrument to support the realizing of economic potential of above-mentioned regions. Moreover, the LQ values show that the number of supported firms within the regions is sufficient so that certain sectors could be attributable to regional specialization.

Riga region is weakly involved in the Hipoteku Bank microloan programme, while other regions show positive trends. In general, it can be concluded that service sector, particularly trade, is dominated and in most cases forms regional specialization by the microloan programme. However, high LQ values in Vidzeme, Kurzeme and Zemgale not only in Trade sector, but also in the Industry sector as a positive fact should be mentioned. However, if the support of microloan programme provides increasing in employment or maintaining employment in the long term, the kind of supported sectors are of little importance.

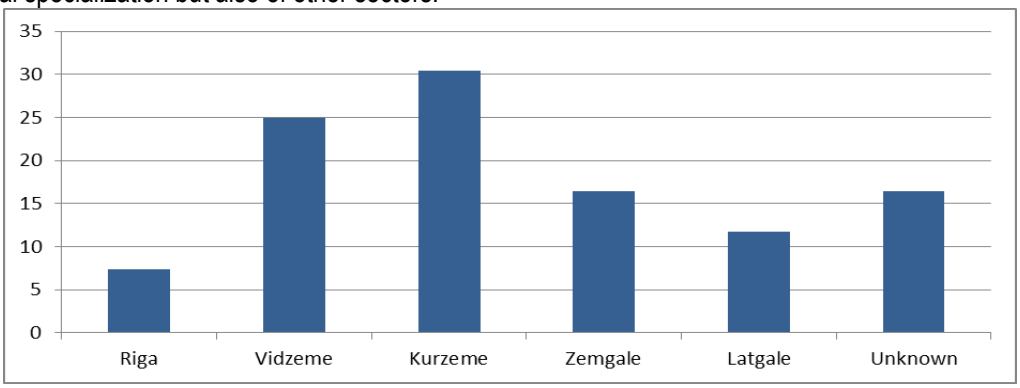



*Source*: Own Calculations based on Data from Hipoteku Banka and the Central Statistical Bureau of Latvia

**Figure 6.** Regional and sectoral specialization by microloan programme in Latvian regions, LQ values

The calculations also indicate that the agricultural sector is the one that is the most involved in the microloan programme in Kurzeme, while in other regions the numbers are lower. We pay attention to this, because according to other calculations (see Table 1) agriculture can be seen as sector of regional specialization in all regions (except Riga).

In general, it can be concluded that the microloan programme promotes development of not only sectors of regional specialization but also of other sectors.



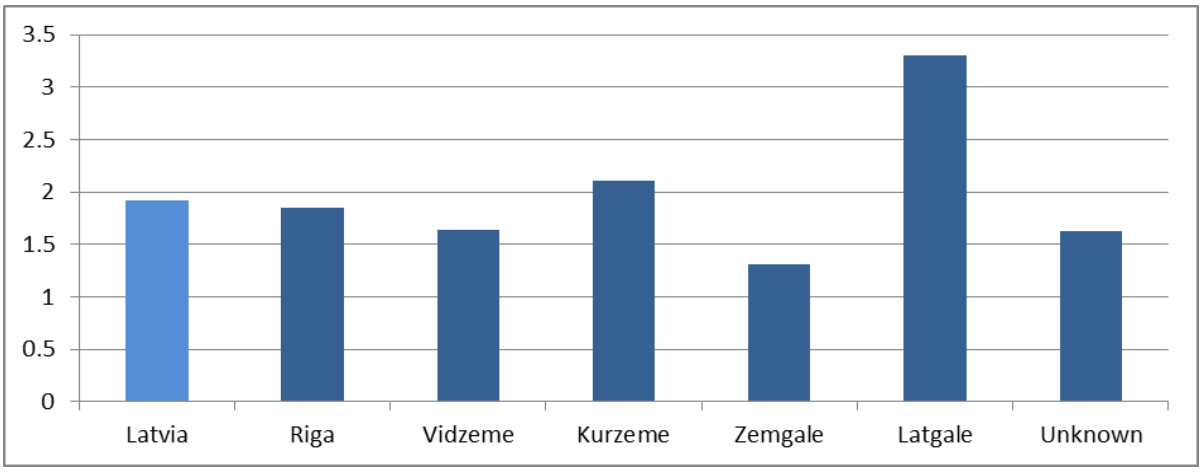

*Source*: Own Calculations based on data provided by Hipoteku Banka

**Figure 7**. Regional Distribution of Supported Projects, in % of total

Figure 7 displays the regional distribution of supported businesses. As discussed above, the Hipoteku Banka focuses its activities on rural and economically less developed regions. The low number of 7% for Riga, where microloans are not promoted as much as in other regions, can therefore be easily explained. In addition, enterprises in the region of Riga only became eligible for loans in December 2010. Small businesses in Vidzeme and Kurzeme attracted considerably more loans than the other regions. The lower share for Latgale may be explained by a relatively low share of the agricultural and manufacturing sectors in this region (see Table 3), which are two sectors heavily supported by the Hipoteku Banka. For Zemgale, there are no such differences in the economic structure. The relatively low share can possibly be explained by the relatively low number of small enterprises in this region (see Figure 4).

### *3.5. The effects on employment*

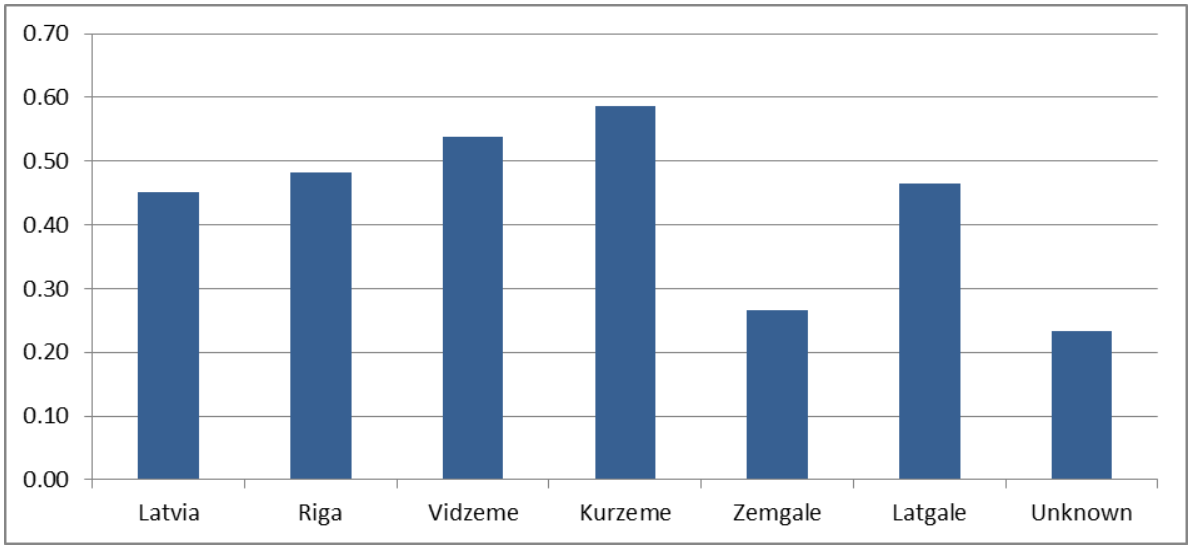
Before looking at the effects on employment, we depict in Figure 8 the average initial employment in the supported enterprises.




*Source*: Own calculations based on data provided by Hipoteku Banka

**Figure 8.** Average initial employment in supported enterprises

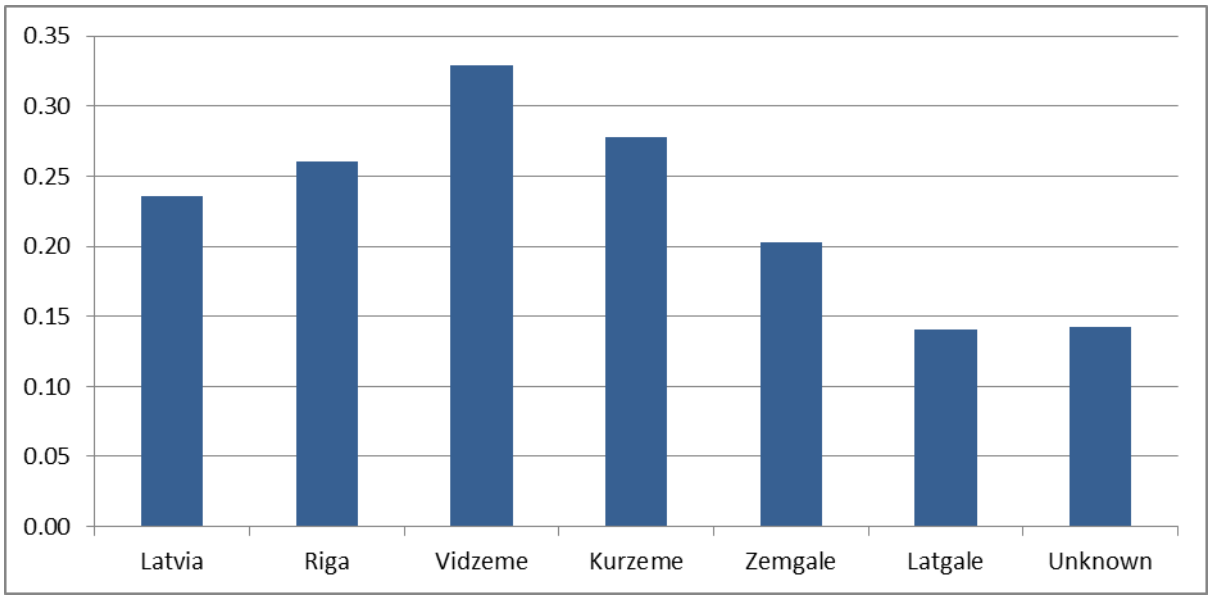
Although Hipoteku Banka in general grants loans to entrepreneurs with up to 9 employees, it mainly supports smaller enterprises or start-ups, which is in accordance with its goals. The average number of employees in the supported enterprises is slightly less than 2. These generally low figures imply that the loans indeed go mainly to small start-ups or unemployed people who want to become self-employed. Average initial employment in the enterprises lies between 1.3 and 2.1 in all regions except Latgale, where it is above 3. The high figure for Latgale may reflect the fact that there are less start-ups in this region as was shown in the last section (compare with Figure 5). Also, the agricultural sector, where people are often self-employed, is less important in Latgale. For Zemgale, the low figure probably reflects the fact that high unemployment in this region (compare with Figures 3 and 5) may have led to a high number of start-ups and self-employment. Besides, one can also see that those firms whose origin is unknown show no significant differences with respect to other regions.




*Source*: Own Calculations based on data provided by Hipoteku Banka

**Figure 9**. Employment increase per supported project

In Figure 9, one can see that employment in the supported enterprises increased during the period of the microloan programme. This is remarkable, because unemployment in the whole economy increased in 2009 and 2010 and decreased only slightly in 2011. Enterprises in the regions of Riga, Vidzeme and Kurzeme seem to have outperformed the other regions. Since the region of Zemgale had the lowest average initial employment level, it also saw the lowest increase in employment per project.




*Source*: Own calculations based on data provided by Hipoteku Banka

**Figure 10**. Employment increase as a ration of initial employment

For the employment increase as a ratio of initial employment, one can see again in Figure 10 that on average, employment increased by a remarkable 23%. The three regions Riga, Vidzeme and Kurzeme are above average with increases between 25-33%, while Zemgale and Latgale lag behind showing numbers of approximately 20% and 14%, respectively.

*3.6. The employment effects across sectors of economic activity.*

In this section, we briefly describe the evolution of average employment across different sectors of activity. As mentioned above, the number of observations for most of the sectors is low, which results in high standard deviations of these average changes. The numbers nevertheless show interesting tendencies and differences across sectors (see Table 8).

**Table 8**. Jobs created per sector of economic activity, in % of initial employment

| Sector of Economic Activity | Employment Increase |
|---|---|
| Agriculture | 45.0 |
| Manufacturing | 19.2 |
| Wholesale and retail Trade | 14.5 |
| Transportation | -19.9 |
| Accommodation and Food Services | 58.6 |
| Information and Communication | 16.7 |
| Real Estate Operations | 0.0 |
| Scientific and technical activities | 5.3 |
| Arts and Recreation | 60.2 |
| Other and Unknown | 15.1 |

*Source*: Own calculations based on data provided by Hipoteku Banka

The highest increase can be found in agriculture, accommodation and food services, and also in arts and recreation. In addition, manufacturing, wholesale and retail trade, and also the information and communication sector show considerable increases in employment. The employment increases are therefore the highest in those sectors where the Hipoteku Banka is mainly active (compare with Table 7).

## Conclusion

In this paper, we studied the economic impacts of microloans using a case study from Latvia. We used a dataset provided by the Latvian development bank *Hipoteku Banka* and compared the results with economic indicators of Latvia and its regions. We find that the firms that were granted a loan from *Hipoteku Banka* on average considerably increased their employment during the loan period. While one cannot clearly identify the specific effect of the microloan programme on this employment increase, the rise in average employment is nevertheless a clear sign that Hipoteku Banka supported serious micro-enterprises and on average helped the enterprises through its loans to succeed. The regional spread of the loans has been rather even across the rural regions of the country and there have not been considerable differences in the performance of the supported firms across regions. All these things considered, one can conclude that the microloan programme made a successful contribution to the economic development of rural regions in Latvia. However, this study did not analyze the effects of the microloan programme on future access of the microfirms to traditional sources of finance. By providing a credit history to the supported businesses, the microloan programme can be expected to have a positive impact on future access to finance, which an important issue is left to future research.

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DOI: http://dx.doi.org/10.14505/tpref.v5.1(9).03

# SURFING ON THE TIDE? LEAST-DEVELOPED COUNTRIES TRADE DURING THE GREAT GLOBAL TRANSITION

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**Abstract:**

*The rebalancing of global demand towards large emerging countries and the resulting long-lasting cycle of high international commodity prices had a profound impact on LDC trade. This process contributed to a wider geographical diversification of LDCs' exports but led also to a greater reliance on those highly priced commodities. LDCs remain particularly vulnerable to external shocks; the 2008-2009 global crisis and the bumpy transitional recovery that followed illustrate the fragility of the recent trends. A slowdown in the growth of large emerging countries may end the commodity "super-cycle", deepening LDCs' structural trade imbalances. In such a perspective, renewed efforts towards extensive product diversification are called for. Fostering diversification has been supported for many years by preferential market access to develop and --more recently-- to emerging countries. But preferences alone are not sufficient to improve the supply-side capabilities of most LDCs. The new business models related to global value chains offer new opportunities to LDCs for export diversification and trade facilitation is one of the key components of this diversification strategy.*

**Key words:** Least developed countries, trade and development, 2008-2009 global crisis, preferential market access, global value chains, trade facilitation.

**JEL Classification:** F13, F14, F63, O19, O24

## 1. Introduction

Least developed countries as a group are known for being very dependent on the exports of a few primary commodities. This dependency proved to be a blessing during the commodity super-cycle which coincided with the rapid emergence of large developing countries, in particular China. For the first time in 2005 the LDC group registered a trade surplus. But it was short-lived and the trade balance reverted to deficit after the global crisis of 2008-2009.

A return to the upbeat international market conditions that prevailed in the mid-2000s is not to be expected. The Great Global Transition —an on-going process of rebalancing global sources of supply and demand— enters now into a new phase as "emerged" economies rely less on export-led growth and look more at their domestic markets as a source of effective demand. The post-crisis global transition will probably be

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characterised by a weaker global demand and lower commodity prices. Export diversification remains therefore a high priority for LDCs.

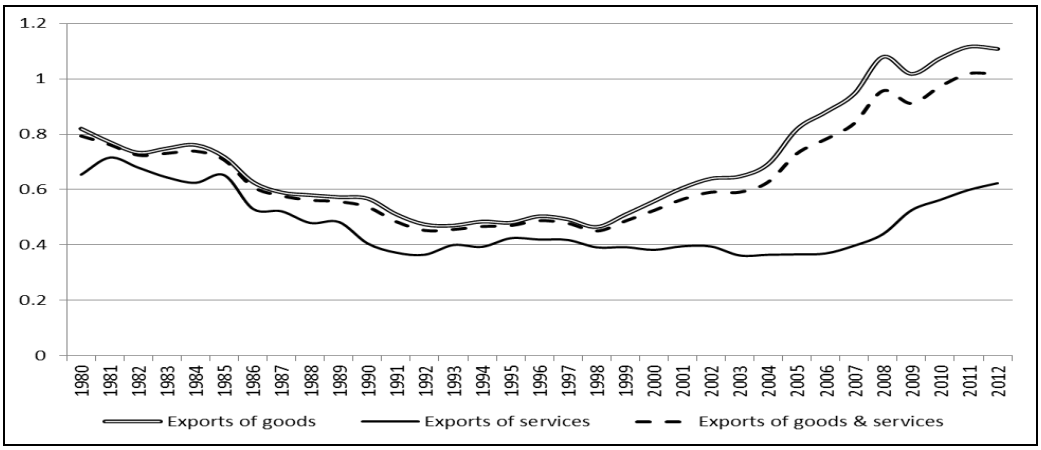
To help in this diversification on the demand-side, LDCs benefit from special and differential treatment in terms of market access under WTO rules. On the supply-side, global value chains offer new perspectives. LDCs which could not build a competitive domestic industrial base through old-style import-substitution industrial policies can now join international production networks and export particular "tasks" rather than entire finished products. In this context, trade facilitation is crucial for fostering LDCs competitiveness.

The article first reviews the main trends that affected LDCs' trade in goods and services since the early 2000s. After looking at the impact of the 2008-2009 crisis, the paper revises the potential of international value chains for export diversification and the main challenges faced by LDCs.

## 2. The least – developed countries and the world market

### *2.1. Least – developed countries in world trade*

Since the early 2000s, least developed countries did more than just riding the globalization tide and they were able to increase their share in key markets. This result contrasts with a somewhat mediocre outcome in the 1980s and 1990s. LDC exports increased at an average annual rate of 21% between 2000 and 2008, to be compared with 15% for all developing countries and 12% for the world. As a result of the rapid rates set in the 2000s, the share of LDC total exports in the world corrected the decline registered since 1980 and closed at over one per cent in 2012 (Chart 1). In services, the market share of LDCs exports has yet to return to the values of early 1980s, despite a good performance after 2005.




*Source*: Based on WTO data.

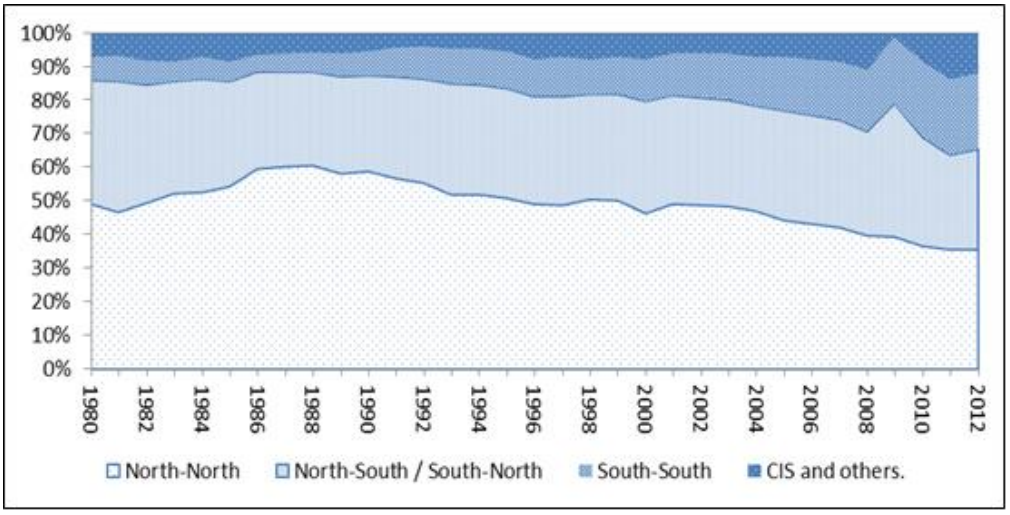
**Figure1:** Share of LDC exports of goods and commercial services in world exports, 1980-2012 (Percentage)

A few words of caution are called for at this stage. Most of the analysis is done from the LDC group perspective; this should not minimize the fact there is a large array of individual country's characteristics that make this group quite a heterogeneous one. If we follow some indicators, such as trade balances, this heterogeneity has increased in the most recent years. Applying exploratory data analysis techniques, Escaith and Tamenu (2013) test the classification of LDCs according to their export specialization and other economic indicators. If trade profiles vary between the various sub-groups, the eventual overall economic and social outcome, as measured by the UNDP's Human Development Index, is quite uniformly low across the group.

A large part of the 2000s success story is due to the so-called "super-cycle" of commodities when the average annual growth rate of LDCs' exports of fuels and minerals jumped to 19.5% in the 2000s as a result of both stronger demand and higher prices. Meanwhile, trade in manufactures lagged behind, even though it accelerated to 10.5%. The shift in barter terms of trade between commodities and manufacture is largely attributed to the rapid emergence of China. On the one hand, the "Factory Asia" phenomenon in global production networks has lowered the production cost of manufacture; on the other hand, Chinese imports of agricultural and mineral goods increased rapidly to satisfy its booming investment and domestic consumption.

The rise of emerging countries in the second half of the 1990s and during the 2000s was closely related to the emergence of global value chains and the delocalization of part of the manufacturing process from the North to the South. Thanks to this trend, a new middle class appeared in the emerging countries, which increased its demand for housing, goods and services. The convergence of these supply and demand factors profoundly altered the geography of trade.

The 2000s were clearly characterised by the growing share of South-South trade and the falling share of North-North trade (Chart 2). This reconfiguration is occurring while trade volumes increase in both cases, *id est*, in a win-win situation for both North and South. Between 2000 and 2008, South-South trade expanded by an annual average of 19% while the share of South-South trade in world trade increased from 11% in 2000 to 18% in 2008. On the other hand, despite a 9% average annual growth, the share of North-North trade in world shrank from 50% in 2000 to 41% in 2008.



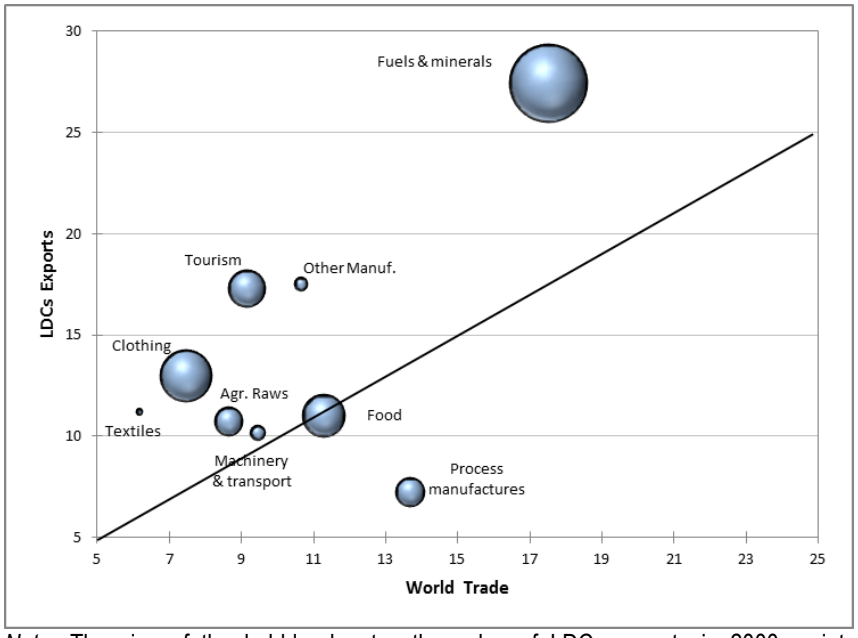

*Source*: Based on UN Comtrade database.

**Figure 2:** Geographical distribution of world trade in merchandises, 1980-2012 (Percentage)

During the 2000s, China emerged as the top destination for LDC exports. In 2012, this country absorbed 23% of LDCs' total exports, up from 9% in 2000. Actually, China represents 44% of LDCs' South-South exports. [5] The European Union accounted for 19% of LDCs' exports in 2012, down from 27% in 2000. The United States was the third destination market for LDC products with 11% in 2012 - half of the 2000 share. It should be highlighted that the relative drops in the weight of South-North exports took place in spite of 13% and 9% average annual growth of LDCs exports to the European Union and the United States between 2000 and 2012. In other term, relative gains/losses took place in a dynamic context. Charts 3 and 4 are 45° diagrams that depict the extent to which LDCs gained/lost market shares in selected products and markets between 2000 and 2008. During the super-cycle, LDCs have gained market shares in the world's most dynamic sectors (fuels and minerals) and most dynamic markets (China and India). In view of this, it is not surprising that the overall market share of LDC exports rose during this period. A more elaborate shift-share analysis [6] leads to the same conclusion, with fuels and minerals accounting for more than three-quarters of the growth of LDC exports between 2000 and 2008. The chart shows also that LDCs improved their market share in the dynamic sector of travel services (tourism).

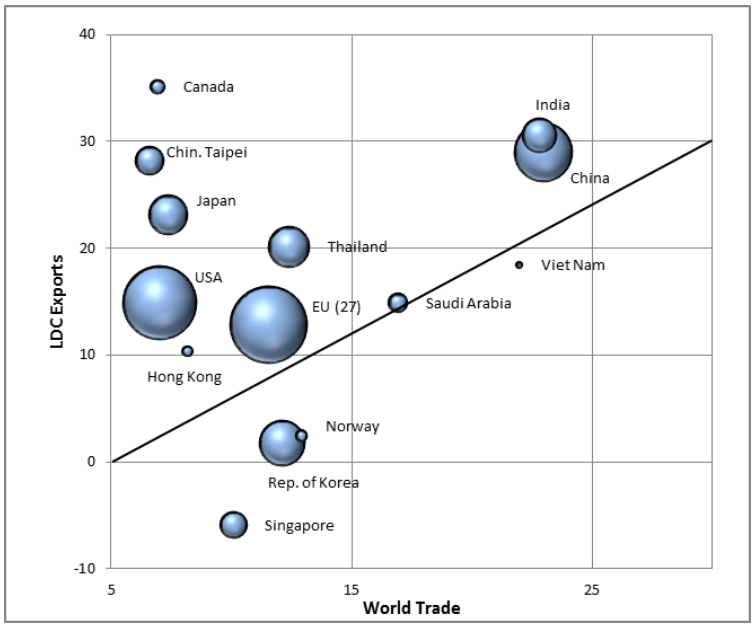
[5] As destination markets for South-South trade, other developing Asia and Africa represented 16% and 10% of LDCs exports in 2012. Intra-LDC trade is under recorded due to statistical gaps; WTO estimates indicate an average annual increase of 17% in intra-LDC trade in the last 12 years (WTO, 2013d). Due to geographic proximity, most of this trade takes place within Africa.

[6] A method used to identify the extent to which growth can be attributed to general global trends and to more distinctly national ones (such as improved competitiveness). See PIEZAS-JERBI, Ninez and Coleman NEE (2009) for further details.




*Note*: The size of the bubble denotes the value of LDCs exports in 2000; points above/below the 45° line denote a growth higher/lower than world average.
*Source*: Based on WTO data.

**Figure 3:** Comparative evolution of LDCs' product specialization, 2000-2008 (Annual average growth, %)




**Notes:** The bubble size indicates the importance of the corresponding market for LDCs exports in 2000; points above/below the 45° line are those for which LDCs have gained/lost market share.
**Source:** Based on WTO data.

**Figure 4:** Comparative evolution of main LDC markets for goods, 2000-2008 (Annual average growth, %)

The value of trade in services, a sector of particular relevance for many small LDCs, increased also at a relatively fast pace, especially after 2005. Albeit LDCs typically run a deficit in the services account, as a group they record a surplus in travel, reflecting the importance of in-bound tourism in their economies (ITC, 2013). Honeck (2012) points that, amongst the few LDCs that have graduated or are expected to do so, almost all have a strong tourist sector.

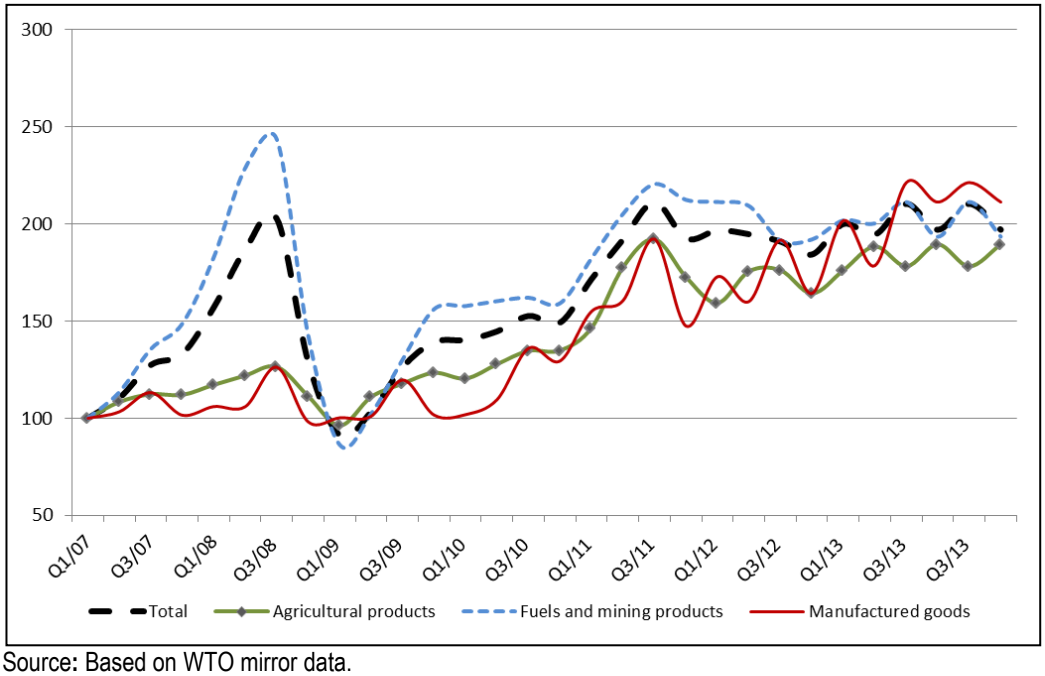
### *2.2. Least developed countries and the great trade collapse*

The rapid increase in the total value of goods and services exported by LDCs during the 2000s came to an abrupt halt in 2008, in the wake of the global financial crisis. Global trade contracted by 22.5% during 2009. For LDCs, the main channel of contagion was through the price effect on commodities. As far as LDC exports of clothing are concerned, specialization in the low-price range of products helped some LDC producers weathering the storm, as cash-constrained consumers in developed markets shifted to the cheapest options. Bangladesh was even able to increase its exports, albeit marginally, thanks to its diversified export partners.

The market for primary commodities, such as fuels and minerals, was one of the first to bounce back but did not recuperate the high value observed immediately before the crisis. All in all, as shown in Chart 5, LDC exports of goods remained below their pre-crisis levels up to the first quarter of 2011. This underperformance is nevertheless, fully attributable to the export price of fuels and mining products. Manufactures (mainly clothing exported by Asian LDCs) fared better than other products during 2013.

Trade in commercial services has been generally more resilient than trade in merchandise. However, transportation and – to a lesser extent – travel (which includes tourism expenditure) have been significantly affected. All in all, the LDCs went through the 2008-2009 crisis reasonably well, considering the structural vulnerability of their economies and the extent of the global recession. In contrast to past crises and to other groups of countries in the world, growth remained positive for LDCs as a group and in two-thirds of individual LDCs (for a review, see Audiguier, 2012).

Recovery suffered a second negative shock in 2011 when the world economy was plagued by a series of economic, political and natural shocks. The European economy was hit by the euro sovereign debt crisis, with negative impact on its economic growth and international trade lasting up to mid-2013. In the meantime, China and most other large emerging economies were revising downward their growth expectations. After rebounding in 2010 and 2011, world trade growth remained sluggish during 2012 and 2013, not growing much over 2% in real term. All in all, the 2008-2009 crisis probably signalled a turning point in the Great Global Transition which started with China's accession to WTO in 2001. After a first period of rapid growth and profound structural changes that marked the global rebalancing between East and West, the world economy may have entered a period of slower growth.

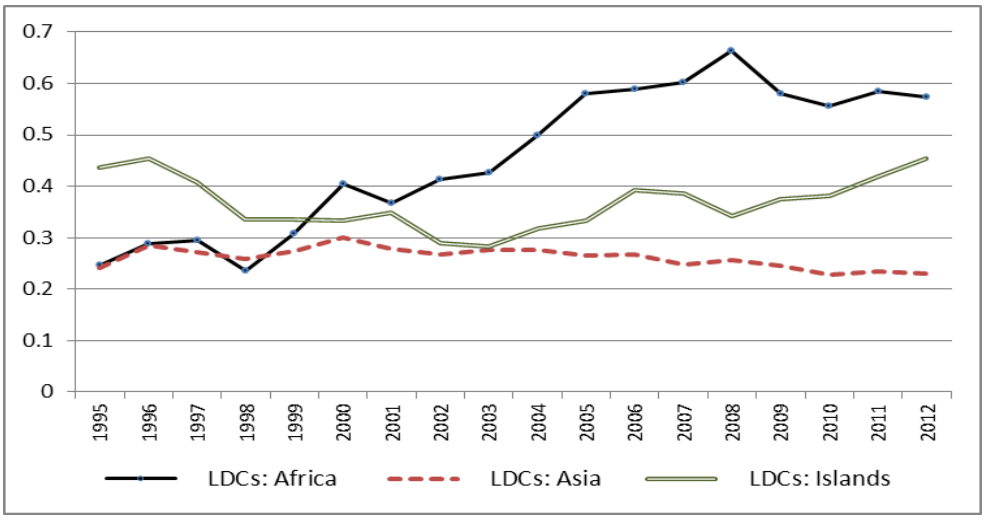



Source: Based on WTO mirror data.

**Figure 5:** Quarterly evolution of LDCs merchandise exports value, by major product groups, 2007-2013 (Index Q1/07 = 100)

### *2.3. Dynamic momentum but structural weaknesses*

LDCs' income from exports is known to be particularly vulnerable to external shocks due to their lack of diversification. Export concentration is usually understood as the degree to which a country's exports are concentrated on a small number of products or a small number of trading partners. Due to the lower degree of development of their productive sectors, LDCs are heavily dependent on a few natural resources products where they enjoy some degree of comparative advantage. Even when LDCs were able to diversify into manufactures, the range of exports is usually limited to a few labour-intensive industries, mostly in clothing. For eight LDCs, the top three products accounted for more than 95 per cent of their export receipts before the 2008 crisis, illustrating the vulnerability of these economies to fluctuations in international trade. Some small island LDCs also depend very heavily on tourism receipts as the dominant source of exports.

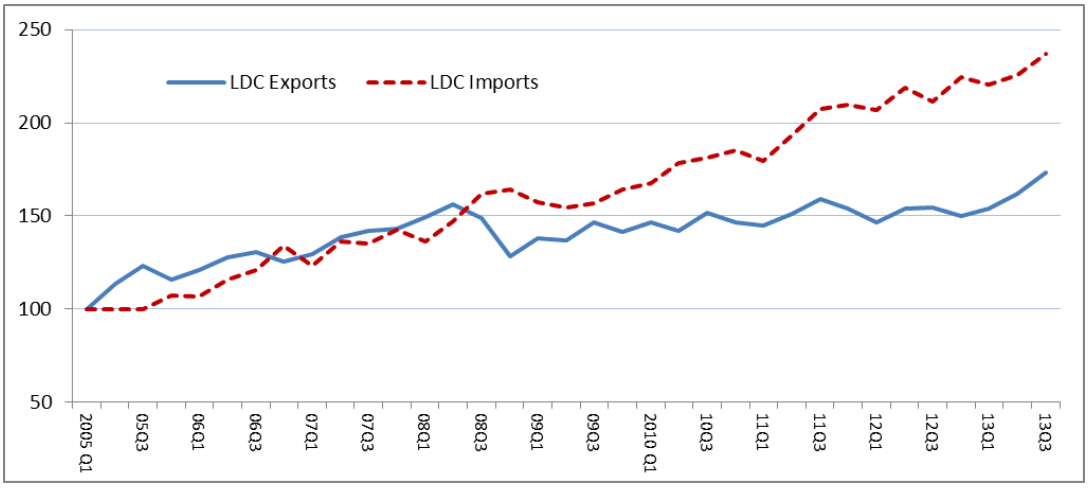



*Note*: Herfindahl-Hirschmann index normalised to range from 0 (minimum) to 1 (maximum).
*Source*: Based on UNCTAD.

**Figure 6:** Evolution of the concentration of LDC merchandises exports, 1995-2012

If the geographical diversification of LDCs exports improved during the past decade, the rise of commodities during the super-cycle tended to exacerbate the dependency on commodity exports, at least for the LDC countries that have large natural resources endowments. Chart 6 shows that the concentration index of African LDCs increased up to the 2008 global crisis. This is almost entirely due to the rise in the international price of fuels and minerals. On the contrary, the concentration index of Asian LDCs, which are diversifying into labour-intensive manufactures, decreased. Island LDCs are somewhere in between but they tend to rely more on services (particularly tourism) for their export revenues; a higher concentration on merchandises exports is less of an issue for them than in the case of Africa.

While African LDCs' export dependency increased because of the super-cyclical commodity price hike, it should not be understood as a structural regression or a bad thing by itself. This is a windfall gain which can translate into structural improvements if used for developing infrastructure or fostering productive investment in tradable goods and services production. On the other hand, the vulnerability to export price fluctuations is a real issue, because the LDCs as a group have recorded trade deficits, with the exception of a few years that immediately preceded the global crisis of 2008-2009. This structural deficit, symptom of supply shortcomings, micro-economic inefficiencies and economic imbalances, develops into acute economic and social issues when export earnings drop while imports include a large share of essential goods such as fuels or food whose demand is inelastic.




*Source*: Based on UNCTAD and WTO data.

**Figure 7:** Quarterly evolution of LDCs export and import volumes, 2005-2013 (index 2005 Q1 = 100).

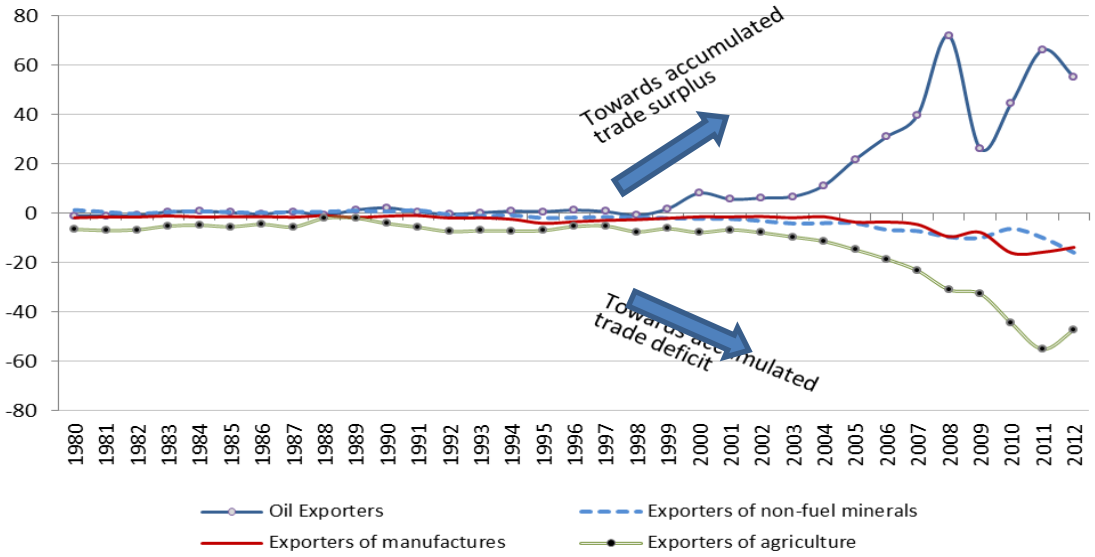
The risk is compounded if, after a commodity price bonanza, the windfall gains are treated as a permanent income shift that increases the structural demand for imports. It may have been the case on the basis of the limited statistical information available. While import and export volumes tend to move together up to the 2008-2009 crisis, a decoupling took place after the crisis and merchandises imports have been growing faster than exports (Chart 7). In such a situation, the end of the super-cycle would translate into growing trade deficits that would prove unsustainable.

The deficit is particularly high for manufactures, followed by agricultural goods (Table 1). The heterogeneity between sub-groups exploded in the 2000s. The oil exporting sub-group was the only one to post trade surpluses in the 2000s, although this was not even the case for all countries within that group. Trade balances of mineral and manufacture exporters became somewhat equilibrated in the 2000-2008 period, albeit these groups incurred trade deficits towards the end of the period. The super-cycle was obviously not such a good thing for LDCs that are net importers of fuels and minerals; they saw their trade balances becoming increasingly negative, with the largest trade deficits being among the agricultural exporters and the LDCs without a clear export specialization.

**Table 1:** LDCs trade balance in goods by merchandise groups, 2000-2012 (billion dollars)

| | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|
| Total merchandise | -7.3 | -4.7 | 2.9 | 3.6 | 6.0 | -26.0 | -7.0 | -4.3 | -18.4 |
| Agriculture [a] | -1.9 | -5.3 | -6.6 | -9.3 | -15.2 | -14.4 | -17.6 | -23.4 | -23.8 |
| Fuels | 10.5 | 37.2 | 47.5 | 62.8 | 87.7 | 52.3 | 64.0 | 76.3 | 78.0 |
| Non-fuel minerals | 1.1 | 3.3 | 6.6 | 8.0 | 10.0 | 7.8 | 13.2 | 16.4 | 16.4 |
| Manufactures | -17.5 | -39.3 | -48.6 | -59.3 | -78.7 | -74.8 | -89.1 | -107.9 | -116.3 |

*Note*: Trade balances refer to FOB valuation on both export and import sides. [a] Includes forestry and fishery products.
*Source*: WTO.




*Source*: Based on WTO and UN Comtrade database.

**Figure 8:** LDCs merchandise trade balance by export specialization, 1980-2012 (Billion dollars)

Separating the price and volume effects provides some additional insights into what has been behind these divergent trends (Table 2). Whereas most exporters enjoyed similar export growth in terms of volume, they fared quite differently when it came to the evolution of the average price of their merchandises exports (defined as the average unit value of their total exports) and their year-to-year fluctuations (12% in average for manufacturers vs. 50% for fuel exporters). A completely symmetrical picture emerges when looking at the import side: annual average rate of growth of volume varied significantly across LDC sub-groupings while import prices rose at a more comparable rate. The corollary is that the evolution of the barter terms of trade – positive in the case of fuel and mineral exporters, negative for the rest – goes some way to explain the different trade balance trajectories. Moreover, it is worth pointing to the wide heterogeneities within the different groups in terms of the year to year fluctuations of volume and prices of their traded goods, as indicated by the coefficient of variation.

**Table 2:** LDCs' exports and imports: evolution of volume, unit value and value, 2000-2012 *(Percentage)*

| | Volume | | Unit Value | | Value | |
|---|---|---|---|---|---|---|
| | YoY variation [a] | *Coef .of variation* [b] | YoY variation | *Coef .of variation* | YoY variation | *Coef .of variation* |
| **Exports** | | | | | | |
| LDC Group | 8 | 31 | 10 | 44 | 16 | 59 |
| *of which:* | | | | | | |
| Agricultural exporters | 8 | 28 | 7 | 35 | 13 | 54 |
| Fuel exporters | 7 | 31 | 12 | 50 | 17 | 63 |
| Mineral exporters | 10 | 31 | 9 | 41 | 18 | 63 |
| Manufacture exporters | 10 | 39 | 2 | 12 | 12 | 48 |
| Other exporters | 5 | 15 | 8 | 34 | 10 | 38 |
| **Imports** | | | | | | |
| LDC Group | 10 | 38 | 6 | 26 | 15 | 54 |
| *of which:* | | | | | | |
| Agricultural exporters | 10 | 35 | 6 | 26 | 14 | 53 |
| Fuel exporters | 13 | 46 | 5 | 21 | 17 | 58 |
| Mineral exporters | 12 | 40 | 6 | 25 | 17 | 61 |
| Manufacture exporters | 6 | 22 | 6 | 30 | 12 | 50 |
| Other exporters | 4 | *18* | 7 | *31* | 11 | *42* |

*Notes*: [a] Average annual rate of growth over the 2000-2012 period of total merchandise exports for LDCs group and by export specialization sub-groups. [b] Standard deviation divided by average variation.

*Source*: based on WTO and UNCTAD data.

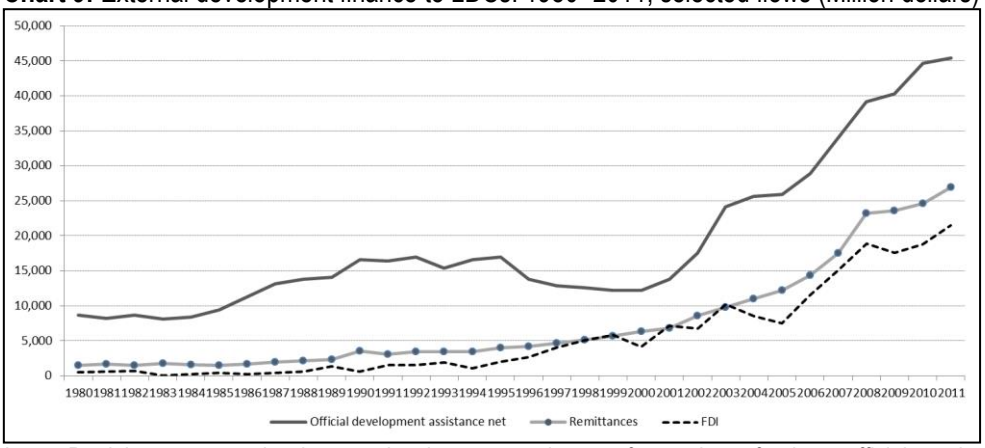
As far as services are concerned, LDCs typically run a deficit in the services account. As a group they tend to record a surplus in Travel services, once again reflecting the importance of in-bound tourism in their economies.

### *2.3.1. Financing the gap: role of aid and worker remittances*

LDCs registered trade surpluses in 2006-2008, but from the perspective of the past three decades this was an "exception to the rule". Moreover, these positive trade balances were due primarily to fuel exporting countries and, to a lesser extent, to mineral exporters. Because LDCs cannot finance their structural deficit on private markets as do some high-income countries, these deficits could exist in the long-term without leading to unsustainable external debt only because they were financed from other external sources, such as official assistance (including debt cancellation) or workers remittances.

Although data are not available for all LDCs, Chart 9 indicates the importance of foreign direct investment (FDI), Official Development Assistance (ODA) and worker remittances. Between 1980 and 1999, ODA, remittance and FDI flows increased by an annual average of 1.8%, 7.4% and 13.4% respectively; while the corresponding growth figures for the years 2000 and 2011 were much higher at 12.6%, 14.1% and 16.1%. The global crisis affected only FDI flows, which declined by 7% in 2009. Besides its financial importance for balance of payments, FDI plays a fundamental role in transferring technology and skills to LDCs. [7] FDI caught up the lost ground in 2010 and continued to grow by a further 14% in 2011 thanks to inflows coming notably from emerging Asian economies. Albeit at relatively decelerated rates, both ODA and remittances kept growing during the crisis.

**Chart 9:** External development finance to LDCs: 1980- 2011, selected flows (Million dollars)




Notes: Partial coverage only; data on development assistance from private funds or official south-south partners are missing, as well as other flows of importance such as debt relief and budget support.

*Source*: OECD, World Bank and UNCTAD.

Remittance receipts of LDCs had nearly doubled from US$3.5 billion in 1990 to US$6.3 billion in 2000. Between 2000 and 2011, remittances quadrupled to US$27 billion. The magnitude of ODA was twice that of remittances and three times of FDI in 2000. In 2011, ODA was only one and half times bigger than remittances and double that of FDI mainly due to budgetary constraints in the developed economies. However, official figures underestimate actual flows of remittances. According to World Bank (2010), if remittances sent through informal channels are included, total remittances could be as much as 50% higher than the official record. Remittance flows have offset large trade deficits in many countries like Bangladesh and Nepal and enabled these countries to maintain a current account surplus (Mohapatra, Ratha and Silwal, 2010). Moreover, they constitute a significant complement to domestic income, about 8% of GDP in average of the LDCs in 2011 according to World Bank data. In some cases (Haiti, Lesotho, Nepal, Liberia and Samoa) remittances are higher than 20% of GDP. In addition to providing a supplement to household income, resources from remittances have been directed to investments in infrastructure, education and health, among others (Varma, 2009).

[7] In 2011, at US$21 billion, FDI flows to the LDCs accounted for only 1.3% of world FDI according to UNCTAD. More positively, FDI to the LDCs takes mainly the form of greenfield projects rather than mergers and acquisitions between existing firms.

## 3. Trade policy and preferential market access

LDCs have benefited from a series of preferential market access to developed countries, promoted under the "Enabling Clause" and the Generalized System of Preferences (GSP) or resulting from bilateral or regional agreements. [8] More recently, South-South trade preferences were promoted with the establishment of the Global System of Trade Preferences among Developing Countries (GSTP). In December 2005, the Sixth WTO Ministerial Conference in Hong Kong adopted a decision to extend LDCs' duty-free quota-free (DFQF) market access granted by developed countries to at least 97% of tariff lines. India became the first developing member country to announce its intention to implement the decision in April 2008; since then a growing number of developing countries have also granted specific preferences to LDCs. The utilization and effectiveness of such preferences have been intensively debated in the development economics literature (see Hoekman and Ozden, 2005 for a review).

### *3.1. LDC trade policy*

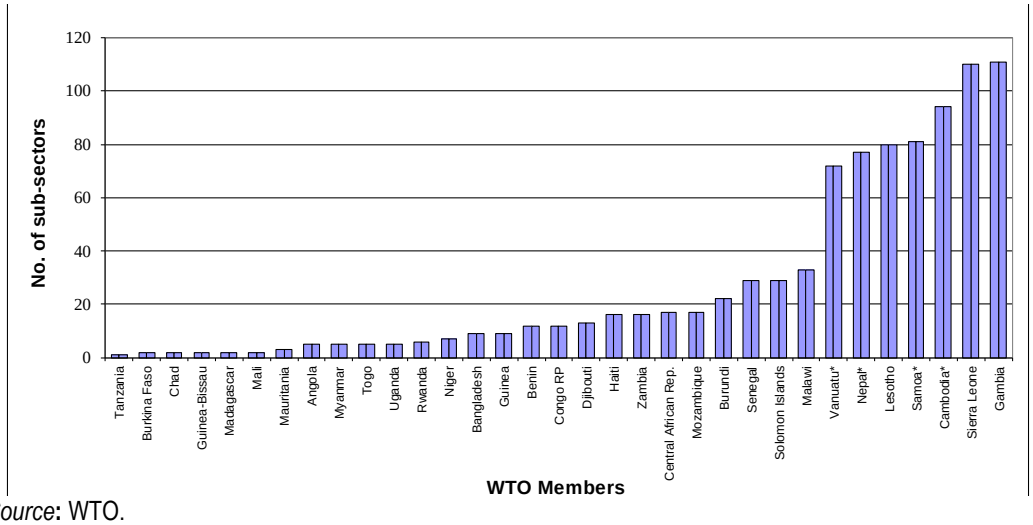
LDC tariff policy is usually characterised by high bound and applied tariffs, and incomplete binding. As shown in Diakantoni and Escaith (2009), LDCs tend to apply high duties (with some exceptions). The bound tariffs and the binding overhang (difference between bound and applied tariffs) are higher for agriculture than other products (Table 3).

**Table 3:** Average tariff profile of LDC countries, 2011 (Percentage)

| pplied MFN Tariff [a] | | | Binding Coverage b | | Average Bound Tariff [a] | | |
|---|---|---|---|---|---|---|---|
| Total | Agriculture | Other products | Total | Non-Agriculture | Total | Agriculture | Other products |
| 11.7 | 14.8 | 11.3 | 59.3 | 53.2 | 59.9 | 73.7 | 42.6 |

*Note*: [a]: ad valorem and equivalent, simple average of countries' tariffs; [b]: percentage of tariff lines.
*Source*: Based on World Tariff Profile 2012, ITC-UNCTAD-WTO

With respect to services, the difference between the existing (or applied, using the term used in tariff) LDC trade openness in services and their GATS (binding) commitments is now quite wide according to Gootiiz and Matoo (2009) and Honeck (2012). In order to attract FDI, many LDCs have already fully opened a wide range of services sectors. As seen in Chart 10, the number of existing GATS commitments varies widely among the LDCs by subsector, ranging from over 110 (Gambia and Sierra Leone) to only 1 or 2 sub-sectors (Burkina Faso, Chad, Madagascar, Mali and Tanzania).




*Source*: WTO.

**Figure 10:** LDCs GATS Commitments, 2012

[8] Among the specific LDC schemes are Canada's Least Developed Country Tariff (LDCT) and the EU's everything but Arms (EBA) initiatives. In addition, LDCs and other developing countries have benefited from regional preferential schemes, such as the EU's arrangement for Africa, Caribbean and Pacific (ACP) countries and the US' African Growth and Opportunity Act (AGOA) and Caribbean Basin Initiative (CBI).

### 3.2. Preferential market access

In terms of market access conditions for their exports, LDCs benefit from lower tariff duties for their merchandise exports, either because they tend to export on tariff lines with low MFN tariff (fuels and minerals) or thanks to preferential schemes. As shown in Table 4, the situation varies according to the markets of destination (developed vs. developing economies) and the type of exported products. On agricultural products, the average margin of preference over MFN treatment (6 percentage points) granted to LDCs exports is similar for both developed and developing countries. Nonetheless, the resulting best tariff remains much higher when the products are shipped to developing countries (7.6%) rather than industrialised ones (2.2%). On non-agricultural products, the situation is reversed. LDCs exports to other developing countries benefit from very low margin of preference, yet the best tariff applied is usually lower (1.1% in average) than in developed countries (2.3%).

This apparent paradox is explained by the different product composition of South-North and South-South LDCs exports. True preferential treatment, after discounting those tariff lines that are not dutiable under the common MFN treatment, is considerably lower for exports to developing countries as only a few emerging countries have operative preferences in place. Low applied duties on South-South trade results from trade being largely dominated by exports of primary commodities (fuels and minerals) that have a very low MFN tariff while South-North exports are more concentrated on those processed goods and other manufactures that benefit from higher preference margin (4.2 percentage points).

**Table 4:** Exports of LDCs to developed and developing markets, per sector and duties faced, 2011 or closest year (Million dollars and percentage)

| Market of destination | Sector | Trade value (Mn$) | MFN tariff average [a] | | Preference | Best tariff | DutyFree Imports | |
|---|---|---|---|---|---|---|---|---|
| | | | Simple | Weighted | | | % of TL | % of Value |
| Developed countries | Agriculture | 3,467 | 51.0 | 8.2 | 6.0 | 2.2 | 99.6 | 98.6 |
| | Other | 45,503 | 5.3 | 6.4 | 4.2 | 2.3 | 90.9 | 86.1 |
| Developing countries | Agriculture | 4,069 | 15.4 | 13.5 | 5.9 | 7.6 | 54.5 | 61.8 |
| | Other | 65,310 | 8.6 | 1.6 | 0.6 | 1.1 | 56.3 | 81.1 |

*Notes*: a: Traded tariff lines only.
*Source*: Based on World Tariff Profile 2012, ITC-UNCTAD-WTO

#### *3.2.1. Facilitating trade and operationalizing market access preferences*

All the above mentioned indicators based on best applicable tariffs are established on the hypothesis that available preferences are fully used by the exporters. This may not be the case for a number of reasons; ranging from ineligibility –due to non-conformity to some criteria such as rules of origin or non-tariff measures– to excessive administrative cost to benefit from the preferential scheme. Other limitations are closely related to supply-side issues rather than pure trade questions. For example, sanitary and phytosanitary standards (SPSS) are often an obstacle for agricultural exports to developed countries. Using the example of Senegal, Mbaye and Gueye (2014) relate how the issue of pesticide residues has become an issue for African exports to Europe over the past several years.

The specificity, design and application of rules of origin can make it difficult for LDC exporters to benefit from preference schemes. Strict rules of origin (or regional cumulation) were justified on the ground that they help in promoting integrated production structure in the recipient country. This aim is now questioned as manufacture production is increasingly performed in the context of global industrial networks (Zedillo *et al*, 2005; Jara and Escaith, 2012). This is a particular problem in textiles and apparel, which are key exports for LDCs, as recalled during the 9th WTO Ministerial in 2013. Looking at agriculture, Bureau *et al*. (2006) find that the overall rate of utilization for non-reciprocal preferences is high in the case of the EU and the USA (89% and 87%) thanks, in part, to the various options offered to exporters that allow avoiding the most demanding schemes. When exporters to the EU or the US have the choice, they favor Cotonou in the case of EU, or CBERA in the case of the US. Controlling for tariffs, the authors infer that administrative requirements, rules of origin or predictability of

the respective regimes are potential determinants of the choice between regimes, Bureau, Jean Claude, Raja Chakir and Jacques Gallezot (2006).

Thanks to leaner administrative procedure and simpler rules of origin, utilization rates of preferential treatment in developed countries have steadily improved in the past decade and are now at an average of 90 %. No data are available yet for the utilization of preferences granted by developing countries. It is often stated that preferences lower than 4 percentage points do not materialize in significant competitive advantages and lead to low preference utilization. On this last point, however, recent research shows that they may still matter below such threshold. Keck and Lendle (2012), using US import data, find that utilization rates remain often very high, even for very small preferential margins. Measuring the actual impact of preference remains an empirical debate due its statistical complexity. Disdier *et al*. (2013) develop a dedicated database for 1996 and 2006 and find that the impact on LDCs and non-emerging developing countries was more at the intensive margin than at the extensive one (export diversification). Besides the empirical debate, the fact that preferences are generally fully utilised by exporters tend to suggest that these preferences have positive effects.

Another constraint for diversification is that better LDC preferences, even when fully utilized, are counterbalanced by higher transaction and transportation costs that reduce LDCs' competitiveness vis à vis their main competitors. Trading involves a series of transaction costs — delays, documents and administrative fees — that increase domestic prices. When these costs are significantly higher than those of the competitors, as it is often the case in LDCs, they may lead to loss of market share or missed business opportunities. These costs are part of the supply constraints that frequently reduce the international competitiveness of LDCs and limit their trade potential.

The comparison of transaction costs confirms that LDCs face a comparative disadvantage when exporting goods (see low income countries in Table 5). According to UNCTAD (2007) CIF/FOB difference for Africa was 10 per cent in 2005, compared to a world average of 6 %. ECE (2003) reviews a series of transport cost studies for developing countries and conclude that a large part of the disadvantages faced by Southern Africa has to do with transport costs; this problem being particularly acute for landlocked countries. As mentioned by Djankov *et al* (2010), each additional day that a product is delayed prior to being shipped reduces trade by more than 1%. The delays are particularly damaging for time-sensitive goods, such as perishable agricultural products, which are of particular interest to LDCs as they are both labour intensive and high value-added

High international trade costs are usually correlated with poor inland transportation infrastructure which reduces not only the potential for international trade but also dampens the possibility for small producers in remote areas to tap the potential of regional markets. The issue is particularly acute for Sub-Saharan Africa (Buysa *et al*., 2010) but is also representative of the situation of most large LDCs,

Cross-border bottlenecks such as border procedures, cumbersome documentation or complex and mismanaged regulations reduce the competitiveness of LDCs exports. They act like a tax on the income of the exporters who are "price takers" and cannot include the higher transaction costs into their bidding prices. The problem, as we shall see later, is compounded when LDCs intend to diversify by joining global value chains. Delays in delivery and the necessity to maintain high inventory levels to cope with them run against the core management model of international supply chains, based on just-in-time and minimum buffer stocks. Indeed, the issue was deemed serious enough for the WTO to devote its entire 4th Global Trade Review of Aid for Trade in 2013 to the role of trade facilitation in helping LDCs joining global value chains[9].

**Table 5:** Logistics Performance Index by country grouping, 2012

| Country grouping [a] | LPI [b] | Customs | Infras-tructure | International shipments | Logistics competence | Tracking & tracing | Time-liness |
|---|---|---|---|---|---|---|---|
| High income | 3.55 | 3.36 | 3.56 | 3.28 | 3.5 | 3.65 | 3.98 |
| Upper middle income | 2.82 | 2.49 | 2.54 | 2.86 | 2.71 | 2.89 | 3.36 |
| Lower middle income | 2.59 | 2.23 | 2.27 | 2.66 | 2.48 | 2.58 | 3.24 |
| Low income | 2.43 | 2.19 | 2.06 | 2.54 | 2.25 | 2.47 | 2.98 |

*Notes*: [a]: According to World Bank specifications; [b]: Logistics Performance Index (LPI) is the weighted average of the country scores on six key dimensions: Efficiency of the clearance process by border control agencies; Quality of trade and

[9] "Fourth Global Review of Aid for Trade: Connecting to value chains" 8-10 July 2013, Geneva.

transport related infrastructure; Ease of arranging competitively priced shipments; Competence and quality of logistics services; Ability to track and trace consignments; Timeliness of shipments in reaching destination within the scheduled or expected delivery time. The index ranges from 1 to 5, with a higher score representing better performance.

*Source*: Logistics Performance Index: Connecting to Compete 2012, World Bank.

Trade facilitation is vital for LDCs as it will reduce costs for traders. It will also boost intra-regional trade, which is often the first exporting step for small and medium sized domestic firms. It is particularly important for African least developed and low-income countries, many of them being land-locked. For these landlocked countries, the average customs transaction costs was almost 240% higher than other LDCs in 2012; and it took more than 40 days to ship a container, compared to the already long 27 days necessary to get things done in other LDCs.

**Table 6:** LDCs cost to export, 2010 and 2012

| | Cost to export (US$ per container) | | Documents to export (number) | | Time to export (days) | |
|---|---|---|---|---|---|---|
| | *2010* | *2012* | *2010* | *2012* | *2010* | *2012* |
| Total LDCs | 1818 | 1860 | 7.6 | 7.6 | 33.8 | 32.5 |
| - Landlocked | 2885 | 2977 | 8.6 | 8.5 | 44.6 | 42.4 |
| - Non-landlocked | 1230 | 1244 | 7.1 | 7.1 | 27.9 | 27.0 |

*Source*: Based on World Bank data

Besides trade facilitation, the overall reduction in tariff barriers obtained through MFN or preferential agreements means that additional issues such as non-tariff barriers, compliance with sanitary and phyto-sanitary standards, are getting more and more attention.

## 4. The way ahead: export diversification and trade in tasks

While LDCs "surfed" relatively well through the Great Trade Collapse of 2008-2009, their next challenge is the probable conclusion of the "super cycle" that kept the international prices of most commodities at historically high levels. The second phase of the Great Global Transition is driven by further changes in the sources and origin of global demand, in particular the shift in the main sources of China's growth. The reduction of public investment in infrastructure and heavy industry in this country may reduce the growth of imports of minerals and fuels, driving down their international prices. The future of oil prices is further obscured considering that the USA is progressively becoming self-sufficient thanks to the exploitation of new sources of gas. This reversal will/may catch the LDCs in a situation of renewed external vulnerability, as their trade balance has returned into negative territory after the 2008-2009 crisis.

In order to avoid returning to the boom-and-bust pattern that characterized their growth in the past, it is increasingly necessary for LDCs to diversify their exports into new (labour-intensive) activities. One traditional determinant of trade performance for least-developed countries is product and market diversification. Services, in particular tourism, are an example of such diversification. In the case of merchandises, this strategy has more recently been enriched with additional possibilities created by the changes in consumer preferences ("trade in varieties"), on the one hand, and the way manufactures production is now organised along global supply chains ("trade in tasks").

Our first option for product upgrading is tapping the new potential created by consumers' demand for varieties to increase revenue per unit of output. Quality control (such as reducing pesticide content and improving handling and storage facilities, as suggested by Mbaye and Gueye, 2014 in the case of Senegal), labelling and branding are being used by producer of agro-food products to extract a better price from their traditional exports. "Trade in varieties", including organic farming certification and labels of origin, allows small producers to benefit from niche markets and should now be considered as export diversification.

The other option is the possibility of joining global production networks and exporting particular "tasks" rather than entire finished products. Trade in tasks and global value chains are among the important markers of international trade in the early 21st century; Jara and Escaith (2012) review the implications on global governance, trade policy and trade statistics. By accelerating the transmission of technology and know-how, this trend contributed greatly to the rapid industrialization of emerging countries in the past 15 years. Actually, most of

the East Asian miracle can be attributed to trade in tasks; and even China's rapid march towards industrialization relied on global supply chains (see WTO and IDE-JETRO, 2011).

Yet, with a few exceptions, connecting to global production networks in order to benefit from these new opportunities is a formidable challenge for most LDCs. The usual points of entry for LDCs into global value chains are agro-food, clothing and tourism sectors. Nevertheless, as highlighted by P. Lamy (WTO, 2013b), in a new global world where connection to industrial networks is the key to industrialization, least developed countries are also the "least connected countries". With these caveats in mind, the overall picture is not negative when looking at the trend of intermediate goods imports. LDCs imports of such goods have increased from US$18 billion in 2000 to US$87billion in 2012, which represents an average annual increase of 14% in comparison to the world average of 8%.

Using network analysis, Escaith and Tamenu (2013) analyse the topology of LDC trade in imports of intermediate inputs and in exports of final goods. They observe the rise of China as a key supplier of intermediate inputs to LDCs during the 2000s. Even if EU27 remains the lead supplier of LDCs (many of them being in Africa), its dominant position was much eroded between 2000 and 2011. Surprisingly, the USA is not such an important source of supply for LDCs, even in 2000. The 2011 trade network is less “dense” than in 2000, pointing towards a better geographical diversification of LDCs sources of supply. Yet, trade in intermediate inputs is very heterogeneous within the LDC group. Bangladesh is by far the largest LDC importer of intermediates (US$21 billion in 2012, up from US$5 billion in 2000), followed by Angola (US$8 billion in 2012). Bangladesh alone accounted for 24% of LDCs total imports of intermediate goods in 2012.

South-North trade remains predominant when it comes to LDCs export market of the labour intensive products (agri-food and manufactures) that are typically the result of GVCs. EU27 is the most important trade partner for this type of exports and USA’s role is also prominent. China’s imports, though growing during the decade, remains secondary while India emerged as one of the main regional importers of LDCs final goods during the 2000s.

Besides tracking trade flows of intermediate and final goods, countries' and sectors' participation in global value chain is given by a new measure of trade called "trade in value added". Using inter-linked input-out matrices, the idea is to track down for each industry in each country the use of domestic and imported inputs, in order to estimate the foreign and domestic content of output, including exports (see OECD and WTO, 2012 for a presentation of the methodology). The OECD-WTO Trade in Value-Added (TiVA) database is intensive in the use of trade and structural data and it relies only on official data sources. For this reason, only one of the 57 countries covered (Cambodia) was an LDC at the time of writing this document. But the results obtained on this country are illustrative, even if they cannot be counted as representative.

Cambodian exports of manufactures are concentrated on "clothing", by far the major manufacturing sector represented in LDC exports (60% of LDCs' manufactured products, WTO 2013b). The foreign value-added content in Cambodian exports of clothing, estimated at 63% in 2008 is much higher than what is observed for developing economies and the world average (around 25%). 10 This high share reflects the fact that LDCs usually insert themselves in GVCs thanks to their comparative advantage in terms of labor cost for assembling or processing imported intermediate components. This processing trade, typically done in "Export Processing Zones" relies on imported inputs to produce and export goods for lead foreign companies. For other developing countries that have been moving-up on the value-chain ladder, 75% of their exports in "textiles and textile products, leather and footwear" were based on domestic value added. Moreover, while most of the domestic value added of Cambodia's textiles and clothing exports were destined for final consumption, two-thirds of other developing countries exports were further processed in other countries, showing a deeper insertion as upstream suppliers in international supply chains.

The UNCTAD-Eora dataset that was developed for UNCTAD (2013), extends trade in value-added calculation to 187 countries. In contrast to WTO-OECD TiVA, Eora uses an algorithmic approach to fill data gaps when actual statistics are missing (for a review of the methodology, see Lenzen *et al*., 2012). On the basis of these estimates, the foreign content of LDCs exports (an indicator of supply chain vertical integration) is low (14%) in average of all industries, only half the world average (28%).11 For comparison, the group of developing

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[10] The "Foreign value added content of exports" corresponds to the inputs that were imported to produce the exported goods and services, net of any domestic content that could have been incorporated in the production of these inputs.

[11] It may be counter-intuitive to use foreign input content in exports (or "vertical specialization", as in Hummels *et al*. 2001) as an indicator of product sophistication and insertion in global value chains. This paradox is only apparent; manufacture (often considered as "high value-added" activity) is in fact characterized by low added-value per unit of output compared to

economies relies on foreign content for 25% of the value of its exports, a proportion that climbs to 30% in East and South East Asia.

LDC suppliers face significant obstacles at most stages for entering and then moving up the value chains. The result of an OECD-WTO survey on the main obstacles identified by private and public stakeholders when joining a GVC were presented at the 4th Global Review of Aid for Trade: Connecting to Value Chains (WTO, 2013b). While value chains are inherently sector-specific, some horizontal conditions across sectors determine firms' abilities to economically upgrade and connect to value chains. 12 Contrary to what is often believed, low production costs do not always substitute for quality when it comes to attracting lead-firms' contracts. 13 Among the main obstacles that LDC firms face in connecting to value chains, more than half of the partner countries identified inadequate domestic infrastructure as the foremost issue, followed by access to trade finance and compliance with SPS or technical standards. Support through better market access, feature high among LDC suppliers (identified as such in 73% of the responses to the survey) as well as among lead firms (44%). Lead firms cited trade facilitation measures (44%) as the most crucial area where support would be effective in bringing LDC suppliers into value chains. Other major areas of support cited are in labor force training (51% of LDC suppliers) and improving public-private dialogue with national authorities (43% of lead firms).

In the context of global value chains, where costs are only one factor of competitiveness to be complemented by just-in-time delivery and reduced logistic and transaction costs, trade facilitation is taking an increasing role in fostering export diversification. In contrast to the more traditional export-led policy, improving import efficiency is also an area that requires additional attention; since in a global production network, access to competitive imports is a key component of the trade strategy. As highlighted by the result of the 4th Global Review, too frequently aid-for-trade programmes fail to exhibit sufficient concerns about this dimension of competitiveness. But border facilitation is just one factor of the new policy equation. From the GVC perspective, investment and trade are inextricably intertwined and other behind-the-border considerations (often referred to as "WTO +" or "WTO X" measures governing market and investment behavior, regional trade agreements, intellectual property regime and business facilitation policies) become particularly relevant (WTO, 2011 and UNCTAD, 2013). Moreover, as highlighted in Milberg and Winkler (2013), insertion in GVCs should not be seen as a risk-free panacea: in a market characterized by quasi-monopolistic organizations, competitive advantages and lead-firms' strategies may change rapidly.

## Conclusion:

A perceptible shift in LDC trade has taken place in the past decade, thanks to the rebalancing of global demand towards large emerging countries and the resulting long-lasting cycle of high international commodity prices. This process resulted in a wider geographical diversification of LDCs' exports but contributed to a higher concentration of exports revenues on a few basic commodities. The latter is most entirely due to a price effect. Indeed, trade statistics show some successful example of diversification in labour-intensive activities, such as textiles and clothing or services, particularly tourism.

From a quantitative perspective, the picture that emerges so far from the changes to the sources of global trade and growth that resulted from the Great Global Transition is positive for the LDCs in both absolute and relative terms. The LDCs' total exports of goods and commercial services registered an annual average growth of 15.5% between 2000 and 2012; higher than other developing economies whose corresponding exports increased on average by 12% per year during this period.

Notwithstanding some progress in market and product diversification, LDCs' trade remains concentrated on a few products, increasing the fluctuation of export revenues due to variation in international prices. The vulnerability is accrued when considering that, with the exception of 2006-2008, the LDCs as a group have systematically recorded a trade deficit. Actually, net trade balances started diverging dramatically in the early

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primary or tertiary sectors. Upstream industries (agriculture, mining) that rely less on domestic or imported inputs have typically much higher value-added coefficients (up to 100% in the case of subsistence agriculture which does not use commercial inputs such as fertilizers or improved seeds).

[12] The exercise conducted by OECD and WTO was based on self-assessments from 80 developing countries and 52 bilateral and multilateral cooperation agencies. On the business side, 524 supplier firms in developing countries and 173 lead firms were surveyed. The survey includes sector-specific issues for agro-food production, tourism, textiles and apparel, information and communication technology, transport and logistics.

[13] Better said, price and quality can be substitutes, but only up to a certain point. Sutton (2012) shows that wage adjustments cannot fully compensate for poor levels of productivity and quality. More generally, trade in "varieties and qualities" are features that weight more and more on export diversification and product up-grading.

2000s, reflecting a deeper heterogeneity in the situation of individual countries. Fuel exporters record persistent trade surpluses while the non-fuel LDC exporters have to resort to external resources to finance their growing trade deficits. Their merchandise export revenues cover does not cover more than 57% of their merchandise imports. The situation is particularly acute for LDCs that specialize in agricultural exports.

The 2008-2009 global crisis and the bumpy recovery that followed illustrate the fragility of the recent trends. A slowdown in the growth of large emerging countries and a more inward oriented economic policy in China and other "emerged" economies may put an end to the unprecedented commodity "super-cycle" that lifted the value of LDCs exports since 2003. From such a perspective, renewed efforts towards product diversification are called for.

The efforts of diversifying away from minerals and fuels to labour-intensive products such as agriculture, textiles and clothing has been supported for many years by preferential market access to developed countries. More recently, emerging countries have also been granting such preferences to LDCs product. Despite the worldwide trend of lowering external tariffs through MFN or regional preferential treatment that gradually erodes LDCs margin of preferences, a closer analysis reveals that these countries still benefit from significant preferences, in particular in agriculture.

In the face of changes in consumer behavior, fostering quality control, labelling and branding are some of the options available to diversify at the intensive margin. The objective here is to upgrade by tapping the new potential of niche markets for traditional agro-food exports ("*trade in varieties*"). The rapid development of international production networks as part of the new business model of global value chains offers also new opportunities for export diversification on "*trade in tasks*" at the extensive margin. Because the activities focus on a small part of the value-chain and is often developed in cooperation with lead firms, this new form of industrialisation is particularly relevant for alleviating the supply-side constraints that limit LDCs' export diversification.

On the other hand, competition is fierce and GVC participation cannot materialize without a proper conducive environment. For many LDCs, one of the main obstacles for joining GVCs remains deficiencies in trade and transport facilitation which entail high cost for importing the necessary inputs and exporting the processed goods. Active trade facilitation programmes offer new options to LDCs for joining GVCs. Trade facilitation is also important for improving producers' income, because the price they receive for their products is partly determined by the cost of moving the goods from the farm to the end-markets. For those, like Bangladesh or Cambodia, that have already been able to join these global production network, up-grading towards higher "value-added" activities requires more encompassing horizontal policies.

Finally, in the on-going Doha Round negotiations, the special and differential treatment of LDCs has received increasing attention since 2008. Notwithstanding the difficulties in reaching a global agreement on the various issues to be negotiated, the "LDC package" appeared as a low-hanging fruit. Besides, agreeing on trade facilitation, the WTO members confirmed in December 2013 at the 9th Ministerial Conference in Bali, the importance of trade facilitation and Duty-Free and Quota-Free market access for LDCs. The challenge now is to operationalize such special and differential treatment in a way that enables recipients to eventually graduate out of the LDC category.

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# THE DEMAND FOR CURRENCY IN MALTA

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**Abstract:**

*This article studies the demand for one particular component of the money stock, currency, in Malta in the light of the existing theoretical and empirical frameworks. In particular, it argues that the commonly applied analytical framework needs to be tweaked slightly for it to explain better the reasons underpinning the relatively high currency demand in Malta compared with other euro area countries. In particular, the presence of a large tourism sector is likely to be boosting demand beyond what one would expect. Similarly the presence of a significant shadow economy appears to be exerting some influence on the magnitude of currency holdings. That said, this study suggests that there is scope for a number of policies which could lead to lower demand for notes, particularly measures to facilitate the use of electronic means of payment and efforts to discourage the shadow economy.*

**Keywords:** money demand; currency; Malta.

**JEL Classification:** E41, E44

## 1. Introduction

Malta joined the euro area at the beginning of 2008. Prior to that date, it had its own currency, the Maltese lira, whose value was determined according to developments in a trade-weighted basket of currencies.[15] Over the decades, its economy turned steadily from a mainly manufacturing and tourism base towards increasing provision of international financial (and other professional) services. The country also passed through a rapid phase of financial sector liberalization ahead of joining the European Union in 2004. Nevertheless, the Maltese economy remains characterized by a very high demand for currency, which contrasts somewhat with its increasingly complex evolution.

This paper, after reviewing the main theories that seek to explain the determinants of money demand, argues that the commonly applied analytical framework needs to be tweaked slightly for it to explain better the reasons underpinning the relatively high currency demand in Malta. In particular, the presence of a large tourism sector is likely to be boosting demand beyond what one would expect. Similarly the presence of a significant shadow economy appears to be exerting some influence on the magnitude of currency holdings. That said, this study suggests that there is scope for a number of policies which could lead to lower demand for notes, particularly measures to facilitate the use of electronic means of payment and efforts to discourage the shadow economy.

[14] Dr. Grech manages the Modelling and Research Office of the Central Bank of Malta. Any errors, as well as the views expressed here, are the author's sole responsibility.

[15] For a description of Malta's pre-euro adoption monetary policy, see Grech (2003).

## 2. Literature review on demand for money functions

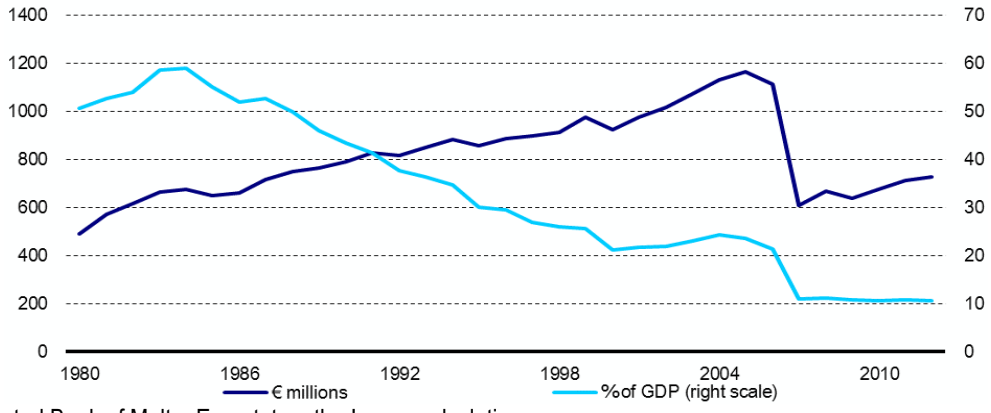
Money serves four main purposes, namely as the main medium of exchange in a modern economy, a store of value, a unit of account and a source of deferred payment.[16] Like any commodity, demand for currency, the most liquid form of money, is mainly driven by price and income variables. Currency is needed to conduct transactions, but holding cash has its cost as its value is eroded by inflation while no interest is earned on it.

In traditional classical theories like Fisher's quantity theory,[17] money does not have any intrinsic utility and serves only as a means of facilitating exchange. The quantity of money is related to the volume of transactions multiplied by the price level of goods and services traded by means of the velocity of circulation. The latter, while assumed to be stable in the immediate future, is deemed to move over time due to changing preferences and payment systems. Therefore, demand for money in this view is solely driven by transactions demand and by changes in payment system arrangements or in consumer payment habits.

In contrast, another strand of the literature, known as the Cambridge approach, argued that money demand played a more substantive role.[18] Rather than being determined by the volume of transactions and by the payments system, currency was seen as demanded in its own right, as a store of value that is convenient and secure. These economists emphasized the role of interest rates, wealth and inflation in helping to determine the demand for money. This was more rigorously defined by Keynes (1936), who developed the concept of precautionary demand (i.e. money kept for contingencies) and of speculative demand (i.e. currency holdings seen also as a reflection of portfolio choices and expectations). These ideas influenced and were, to some extent, incorporated in many other later theories, such as those developed by Friedman in the late 1950s.[19]

Given the importance of understanding the precise nature of money demand, especially the stability or not of this function for monetary policy purposes, many empirical studies have been undertaken in this area.[20] While all studies start with a basic relationship between real money balances to a scale (or transactions demand) variable and an opportunity cost variable,[21] the role allocated to particular variables tends to differ according to the theoretical inclination of the authors. However, most recent studies tend to include the lagged value of the dependent variable as an explanatory variable to better explain its short-term dynamics. These partial adjustment models assume that agents are always in the process of adjusting their current cash holdings to the desired long-run level.[22] On the other hand, the definition of the dependent variable tends to differ, ranging from real currency in circulation or broader monetary aggregates in absolute terms, to ratios of monetary sub-aggregates to broader aggregates, or to measures of total payments.[23]

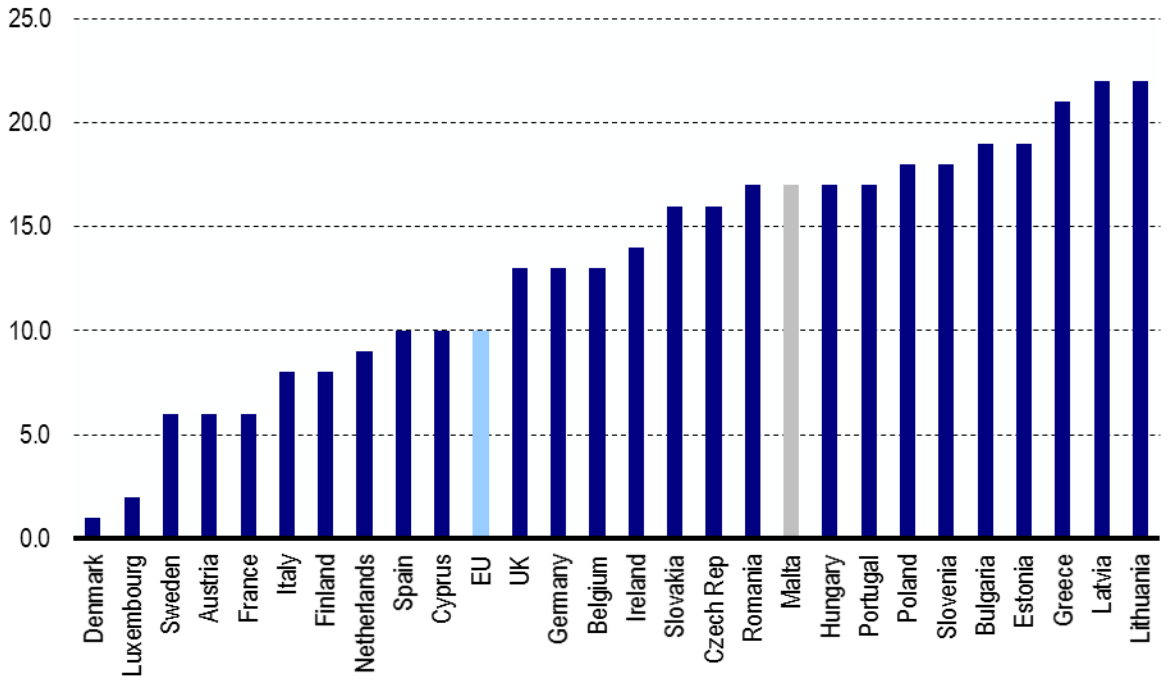
## 3. Currency demand in Malta




*Source*: Central Bank of Malta; Eurostat; author's own calculations.

**Figure 1:** Currency in circulation in Malta: 1980-2012

[16] For a broad explanation of these different roles, refer to Laidler (1993).
[17] Fisher (1911).
[18] See Pigou (1917) and Marshall (1923).
[19] Friedman (1956).
[20] See footnote 2
[21] Sriram (1999).
[22] See Gordon (1984).
[23] For instance, recently some authors are using the ratio of the flow of cash withdrawn from bank accounts to total non-cash payments. See for instance, Ardizzi *et al* (2012).




*Source*: European Central Bank; author's own calculations.

**Figure 2:** Cash withdrawals in EU countries: 2011 (as a percent of GDP)

However, the amount of banknotes issued by the Central Bank of Malta is significantly greater than the value of euro banknotes allocated to the Bank in accordance with the European Central Bank's banknote allocation key, which in turn is based on the Bank's share in the ECB's capital.[24] In addition, the demand for higher denomination banknotes, such as the €200 and €500 notes, is rising and also exceeds that in the rest of the euro area.[25] Moreover, holdings of currency are still very high in Malta, especially when compared with advanced Western European countries.[26] The implied velocity of currency in circulation in Sweden is more than three times higher than in Malta, for instance. In 2011 cash withdrawals from ATMs were equivalent to €2,570 for every Maltese person. This is just below the average observed in the euro area. However, when one translates this in terms of GDP per capita, the amount for Malta becomes nearly double the EU average. As can be seen from Figure 2, cash withdrawals in Malta from ATMs remain relatively high.

## 4. Factors underpinning currency demand in Malta

There are a number of reasons why cash still remains so popular in Malta. Possibly, the most important is Maltese consumers' payment preferences. Besides consumer preferences, this could also reflect those of retailers. The fragmented nature of the retail market in Malta, possibly combined with the uneven impact of bank charges on small retail outlets, could be a contributing factor for the popularity of cash. Convenience may also play a role, as the availability of ATMs in Malta is quite low on a per capita basis, standing at less than half the euro area average. This could lead consumers to maintain higher cash balances.

Despite it probably becoming less important over the years, the relative thinness and weak liquidity of the local financial markets may also contribute to high domestic cash balances. Although the household saving rate in Malta has declined substantially, households have accumulated considerable financial wealth over time. In fact, on a per capita basis, the average Maltese household holds twice the financial assets of the average euro area household.[27] For a considerable period of time, these savings mostly ended up either as cash or bank deposits on account of strict capital controls and the unavailability of alternative assets, such as private debt

[24] The regulation setting out this allocation can be downloaded at: http://www.ecb.europa.eu/ecb/legal/pdf/l_03520110209en00260030.pdf

[25] These data were obtained from the ECB's Statistical Data Warehouse. See http://www.ecb.europa.eu/stats/payments/paym/html/index.en.html

[26] On the other hand, the ratio to M2 to GDP is in line with those in countries like Germany, France and Italy.

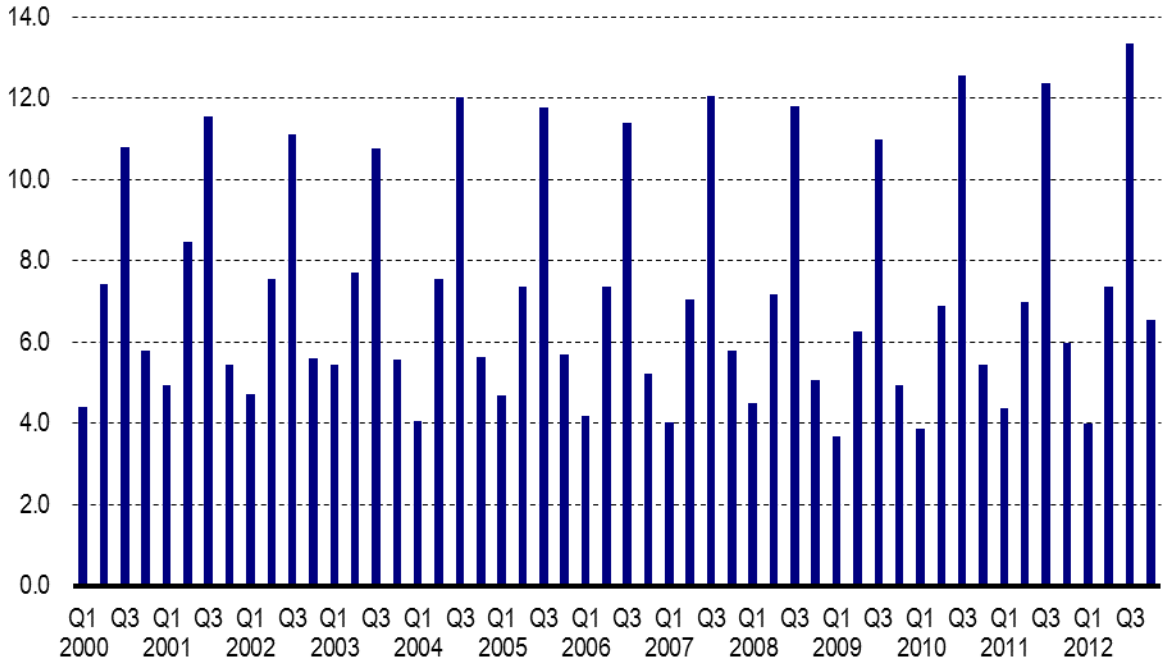
[27] This estimate, based on the results of a survey carried out in 2010, can be found in Caruana *et al.* (2013).

securities, equity and private pension products. In recent years, Maltese households have had more investment options, both local and overseas, but cash may still have retained a larger-than-average share in their portfolio allocation.

Another possible cause could be the shadow economy, i.e. "market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP".[28] A sizeable shadow economy would boost the demand for currency since cash-based transactions are harder to trace. Many US economists in the 1960s and 1970s,[29] who tried to rationalize the rise in currency demand in the post-war period, noticed that standard price and income variables did not have much explanatory power. They therefore introduced tax burden or government regulation variables, arguing that higher demand for cash was being driven by a desire to operate in the shadow economy. They found that these additional explanatory variables were, indeed, significant.

Incidentally, a similar argument was made in Malta in the 1970s in relation to "cash-hoarding".[30] There are a number of estimates of the size of the shadow economy in Malta.[31] Some are the result of cross-country studies, undertaken by the European Commission and by Schneider, which estimate the size of Malta's shadow economy at around a quarter of GDP.[32] Interestingly, these results are very similar to those found in earlier studies conducted by Maltese economists.[33]

One frequently ignored determinant of the use of cash in Malta is the large size of the inbound tourist industry. In parallel with the situation in one part of any monetary union, the currency stock in one country within a multi-country monetary union, such as the euro area, includes the amount issued by the national central bank, plus the net amount that is carried in or out by visitors.




*Source*: own calculations using NSO data on tourist departures, length of stay and population

**Figure 3:** Impact on population size of tourism (percentage)

In 2012 more than 1.4 million tourists visited the Maltese islands, more than three times the size of the resident population. Figure 3 quantifies this impact by converting the number of tourists into an equivalent resident using data on the average length of stay of tourists. Thus, if on average tourists stay 7.5 days in a month,

[28] Smith (1994).
[29] Cagan (1958) and Guttman (1977).
[30] Delia (1978).
[31] These studies tend to follow the approach developed by Tanzi (1983).
[32] See Schneider (2007) and Kearney & Schneider (2012). According to these studies, Malta has one of the largest shadow economies, equivalent to between two and three times the euro area average.
[33] See Cassar (2001) and Briguglio (1989).

they are treated as equivalent to a quarter of a resident. Using this approach one finds that there have been points at which the local population has been boosted by nearly a seventh as a result of incoming tourists.[34] Incidentally, the latest available ECB payment statistics suggest that in 2012 €0.2 billion were withdrawn from ATMs in Malta by means of cards issued outside the country, equivalent to one-sixth of the total amount withdrawn using cards issued in Malta. A similar proportion is reported in Cyprus. In contrast, across the euro area this ratio stood at less than 3%.

## 5. Estimation

To study the extent to which these different factors drive the demand for currency in Malta, two currency demand specifications, both modelled in error-correction form, were applied to Maltese data.

In the first specification the dependent variable is currency in circulation as a ratio of M2. In the second the dependent variable is currency holdings deflated using the GDP deflator. Note that both specifications differ slightly in two ways from those used in literature. A linear trend was included to account for growing financial sophistication (such as the increasing use of electronic payments). Two dummy variables were used to capture the impact of one-off shocks, namely a significant change in monetary data compilation in 2003 along with the adoption of the euro in 2008. In the latter case, while there was a large decline in currency in circulation, this resulted from the euro changeover, and evidence suggests that people quickly reverted to previous patterns of behavior.

**Table 1**: Currency demand specification results for Malta(1)

| | Specification 1: Dependent = Currency/M2 | Specification 2: Dependent = Currency/deflator |
|---|---|---|
| **Constant** | -0.34*** | -2.49*** |
| **dlog(Touristeq$_t$)** | 0.02*** | 0.14*** |
| **d(IR$_t$)** | -0.01** | -0.12** |
| **d(TR$_t$)** | 0.26* | 0.19 |
| **dlog(VT$_t$)** | 0.14 | 0.70 |
| **Log(Dependent$_{t-1}$)** | -0.13*** | -0.15*** |
| **Log(Touristeq$_{t-1}$)** | 0.05*** | 0.23*** |
| **IR$_{t-1}$** | -0.01** | -0.03** |
| **TR$_{t-1}$** | 0.09** | 1.69*** |
| **Log(VT$_{t-1}$)** | 0.08** | 0.31 |
| **Log(FW$_{t-1}$)** | 0.04** | 0.22** |
| **Log(DOW$_{t-1}$)** | -0.01** | -0.00 |
| **Trend** | -0.01*** | -0.01*** |
| **Dmondata** | -0.03*** | -0.01 |
| **Dintro** | -0.02*** | -0.31*** |
| | | |
| **Adjusted R$^2$** | 0.87 | 0.89 |
| **Standard Error of regression** | 0.00 | 0.02 |
| **Durbin-Watson** | 2.39 | 2.06 |

*Source*: author's calculations.

*Notes*: (1) Sample is 2000Q1 to 2012Q4. Data were not seasonally adjusted, but seasonal dummies (results not shown here for conciseness) were included in the estimation. Interest rate data are CBM measures, and not MIR data. *** denotes significant at 1% level, ** at 5% level and * at 10% confidence level.

[34] Arrivals are quite seasonal, peaking in the third quarter of the year. This implies that on an annual basis, the impact falls to 5%, on average. This is still much higher than the 0.6% impact of incoming tourism on the European Union's population. Only Cyprus faces a similar situation to Malta in this respect.

Dependent variable in specification 1 is currency holdings as a share of M2; it is real currency holdings in specification 2, VT is transactions demand (i.e. GDP per capita), IR is the real deposit rate, TR is the tax ratio, Touristeq measures the impact on population size of tourist arrivals, FW is total government bonds and M2 excluding currency, and DOW is the level of the Dow Jones index. Dintro is a dummy for the adoption of the euro and dmondata is a dummy for a change in methodology of monetary statistics in 2003.

The results of these regressions, shown in Table 1, suggest that the increase in population caused by tourists does play a significant role in determining both the short-run and long-run dynamics of currency demand in Malta.[35]

The tax ratio, computed as the sum of income tax paid by households, social security contributions and VAT as a share of GDP, also appears to play an important part. As expected, an increase in the tax burden raises the demand for cash, with this effect being significant in the long run. In line with theory, demand for currency is also affected by its opportunity cost, with the real deposit interest rate exerting a relatively strong impact both in the short term and in the long term. An increase in real deposit rates lowers the demand for currency.

Currency holdings are positively related to household financial wealth, which is peroxide by a variable that is the sum of Malta Government Stock outstanding and M2 (excluding currency). This suggests that Maltese households allocate a share of their financial asset portfolio to currency, with an increase in their financial wealth being accompanied by higher cash holdings.

In contrast, Table 1 suggests that transactions demand plays a limited role in determining the demand for currency, with the coefficient on GDP per capita being insignificant even at the 10% confidence level. In part, this could reflect the very significant persistence of currency demand, which contrasts with the relative volatility of economic activity. Finally, there is some evidence that the attractiveness, or not, of foreign investment assets could slightly affect currency holdings in Malta. In one specification, the latter are negatively related to the level of the Dow Jones stock index (used here as a proxy for the return on foreign investment).

## Conclusion

The estimates shown above must, however, be interpreted and used with due caution. Despite the popularity of estimating demand for money functions, there are several issues to keep in mind. For instance, the currency demand equation could be incorrectly specified. This is particularly true when there are structural breaks in the demand for cash, such as changes in payment preferences or in payment systems. A further major issue is correctly accounting for the abrupt change in the relative size of currency in circulation as a result of the adoption of the euro.

Following euro adoption, it is almost impossible to assess with a good degree of certitude how many banknotes (and coins) are circulating at any one time in the Maltese economy as euro banknotes (and coins) can be brought in from overseas by both locals and visitors, while those issued in Malta can be taken and used abroad.

In terms of policy implications, these results suggest that the Maltese economy is likely to continue to use more currency than larger economies in the short to medium term. Moreover, the impact of a large tourism sector in raising currency demand merits further investigation.

The demand for cash could be reduced if more transactions are carried out using electronic means. The latter development would be facilitated if payment preferences of the Maltese population change significantly. This could be aided by modified bank charges, particularly on smaller operators in the retail and tourism sectors. Efforts to discourage the shadow economy, for instance by strengthening tax enforcement and by creating the right incentives to formalize activity, could also contribute.[36] The faster development of the local financial sector, for example through the establishment of a private pension industry, should widen the investment options for Maltese savers. Coupled with the continued high level of regulatory oversight, this should gradually help reduce reliance on currency as a store of wealth.

[35] Note that the seasonal dummies were found to be significant, implying that besides the fluctuations in population size due to tourism, there are other seasonal determinants of the demand for money in Malta, such as the increase in consumption around Christmas.

[36] There are wider benefits resulting from a smaller shadow economy. The latter not only leads to resource misallocation in an economy, with too many self-employed or small firms in the traditional sectors (i.e. construction, agriculture and retail trade), but also boosts unnecessarily the level of prices (as margins need to be higher to make up for low turnover), as well as to unfair competition with operators in the formal economy. For more on this topic, see Singh *et al* (2012).

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# SUNK COSTS OF CONSUMER SEARCH: ECONOMIC RATIONALITY OF SATISFICING DECISION

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## Abstract

*The paper argues that sunk costs' sensitivity can lead to the optimal consumption-leisure choice underprice dispersion. The increase in quantity to be purchased with the extension of the time horizon of the consumption-leisure choice equalizes marginal costs of search with its marginal benefits. The implicit optimal choice results in the explicit satisficing decision. The transformation of cognitive mechanism of discouragement into satisficing happens only in the "common model" of consumer behavior. The paper argues that the cognitive mechanism of aspiration takes place when consumers try to get marginal savings on purchase greater than the wage rate and, therefore, they follow the "leisure model" of behavior where both the marginal utility of labor income and the marginal utility of consumption become negative.*

**Keywords:** sunk costs, consumption-leisure choice, search, satisficing, maximizing

**JEL Classification:** D11, D83.

## 1. Introduction

The analysis of sunk costs usually have been followed by experimental studies, previewed by strong assumptions that "sunk cost effects on decision-making (were), of course, irrational from the perspective of both classical economic and normative decision theories."(Garland and Newport 1991, p.55). However, there were some efforts to explain the phenomenon of sunk costs on the basis of economic rationality (McAfee *et al*. 2010).

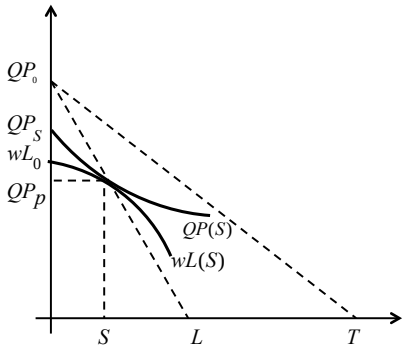
In 1980 R.Thaler attempted to point the way towards a positive theory of consumer choice on the basis of the prospect theory of D.Kahneman and A.Tversky (Thaler 1980). R.Thaler reviewed some issues that were considered inconsistent with economic theory. The analysis of that inconsistency included the endowment effect, the search for big-ticket items, and the sunk costs effect. This paper continues to argue that there are no inconsistencies and the standard tools of economic theory can explain all these effects that do require neither alternative descriptive theories nor specific utility functions.

It was previously shown that the development of the G.Stigler's marginal approach could reveal the general relationship between labor, search or home production, and leisure (Aguiar and Hurst 2007, Malakhov 2003). Furthermore, that general relationship could retain a metaphorical methodological legacy of M.Friedman and L.J.Savage. Like billiards player, a consumer does not engage complicated calculations. He just relies on his feelings and he takes a satisficing decision. And this satisficing decision automatically equalizes marginal costs of search with its marginal benefit (Malakhov 2012, 2013a, 2013b), or:

$$w\frac{\partial L}{\partial S} = Q\frac{\partial P}{\partial S} \qquad (1)$$

*w* – wage rate*; L* – labor time*; S* – time of search*; ∂L/∂S<0* - propensity to search; *Q* – quantity to be purchased; *∂P/∂S<0* - price reduction in a given store.

If we take this equation as the constraint, we can solve the implicit consumption-leisure utility maximization problem (*max U(,Q)* subject to Eq.1 gives the *MRS (H for Q)=w/P*$_0$) for the following explicit satisficing decision (Figure1):




*Note: wL(S)* – labor income; *QP(S)* – expenditures on the chosen quantity; *wL*$_0$ – reservation labor income; *QPs* – expenditures at the starting price; *QPp* – actual expenditures; *QP*$_0$ – potential labor income {*QP*$_0$*=w(L+S)=-T∂P/∂S}*.

**Figure 1.** Explicit satisficing decision

The general relationship between labor, search, and leisure shows that standard tools of the economic marginal analysis can easily explain the paradox of little pre-purchase search for big-ticket items (Malakhov 2012). Moreover, the explanation of this paradox represents only a part of the synthesis of the search-satisficing concept with the neoclassical paradigm. This synthesis also discovers microeconomic roots of the endowment effect. Indeed, this effect occurs because there is a difference between the actual labor income *wL*, spent on purchase, and the potential labor income *w(L+S),* where search costs *wS* increase the willingness to accept (Figure 1)[37].

The billiard metaphor represents also a basis for the understanding how the search-satisficing procedure can incorporate the consumer sunk costs' sensitivity.

## 2. "Common" sunk costs' sensitivity

The C. Kogut's study of consumer search behavior and sunk costs showed that individuals were making decisions based on the total return from searching, rather than simply the marginal return from another draw (Kogut 1990). The analysis of the search behavior can eliminate the difference between total and marginal estimates. Usually sunk costs are followed by a feeling of disappointment. If the problem is strictly constrained, this disappointment will expose the cognitive mechanism of discouragement. The discouragement is one of the mechanisms that result in goal termination (Simon 1967). However, the nature of the problem of sunk costs by definition needs a relaxation of constraints because "this effect is manifested in a greater tendency to continue an endeavor once an investment in money, effort, or time has been made." (Arkes and Blumer 1985, p.124). From the point of view of the search theory the discouragement means that the search has not been efficient and total losses are greater than total gains. This consideration can be written as *|dwL(S)|>|dQP(S)|*. However, any relaxation needs a marginal evaluation. And hence we can turn from the total discouragement to the marginal disappointment (Figure 2, Eq. 2)[38]:

[37] The analysis of the endowment effect needs a voluminous presentation of discussions on the *WTP-WTA* relationship. Readers, who are interesting in the development of the search model, can make this analysis themselves. Here it is only worth to pay attention to the point of departure, where the following Equation 4, taken for the value *S=0*, provides the equality *WTP=WTA*.

[38] Absolute values do not change the logic of the problem and they are taken here only for the simplicity of presentation.

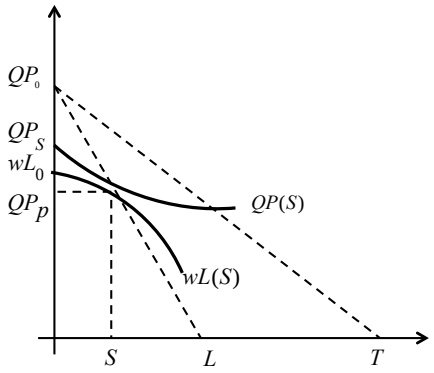



**Figure 2.** Explicit suboptimal disappointing decision

$$|dwL(S)| > |dQP(S)|;$$
$$w\left|dS\frac{\partial L}{\partial S}\right| > Q\left|dS\frac{\partial P}{\partial S}\right| \quad (2)$$
$$w\left|\frac{\partial L}{\partial S}\right| > Q\left|\frac{\partial P}{\partial S}\right|$$

The inequality (2) states the fact that for the given price reduction $\partial P/\partial S$, i.e., in the given store, the absolute value of marginal loss is greater than the absolute value of marginal benefit. We cannot rationalize our purchase of the chosen quantity in the chosen store. Simply, the price in this store for the chosen quantity seems "insufficiently interesting". But it might be satisficing for the greater quantity. The greater quantity may be either explicit, and we buy more potatoes, or implicit, if we come back to the J.Stiglitz's notation that "a good *x* which lasts twice as long as a good *y* (if the interest rate is zero) is just equal to two units of *y*" (Stiglitz 1979, p.342), and the "insufficiently interesting" price corresponds to a higher quality and to a longer product's lifecycle.

The J. Stiglitz's notation shows the way where the phenomenon of sunk costs' sensitivity appears. Consumers increase quantity to be purchased in order to recover fixed sunk costs of visiting the store. "The buyer's sunk travel costs may be exploited…In this case, because the cost of the extra trip may not be worth it, the consumer may still buy other items from the retailer…" (Ratchword 2009, p. 56). However, if we consider the consistent buyer who does not change his intensity of consumption, we have to follow the J. Stiglitz's notation and we should agree that the increase in quantity changes the time horizon of the consumption-leisure choice. Consumers leave the maximum of the current consumption-leisure utility and they look for another maximum with the new time horizon. Again, this shift does not represent calculations of marginal values of search. The choice of another maximum represents the implicit process of the explicit way out from disappointment.

However, the increase in quantity to be purchased changes the marginal values of search. The change in the absolute value of the marginal benefit is obvious:

$$\frac{\partial Q\,|\,\partial P/\partial S\,|}{\partial Q} = \left|\frac{\partial P}{\partial S}\right| > 0 \quad (3)$$

The increase in quantity to be purchased raises the absolute value of the marginal benefit of search. However, the change in the value of marginal costs of search is not so evident. Here we should come back to the properties of the "common model" of search behavior (Malakhov 2012, 2013a):

$$w\frac{\partial L}{\partial S} = -w\frac{L+S}{T} \Rightarrow w\left|\frac{\partial L}{\partial S}\right| = w\frac{L+S}{T} \quad (4)$$

The increase in consumption gives us the following:

$$\frac{\partial w \mid \partial L/\partial S \mid}{\partial Q} = \frac{\partial w(L+S)/T}{\partial Q} = w\left(\frac{T(\partial(L+S)/\partial Q) - (L+S)\,\partial T/\partial Q}{T^2}\right) =$$

$$= \frac{w}{Q}\left(\frac{\partial(L+S)}{\partial Q}\frac{Q}{T} - \frac{(L+S)}{T}\frac{\partial T}{\partial Q}\frac{Q}{T}\right) = \frac{w}{Q}\frac{(L+S)}{T}\left(\frac{\partial(L+S)}{\partial Q}\frac{Q}{(L+S)} - \frac{\partial T}{\partial Q}\frac{Q}{T}\right) = \frac{w \mid \partial L/\partial S \mid}{Q}\left(e_{(L+S),Q} - e_{T,Q}\right) \quad (5)$$

Then we can simplify the expression in parentheses, keeping in mind that being disappointed by the given price reduction, the consumer decides to buy goods not only for this week but also for the next week in order not to travel to the store next Saturday ($\partial S/\partial Q=0$):

$$e_{(L+S),Q} = \frac{\partial(L+S)}{\partial Q}\frac{Q}{(L+S)} = \frac{\partial L}{\partial Q}\frac{Q}{(L+S)}\frac{L}{L} = e_{L,Q}\frac{L}{(L+S)} \quad (6)$$

$$e_{T,Q} = \frac{\partial(L+S+H)}{\partial Q}\frac{Q}{L+S+H} = \frac{\partial(L+H)}{\partial Q}\frac{Q}{L+H}\frac{L+H}{L+S+H} = \\ = e_{(L+H),Q}\frac{L+H}{L+S+H} \quad (7)$$

The decision to buy more changes neither the price and price reduction nor the intensity of consumption $Q/H$. Therefore, the increase in labor time as well as the increase in leisure time should be proportional to the increase in quantity to be purchased, or $e_{L,Q}=1$ and $e_{H,Q}=1$. However, it is easy to show that the proportional increase in labor time ($e_{L,Q}=1$) as well as in leisure time ($e_{H,Q}=1$) give us $e_{(L+H),Q}=1$. And from the Eq. 5, 6, and Eq.7 we have:

$$\frac{\partial w \mid \partial L/\partial S \mid}{\partial Q} = \frac{w \mid \partial L/\partial S \mid}{Q}\left(\frac{L}{L+S} - \frac{L+H}{L+S+H}\right) < 0 \quad (8)$$

or the increase in consumption decreases the absolute value of marginal costs of search. This means that *the increase in quantity to be purchased moves the marginal values of search in opposite directions* (Eq.3 and Eq.8) until the moment when disappointment vanishes and the inequality (2) takes the form of the key equation (1). And this equation means that the consumer maximizes the consumption-leisure utility on its new level for a new time horizon (Figure 4, Eq.9):

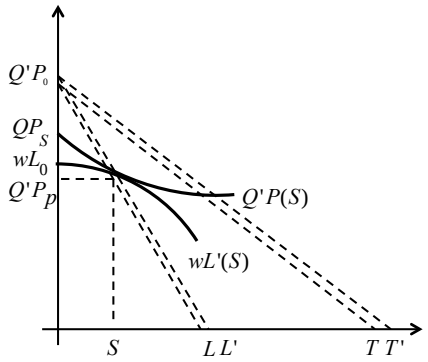



**Figure 4.** Explicit satisficing decision for the extended time horizon $T(Q)$

$$w\left|\frac{\partial L}{\partial S}\right| > Q\left|\frac{\partial P}{\partial S}\right|; w\left|\frac{\partial L'}{\partial S}\right| = Q'\left|\frac{\partial P}{\partial S}\right| \quad (9)$$

## 3. "Leisure" sunk costs' sensitivity

The "common model" of behavior presumes that the absolute value of marginal savings on purchase is less than the wage rate ($w>Q|\partial P/\partial S;|$). This inequality results in the common redistribution of time where search displaces both labor time and leisure time from the given time horizon, like ice displaces both whiskey and soda in the glass ($L+S+H=T$; $\partial L/\partial S+1+\partial H/\partial S=0$; $-1<\partial L/\partial S<0$; $\partial H/\partial S<0$). However, when the absolute value of marginal savings becomes greater than the wage rate, the marginal utility of labor income becomes negative ($MU_w=\lambda<0$) (Malakhov 2013a). Moreover, the inequality ($w<Q|\partial P/\partial S|$) changes the redistribution of time. According to the key equation of the search model (1), the absolute value of the propensity to search becomes greater than one, $|\partial L/\partial S|>1$, or $\partial L/\partial S<-1$. The "price of leisure" becomes greater than the wage rate. And whatever the time horizon we choose, we will always get the positive leisure-search relationship ($\partial H/\partial S>0$). However, the positive leisure-search relationship results in the positive consumption-leisure relationship ($\partial H/\partial S>0$; $\partial Q/\partial H>0$) (Malakhov 2011, 2013a). And with regard to the negative marginal utility of labor income ($MU_w=\lambda<0$) consumption becomes "bad". The negative marginal utility of labor income makes the marginal utility of the absolute value of price reduction $\partial U/\partial|\partial P/\partial S|$ positive. If the prices' search itself has the diminishing marginal efficiency ($\partial P/\partial S<0$; $\partial^2 P/\partial S^2>0$), the greater absolute value of price reduction $|\partial P/\partial S|$ corresponds to the higher price. And as far as the marginal utility of price reduction is positive, or $\partial U/\partial|\partial P/\partial S|>0$, the Veblen effect takes place (Figure 5):

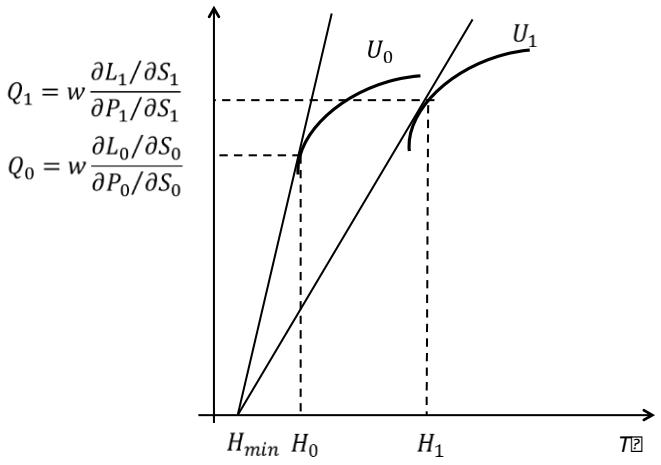



**Figure 5.** Veblen effect and "leisure" sunk costs

Here, the only way to compensate the high price is to increase leisure time in order to depreciate the purchase of the big-ticket item. If we substitute the search by the home production, we will get the same result.[39]

The purchase of big-ticket items clarifies the behavioral difference between the "common model" and the "leisure model". In the "common model" consumers can choose the big-ticket item of higher quality and with guarantees. That makes it more expensive but the recalculation of the time horizon, i.e., of the big-ticket item's lifecycle, as well as the recalculation and the subsequent increase in labor time keeps the consumption-leisure choice within the "common model". The procedure described by the inequalities (3) and (8) makes the high price acceptable. And the explicit form of this rational implicit decision really looks satisficing, like it was well presented by Kapteyn *et al*. in 1979.

The foundation of the "common model" is very strong because it is based on the natural rule of the redistribution of time. When the share of leisure in the time horizon $H/T$ determines leisure-search relationship ($dH(S)=dS\times\partial H/\partial S=dS\times(-H/T)$, and $\partial H/\partial S=-H/T$), the propensity to search $\partial L/\partial S$ can be determined by the very simple equation (4) and it gets the negative derivative, or $\partial^2 L/\partial S^2<0$. This derivative of propensity to search provides the resolution of many microeconomic phenomena along the Cobb-Douglas consumption-leisure utility curve $U(Q,H) = Q^{-\partial L/\partial S}H^{-\partial H/\partial S}$ in the same manner like physical laws provide correct intuition of billiards players.

But it is not true for the "leisure model" of behavior. The Cobb-Douglas curve disappears. There is no natural equivalent to the redistribution of time under the positive leisure-search $\partial H/\partial S>0$ relationship. And we

[39] The analysis of "leisure model" with regard to the home production illustrates well the irrational shortened labour supply in agrarian economics, which expose the Chayanov's backward bending effect (see, for example, Shanin 1986).

cannot determine exactly the depreciation rule for either high price or excess consumption under such extension of leisure time. Indeed, "once individuals have made a large sunk investment, they have a tendency to invest more in an attempt to prevent their previous investment from being wasted. The greater the size of their sunk investment, the more they tend to invest further, even when the return on additional investment does not seem worthwhile." (McAfee *et al*., pp.324). Once the Chateau Lafite Rothschild 1995 from Pauillac is bought for the party, it will need something like the Opus XA from Arturo Fuente in order to make cigars "well-matched" with the good wine. And the leisurely manner of consumption of good wine with good cigars definitely makes the party longer.

## Conclusion

The implicit increase in quantity to be purchased, i.e., the choice of the big-ticket item of high quality with longer lifecycle, makes the satisficing as well as the optimal decision of the depreciation of sunk costs more transparent if we take into account the interest rate. If we presuppose that the interest rate $r$ increases prices of durables and therefore the absolute value of the marginal savings on purchase $|\partial P/\partial S|$ and if the interest rate $r$ does not change the intensity of consumption, the behavior of marginal values of search under the implicit increase in consumption and with regard to the interest rate makes the present dissatisfying decision to be satisficing as well as optimal from the prospective point of view due to the increase in the absolute value of marginal savings and to the decrease in the absolute value of marginal losses (Eq.3, Eq.8). In this manner the interest rate contributes to the recovery of the sunk costs of search.

The "common" sunk costs could be depreciated in the other manner, for example, by the decrease in the intensity of consumption $Q/H$. However, the decrease in the intensity of consumption under the "common model" is voluntary and controlled when it expresses the planned careful use of the big-ticket item and it considerably diminishes the absolute value of marginal losses ($e_{L,Q}<e_{(L+H),Q}$ ; $\partial w|\partial L/\partial S|/\partial Q<<0$). Conversely, if a consumer looks for the marginal savings greater than his wage rate ($w<Q|\partial P/S|$), he recovers "leisure" sunk costs when the increase in consumption-leisure utility is possible only with the obligatory decrease in the intensity of consumption (Figure 5). There, the decision to increase the intensity of consumption immediately discovers the "bad" economic nature of the chosen item.

It looks like a paradox that only for examples like Chateau Lafite Rothschild 1995 - Opus XA Arturo Fuente as well as for many other cases of the "leisure model" of behavior we can definitely talk about *aspiration* as the cognitive mechanism of the goal termination. The properties of the model of behavior of Economic Man seem not to be compatible with the "common model" of behavior. Either Economic Man can perfectly calculate his consumption-leisure ratio and he can choose anytime the store where the price reduction corresponds to his intensity of consumption ($\partial P/\partial S=\partial P/\partial S(Q)$; $\partial P/\partial S = \partial P/\partial S(H)$) and consumption and leisure become perfect complements, or he is a vulgar maximizer. Indeed, he does not need a calculator to compare the wage rate with savings on purchase. He simply tries to find an opportunity to get from the search more than from the labor ($w<Q|\partial P/S|$), when he can be really insatiable. However, the purchase could be unplanned and the table tennis, bought occasionally at sales, really becomes "bad" as the "easy come" item and it can take its right place in a month in the garage. There, being got out to the open air once in a season, it will serve for years, or it will be presented at garage sales as the real "easy go" item.

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# THE SOCIAL ACCOUNTING MATRIX AND THE SOCIO-DEMOGRAPHIC MATRIX-BASED APPROACHES FOR STUDYING THE SOCIOECONOMICS OF AGEING

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## Abstract

*In looking for empirical evidence about the activity of countries, a proposal is made for studying (measuring and modelling) the activity of countries through the use of Social Accounting Matrices (SAMs) and Socio-Demographic Matrices (SDMs).*

*SAMs and SDMs are presented as tools that have specific features for conducting studies in several different areas, particularly in the Socio-Economics of Ageing, as well as for supporting policy decision processes.*

*Based on methodological principles that are derived mainly from the works of Richard Stone, emphasis is placed on the desirability of working in a matrix format, which includes not only people (SDM), but also, at the same time, activities, products, factors of production and institutions (SAM). This is considered to be a way of capturing the relevant network of linkages and the corresponding multiplier effects for the subsequent modelling of the activity of the countries studied. The exposition of this proposal is accompanied by an example applied to Portugal.*

**Keywords**: social accounting matrix; macroeconomic policy; socio-demographic matrices.

**JEL classification**: E16, E61, J11.

## 1. Introduction

The Social Accounting Matrix (SAM) and the Socio-Demographic Matrix (SDM) are tools that have specific features intended for studying the activity of countries. Both matrices cover movements in time and space, which are expressed by the former matrix in units of currency and by the latter matrix in terms of human beings.

Such features allow for the reading and interpretation of the reality under study, leading to the production of an empirical work that is not only capable of highlighting specific aspects of that activity, but also offers the chance to experiment with different interventions in regard to its functioning.

A proposal is made for the development both of a basic SAM and of a standard SDM in Santos, 2013. Together with an explanation of possible alternative taxonomies, this presentation shows how those matrices can be used as an alternative support for studies being undertaken in several areas, as well as for the work of those taking part in the policy decision process. Drawing upon the presentation made in that work, this paper seeks to illustrate a way of using those tools in studies undertaken in the area of the Socio-Economics of Ageing.

Section 2 outlines the main features of the SAM and SDM-based approaches, adopting a methodological framework that is based on Richard Stone's works. According to this methodological framework, SAMs and SDMs can describe the activity of countries either empirically or theoretically, depending on whether they are presented in a numerical or an algebraic version, respectively.

Using the example of an application to Portugal, Section 3 shows how those approaches can be used as an alternative support for studying the Socio-Economics of Ageing at a macroeconomic level, as well as for the work of those involved in the policy decision process. Some concluding remarks will be made in Section 4.

## 2. Approaches based on social accounting matrices and socio-demographic matrices

Richard Stone worked largely with SAMs and SDMs as matrix formats of the national and demographic accounts. Besides numerical versions, he identified algebraic versions of those same matrices, which were worked on mainly under the scope of input-output analysis. In keeping with that work, and due to their similarities, we will call the approach based on SAMs the SAM-based approach – the term that is normally adopted – and the approach based on SDMs the SDM-based approach – a term that is not normally adopted, but which will be used here.

Following the work of Richard Stone, Graham Pyatt and Jeffrey Round in particular played a key role in the study and dissemination of the SAM-based approach.

In the foreword to the book that can now be regarded as a pioneering work in terms of the SAM-based approach, "Social Accounting for Development Planning with special reference to Sri Lanka", Stone stated that the framework of the system of national accounts can be rearranged and "the entries in a set of accounts can be presented in a matrix in which, by convention (…), incomings are shown in the rows and outgoings are shown in the columns; and in which, reflecting the fact that accounts balance, each row sum is equal to the corresponding column sum". That matrix, with an equal number of rows and columns, is the SAM, in the construction of which "it may be possible to adopt a hierarchical approach, first adjusting the entries in a summary set of national accounts and then adjusting subsets of estimates to these controlling totals" (Pyatt and Roe, 1977: xix, xxiii).

In turn, in the abstract to his article "A SAM approach to modeling", Pyatt says: "Given that there is an accounting system corresponding to every economic model, it is useful to make the accounts explicit in the form of a SAM. Such a matrix can be used as the framework for a consistent dataset and for the representation of theory in what is called its transaction form". In that transaction form (or TV (transaction value) form), the SAM can be seen "(…) as a framework for theory" and its cells "(…) can be filled instead with algebraic expressions, which describe in conceptual terms how the corresponding transaction values might be determined". Thus, the SAM is used as "the basic framework for model presentation" (Pyatt, 1988: 327; 337).

Looking at the question from the perspectives outlined above, it can be said that a SAM can have two versions: a numerical version, which describes the activity of a country empirically; and an algebraic version, which describes that same activity theoretically. In the former version, each cell has a specific numerical value, with the sums of the rows being equal to the sums of the columns. In the latter version, each cell is filled with algebraic expressions that, together with those of all the other cells, form a SAM-based model, the calibration of which involves a replication of the numerical version.

In the words of Pyatt, "the essence of (...) the SAM approach to modelling is to use the same SAM framework for both the empirical and the theoretical description of an economy". (Pyatt, 1988: 337).

The construction of algebraic versions (or SAM-based models) can be seen, among others, in Pyatt (2001; 1988), Pyatt and Roe (1977), Pyatt and Round (2012; 1985) and Santos (2012; 2009).

Despite the potentialities of Stone's work on SDMs, the SDM-based approach has not been followed by other authors as much as the SAM-based approach. Thus, the study of the SDM-based approach will be based only on Stone's work.

According to that author, the population of a specific country in a specific year "flows in partly along time from last year, through survival, and partly along space from the outside world, through birth and immigration; and flows out, through death and emigration, and partly along time into next year, through survival" (Stone, 1986: 21). With the survivors from the preceding period constituting the opening stock of the population and the survivors into the succeeding period constituting the closing stock, the SDM can thus be considered a stock-flow matrix.

By connecting "the opening and closing stocks of year θ with flows during year θ" (Stone, 1982: 292), two types of versions will be identified for the SDM: numerical versions, in which each cell has a specific numerical value; and algebraic versions, in which each cell is filled with algebraic expressions that, together with those of all the other cells, form a SDM-based model.

Numerical versions of SDMs can thus be constructed from demographic statistics or they can be replicated by the running of SDM-based models. The former versions measure the reality under study and will be examined in the next section. The latter versions allow for the construction of scenarios resulting from experiments performed with those models, and can be seen in: Stone, 1966, 1971, 1973, 1975, 1981, 1982, 1985, 1986a.

Assuming that the core of the statistics representing the part of the activity of countries that can be expressed in currency units (covered by the SAM), and in human beings (covered by the SDM), are the national and the demographic accounts, respectively, at least as a starting point, their adoption is recommended for any study that is looking for empirical evidence about that activity. This will enable us to work with, and gain a greater knowledge about, the activity that is (supposedly) observed by the national and the demographic accounts, which, both in a SAM and a SDM framework, will benefit from the increased analytical content provided by the matrix format and the possibility of capturing and working with networks of linkages not captured and worked on otherwise. The matrix format will also allow for the use of matrix algebra in possible mathematical treatments associated with the above-mentioned empirical work, enabling us to experiment with different interventions in regard to the functioning of reality.

## 3. Studying the socio-economics of ageing with social accounting matrices and socio-demographic matrices

As mentioned above, this paper is supported by another study (Santos, 2013), which was not included here due to its length. That work includes a description and the methodological details necessary for the construction of the numerical versions of the SAM and SDM presented here. In turn, the description of the algebraic version of the SAM, used in the construction of the two scenarios presented below, can be found in Section 2.2.1 of Santos, 2012. Therefore, those two working papers should also be consulted for a better understanding of this Section.

Any study of the Socio-Economics of Ageing conducted in a specific space, namely, a country, should involve the consideration of its population and the corresponding age groups, together with the economic activity of those groups, which should involve the consideration of the origin and the destiny of the corresponding income. Under the current System of National Accounts (SNA 2008), all of the population in a country is represented by households – one of the five institutional sectors identified by that system, the others being: financial and non-financial corporations, government and non-profit institutions serving households. In keeping with what was said in the previous section, when all of the population of a country is worked upon within a SDM framework, its movements (expressed in numbers of human beings) can be represented in the form of a stock-flow matrix, which offers many possibilities for disaggregation, especially by age groups. In turn, the flows (expressed in currency units) representing the households' production, consumption and income can be worked upon within a SAM framework.

From what has just been said and bearing in mind the support offered by the above-mentioned working papers – Santos, 2012 and 2013 – SAMs and SDMs, and their underlying approaches, allow for the study of a wide range of different aspects involved in the Socio-Economics of Ageing (and many other areas), which can be identified in accordance with the purposes of each specific study. Let's suppose that, in studying possible social policy measures, we wish to identify some macroeconomic effects of changes in either the incomes or the expenditures of those whose retirement pensions are their main source of income.

Given such a purpose, our attention necessarily has to be focused, on the one hand, on those who are aged 65 and over, and who are recipients of pensions, i.e. retired and (supposedly) inactive individuals? On the other hand, we should also focus on the corresponding flows of income that are received and then spent by that group. The following exposition, illustrated by the example of an application to Portugal, will show a simple possible way of using the tools above presented in a study with that particular purpose.

**Table 1**: SDM for Portugal in 2009 (in $10^3$ individuals)

| | | | | Outside World | Population by age group and economic activity | | | | | | | | | | Closing Stock |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0-14 | 15-24 | | | 25-64 | | | 65 and over | | | |
| | | | | | | Active | Inactive | Total | Active | Inactive | Total | Active | Inactive | Total | |
| | | | | 1 | 2 | 3 | 4 | | 5 | 6 | | 7 | 8 | | 9 |
| Outside World | | | 1 | | 5 | 5 | | 5 | 22 | 3 | 25 | 42 | 39 | 81 | 10638 |
| Population by age group and economic activity | 0-14 | | 2 | 105 | 1 510 | | | | | | | | | | 1615 |
| | 15-24 | Active | 3 | 10 | | 456 | | | | | | | | | 466 |
| | | Inactive | 4 | | 110 | | 614 | | | | | | | | 724 |
| | | **Total** | | 10 | 110 | | | 1070 | | | | | | | 1190 |
| | 25-64 | Active | 5 | 16 | | 47 | | | 4734 | | | | | | 4797 |
| | | Inactive | 6 | | | | 100 | | | 1056 | | | | | 1156 |
| | | **Total** | | 16 | | | | 146 | | | 5790 | | | | 5952 |
| | 65 and over | Active | 7 | 0 | | | | | 35 | | | 284 | | | 320 |
| | | Inactive | 8 | | | | | | | 73 | | | 1488 | | 1561 |
| | | **Total** | | 0 | | | | | | | 108 | | | 1772 | 1881 |
| Opening Stock | | | 9 | 10 623 | 1625 | 508 | 714 | 1221 | 4791 | 1133 | 5924 | 326 | 1527 | 1853 | |

*Source*: Statistics Portugal *(INE)*.

*Note*: This table is Table 9 of Santos (2013), in which Appendixes C and D respectively provide details about the sources and the methodologies used in its construction.

In Table 1, we have a SDM for Portugal in 2009, with a disaggregation that is appropriate for the identification of the above-mentioned group of interest to us here. Thus, in column 8 and row 8, we have the population aged 65 and over that is considered as inactive described in terms of their participation both in the labour market and in the supply side of the goods and services market. From the reading of this column, we can see that the opening stock of the inactive population aged 65 and over, measured in thousands of individuals, was 1,527 (14.4% of the total); of these, 39 either died or emigrated and 1,488 remained in the same situation throughout the year. Reading along the row for the same group we can see that the closing stock was 1,561 (14.7% of the total), which is composed of 73 individuals who moved from the inactive 25-64 age group and 1,488 who did not change their status.

In Table 2, we have a SAM for Portugal in 2009 with a disaggregation that is appropriate for identifying the incomes and expenditures of the same group of interest to us here.

Thus, in row 5 and column 5 we have, respectively, the receipts (or incomes) and the expenditures of the current account of the group of households classified as recipients of pensions regarding their main source of income[40]. Since the row and column totals are equal, they represent the aggregate income of that group, amounting to 25,578 million euros, and the corresponding totals of receipts and expenditures. This amount represents 10.2% of the total aggregate income. Reading along the row, we can see that this income derived from the compensation of labour and capital – 3,275 million euros (12.8 %) – while the remaining part came from current transfers within households, from the rest of the world and from the other institutional sectors – 22,302 million euros (87.2%). In this last figure, the part originating from government, i.e. pensions, represents 73.6%. Reading down the column, we can see that this income was mainly spent on final consumption – 18,778 million euros (73.4%), transferred in the form of current transfers within households, to the government (namely in the form of current taxes on income, wealth, etc), to the rest of the world and to other institutional sectors – 4,515 million euros (17.7 %). In the reading of the column, we can also see that the part of the aggregate income that was not spent on final consumption or transferred was saved, and amounts to 2,284 million euros (8.9%).

This SAM represents all the nominal flows (measured by the national accounts) that occurred in Portugal in 2009. Therefore, from this, we can calculate aggregates, indicators and balancing items, representative of the macroeconomic level of the activity of the Portuguese economy in that year. That is the case with what is normally considered to be the main macroeconomic aggregate, Gross Domestic Product at market prices ($GDP_{pm}$), amounting to 168,504 million euros. Since our SAM does not identify the institutional sectors in the production accounts, the part corresponding to our group cannot be identified in that amount, although such a

[40] For a better understanding of the following reading, see Santos (2013) – Section 4.

calculation is possible in the case of both Gross National Income and Disposable Income. Therefore, in the case of total Gross National Income, with an amount of 161,639 million euros, the share of recipients of pensions was 2.03%, while in the case of total Disposable Income, with an amount of 162,800 million euros, the share of recipients of pensions was 12.94%.

In line with the above-mentioned purpose, for a better study of changes in either the incomes or the expenditures of those whose retirement pensions are their main source of income, two scenarios will be sketched out: scenario A, involving a change in incomes; and scenario B, involving a change in expenditures. The numerical SAM and SDM presented above will enable identification of those changes. Algebraic SAMs, representing accounting multipliers (as described in Section 2.2.1 of Santos, 2012) will enable us to quantify the macroeconomic effects of those changes, which will be summarised in the form of the changes occurring in the three above-mentioned macroeconomic aggregates – $GDP_{pm}$, Gross National Income and Disposable Income.

Taking advantage of the availability of the SDM, those scenarios will involve the increase noted between the opening and the closing stocks of the group of inactive individuals aged 65 and over. This increase could be calculated from cells (9,8 and 8,9) of Table 1 and was 2.2%.

If we assume that the *per capita* receipts and expenditures (considering the closing stock of our group) that can be calculated from the SAM and the SDM are the same, and that all the rest remains constant, the effects of that increase on the main items of income and expenditure of our particular group of interest will constitute scenarios A and B, respectively.

As was seen above, the main item of income in our group of individuals is pensions, which amount to current transfers from the government. Scenario A will therefore show the effects of an increase in current transfers from the government, resulting from an increase of 2.2% in the group of inactive individuals aged 65 and over, with the received *per capita* amount remaining the same. Considering the value of cell (5,9) of Table 2, this would represent an increase of approximately 420 million euros in the amount of current transfers from the government to the recipients of pensions. Since the current and capital accounts of the government, as well as the financial and the rest of the world accounts, are considered exogenous, from the running of the accounting multipliers, calculated from the SAM for Portugal in 2009, it can be seen that the effect of such a change on the endogenous part of the SAM showed an increase of 0.31% in $GDP_{pm}$. At the level of Gross National Income, this effect represents an increase of 0.30% in total income and a rise of 0.29% in the share of the recipients of pensions. In turn, the effect on Disposable Income also took the form of an increase of 0.29% in total income and 2.67% in the share of the recipients of pensions.

In turn, scenario B will represent the effect of an increase in final consumption resulting from an increase of 2.2% in the group of inactive individuals aged 65 and over, with the consumed *per capita* amount remaining the same. Considering the value of cell (1.5) of Table 2, this would represent an increase of approximately 378 million euros in the final consumption of the recipients of pensions. Since the current and capital accounts of the two groups of households, as well as the financial and the rest of the world accounts, are considered to be exogenous, from the running of the accounting multipliers, calculated from the SAM for Portugal in 2009, it can be seen that the effect of such a change on the endogenous part of the SAM now represents an increase of 0.18% in $GDP_{pm}$. The effects on Gross National Income (both in total and in the part relating to the share of recipients of pensions) and on total Disposable Income was an increase of 0.17%, whereas, in the part of Disposable Income that relates to the recipients of pensions, there was an increase of 0.11%.

As far as the SAM algebraic version used in the construction of the above scenarios is concerned, the accounting multipliers are based on assumptions that limit the results and the subsequent analysis of the constructed scenarios, as shown by Santos (2012). However, this methodology is very simple to apply and, from the author's point of view, it represents a good way of exemplifying the aspects that we intended to highlight in this paper. On the other hand, some types of algebraic versions of the SDM could also have been adopted, together (or not) with the SAM.

Much work can be undertaken with SAM and SDM-based approaches in studies in many different areas, particularly in the field of the Socio-Economics of Ageing.

**Table 2**: SAM for Portugal in 2009 (in $10^6$ euros)

| Outlays (expenditures) / Incomes (receipts) | | | | | PRODUCTION | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | FACTORS | | |
| | | | | | PRODUCTS | ACTIVITIES | Labour (employees) | Other | Total |
| | | | | | 1 | 2 | 3 | 4 | |
| PRODUCTION | PRODUCTS | | | 1 | 0 | 162 661 | 0 | 0 | 0 |
| | ACTIVITIES | | | 2 | 311 365 | 0 | 0 | 0 | 0 |
| | FACTORS | Labour (employees) | | 3 | 0 | 85 888 | 0 | 0 | 0 |
| | | Other | | 4 | 0 | 63 515 | 0 | 0 | 0 |
| | | Total | | | 0 | 149 403 | 0 | 0 | 0 |
| INSTITUTIONS | CURRENT ACCOUNT | Households (by..source of income) | *Recipients of pensions* | 5 | *0* | *0* | *1 150* | *2 125* | *3 275* |
| | | | *Others* | 6 | *0* | *0* | *84 607* | *32 133* | *116 740* |
| | | | Total | | 0 | 0 | 85 757 | 34 258 | 120 015 |
| | | Enterprises (nonfinancial corporations) | | 7 | 0 | 0 | 0 | 14 615 | 14 615 |
| | | Financial corporations | | 8 | 0 | 0 | 0 | 5 990 | 5 990 |
| | | Government | | 9 | 19 694 | 522 | 0 | - 34 | - 34 |
| | | Non Profit Institutions Serving Households(NPISH) | | 10 | 0 | 0 | 0 | 837 | 837 |
| | | Total | | | 19 694 | 522 | 85 757 | 55 666 | 141 423 |
| | CAPITAL ACCOUNT | Households | | 11 | 0 | 0 | 0 | 0 | 0 |
| | | Enterprises (nonfinancial corporations) | | 12 | 0 | 0 | 0 | 0 | 0 |
| | | Financial corporations | | 13 | 0 | 0 | 0 | 0 | 0 |
| | | Government | | 14 | 0 | 0 | 0 | 0 | 0 |
| | | Non Profit Institutions Serving Households(NPISH) | | 15 | 0 | 0 | 0 | 0 | 0 |
| | | Total | | | 0 | 0 | 0 | 0 | 0 |
| | FINANCIAL ACCOUNT | | | 16 | 0 | 0 | 0 | 0 | 0 |
| REST OF THE WORLD | | | | 17 | 59 823 | - 1 222 | 370 | 16 649 | 17 019 |
| TOTAL | | | | | 390 882 | 311 365 | 86 127 | 72 315 | 158 443 |

*Sources*: Statistics Portugal *(INE);* Portuguese Central Bank *(Banco de Portugal)*.

*Note*: This table is, in fact, Table 3 of Santos (2013) showing the households' current account disaggregated by main source of income – rows 5 and 6 and their respective columns, represented in italic font. This disaggregation is an estimate, adopting the same structure of the same account in the SAM worked upon in Santos (2009).

**Table 2** (continued): SAM for Portugal in 2009 (in $10^6$ euros)

| Outlays (expenditures) / Incomes (receipts) | | | | INSTITUTIONS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CURRENT ACCOUNT | | | | | | | |
| | | | | Households (by main source of income) | | | Enterprises (nonfinancial corporations) | Financial corporations | Government | Non Profit Institutions Serving Households (NPISH) | Total |
| | | | | *Recipients of pensions* | *Others* | Total | | | | | |
| | | | | *5* | *6* | | *7* | *8* | *9* | *10* | |
| PRODUCTION | PRODUCTS | | 1 | *18 778* | *87 428* | 106 206 | 0 | 0 | 37 160 | 3 568 | 146 934 |
| | ACTIVITIES | | 2 | *0* | *0* | 0 | 0 | 0 | 0 | 0 | 0 |
| | FACTORS | Labour (employees) | 3 | *0* | *0* | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Other | 4 | *0* | *0* | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Total | | *0* | *0* | 0 | 0 | 0 | 0 | 0 | 0 |
| INSTITUTIONS | CURRENT ACCOUNT | Households (by..source of income) *Recipients of pensions* | 5 | *11* | *95* | *106* | *1 195* | *1 982* | *18 820* | *63* | *22 165* |
| | | Households (by..source of income) *Others* | 6 | *56* | *639* | *695* | *635* | *3 244* | *10 178* | *33* | *14 784* |
| | | Households (by..source of income) Total | | *67* | *734* | 801 | 1 830 | 5 226 | 28 998 | 95 | 36 949 |
| | | Enterprises (nonfinancial corporations) | 7 | *1 486* | *343* | 1 830 | 0 | 613 | 171 | 0 | 2 613 |
| | | Financial corporations | 8 | *443* | *4 846* | 5 289 | 519 | 131 | 42 | 32 | 6 013 |
| | | Government | 9 | *2 303* | *28 922* | 31 224 | 5 684 | 671 | 8 | 22 | 37 610 |
| | | Non Profit Institutions Serving Households (NPISH) | 10 | *21* | *303* | 324 | 154 | 50 | 1 997 | 0 | 2 525 |
| | | Total | | *4 320* | *35 148* | 39 468 | 8 187 | 6 690 | 31 215 | 150 | 85 711 |
| | CAPITAL ACCOUNT | Households | 11 | *2 284* | *11 444* | 13 728 | 0 | 0 | 0 | 0 | 13 728 |
| | | Enterprises (nonfinancial corporations) | 12 | *0* | *0* | 0 | 8 903 | 0 | 0 | 0 | 8 903 |
| | | Financial corporations | 13 | *0* | *0* | 0 | 0 | 5 283 | 0 | 0 | 5 283 |
| | | Government | 14 | *0* | *0* | 0 | 0 | 0 | - 11 695 | 0 | - 11 695 |
| | | Non Profit Institutions Serving Households (NPISH) | 15 | *0* | *0* | 0 | 0 | 0 | 0 | - 354 | - 354 |
| | | Total | | *2 284* | *11 444* | 13 728 | 8 903 | 5 283 | - 11 695 | - 354 | 15 865 |
| | FINANCIAL ACCOUNT | | 16 | *0* | *0* | 0 | 0 | 0 | 0 | 0 | 0 |
| REST OF THE WORLD | | | 17 | *195* | *1 149* | 1 345 | 240 | 110 | 1 726 | 0 | 3 421 |
| TOTAL | | | | *25 578* | *135 169* | 160 747 | 17 331 | 12 082 | 58 407 | 3 363 | 251 931 |

**Table 2** (continued): SAM for Portugal in 2009 (in $10^6$ euros)

| Outlays (expenditures) / Incomes (receipts) | | | | INSTITUTIONS | | | | | | | REST OF THE WORLD | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CAPITAL ACCOUNT | | | | | | FINANCIAL ACCOUNT | | |
| | | | | Households | Enterprises (nonfinancial corporations) | Financial corporations | Government | Non Profit Institutions Serving Households (NPISH) | Total | | | |
| | | | | 11 | 12 | 13 | 14 | 15 | | 16 | 17 | |
| PRODUCTION | PRODUCTS | | 1 | 7 269 | 19 812 | 1 064 | 5 071 | 834 | 34 051 | 0 | 47 236 | 390 882 |
| | ACTIVITIES | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 311 365 |
| | FACTORS | Labour (employees) | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 239 | 86 127 |
| | | Other | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 800 | 72 315 |
| | | Total | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 039 | 158 443 |
| INSTITUTIONS | CURRENT ACCOUNT | Households (by..source of income) | *Recipients of pensions* | 5 | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *138* | *25 578* |
| | | | *Others* | 6 | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *3 645* | *135 169* |
| | | | Total | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 783 | 160 747 |
| | | Enterprises (nonfinancial corporations) | | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 103 | 17 331 |
| | | Financial corporations | | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 12 082 |
| | | Government | | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 615 | 58 407 |
| | | Non Profit Institutions ServingHouseholds (NPISH) | | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 363 |
| | | Total | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 581 | 251 931 |
| | CAPITAL ACCOUNT | Households | | 11 | 0 | 0 | 53 | 139 | 0 | 192 | - 9 004 | 177 | 5 093 |
| | | Enterprises (nonfinancial corporations) | | 12 | 0 | 0 | 0 | 795 | 0 | 795 | 11 407 | 924 | 22 029 |
| | | Financial corporations | | 13 | 0 | 0 | 53 | 24 | 0 | 77 | - 4 157 | 0 | 1 202 |
| | | Government | | 14 | 3 | 95 | 28 | 0 | 2 | 129 | 17 135 | 1 118 | 6 687 |
| | | Non Profit Institutions Serving Households (NPISH) | | 15 | 0 | 0 | 0 | 344 | 0 | 344 | 840 | 14 | 844 |
| | | Total | | | 3 | 95 | 135 | 1 301 | 2 | 1 536 | 16 222 | 2 232 | 35 856 |
| | FINANCIAL ACCOUNT | | | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 36 659 | 37 209 | 73 868 |
| REST OF THE WORLD | | | | 17 | - 2 179 | 2 122 | 3 | 315 | 8 | 268 | 20 987 | X | 100 297 |
| TOTAL | | | | | 5 093 | 22 029 | 1 202 | 6 687 | 844 | 35 856 | 73 868 | 100 297 | X |

## 4. Concluding remarks

The Social Accounting Matrix (SAM) and Socio-Demographic Matrix (SDM) are tools that can be used for studying the activity of countries both empirically and theoretically, depending on whether they are presented in a numerical or algebraic version. These are the so-called SAM-based and SDM-based approaches for studying (measuring and modelling) the activity of countries.

Using the example of a numerical version, the analysis of the activity of Portugal in 2009 was geared towards the study of some aspects of the Socio-Economics of Ageing. Using an algebraic version of the SAM, the performance of a number of experiments allowed for the analysis of two scenarios that resulted from changes in that same reality. In that example, our attention was focused on the section of the population aged 65 and over, namely, on those who were already retired, inactive, and recipients of pensions. In the case of that population group, our attention was also focused on the flows of income that represent their receipts and expenditures. With our working tools, for the year under study, it was possible to quantify the flows of the population of the country, by age groups and economic activity. On the other hand, for those groups, it was also possible to identify the

corresponding income and expenditures and the underlying structures. From the two scenarios that were experimented with, it was possible to exemplify how the macroeconomic effects of changes in those groups and in the corresponding components of income and expenditure can be quantified. Therefore, with our illustrative application, the above-mentioned approaches and the underlying work undertaken in the matrix format allowed for the capture of some multiplier effects and the subsequent quantification of some macroeconomic effects resulting from changes in the flows of income and expenditure of the Portuguese recipients of pensions in 2009. Those effects were summarised outside the matrix format through the quantification of changes in the Gross Domestic Product at market prices ($GDP_{pm}$), Gross National Income and Disposable Income.

Criticisms can be made, not only of the way in which the above experiments were performed, but also of the constraints imposed by the accounting multipliers (SAM-based model). This was, however, just a simple example of what can be done with the working tools of the SAM and the SDM. With this presentation, from the working papers that supported it (Santos, 2012 and 2013) and the given references, the author hopes to have been able to draw attention to the potentialities of the SAM and SDM-based approaches and to show that much more can be done beyond the example presented.

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# SUSTAINABLE HETEROGENEITY IN EXOGENOUS GROWTH MODELS. THE SOCIALLY OPTIMAL DISTRIBUTION BY GOVERNMENT'S INTERVENTION

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## Abstract

*This paper examines the socially optimal allocation by focusing not on the social welfare function but instead on the utility possibility frontier in exogenous growth models with a heterogeneous population. A unique balanced growth path was found on which all of the optimality conditions of all heterogeneous households are equally and indefinitely satisfied (sustainable heterogeneity). With appropriate government interventions, such a path is always achievable and is uniquely socially optimal for almost all generally usable (i.e., preferences are complete, transitive, and continuous) social welfare functions. The only exceptions are some variants in Nietzsche type social welfare functions, but those types of welfare functions will rarely be adopted in democratic societies. This result indicates that it is no longer necessary to specify the shape of the social welfare function to determine the socially optimal growth path in a heterogeneous population.*

**Keywords:** sustainability; heterogeneity; social optimality; social welfare; social welfare function; inequality; evolution.

**JEL Classification:** D63, D64, E20, F40, I31, I38, O41

## 1. Introduction

Problems of economic inequality, wealth disparity, and justice have long been central issues in economics and are again a hot topic in the midst of the great recession that began in 2008. The concerns of the Occupy Wall Street movement are a recent example. However, the criteria for socially optimal allocation have not been universally agreed upon because of utility's interpersonal incomparability, Arrow's general possibility theorem (Arrow, 1951), and other factors. Although the problem of utility's interpersonal incomparability was solved by Bergson (1938) and Samuelson (1947), their idea was fundamentally criticized by Arrow (1951). Arrow's criticism can be worked around if the assumptions in Arrow (1951) are modified, for example, the assumption that every individual has a single-peaked preference is added (see e.g., Black, 1958); thus, social welfare functions can be used for various analyses. Nevertheless, even if social welfare functions can be used, there is no consensus on their shape. Because of this limitation, it has been difficult to provide useful information for arguments of social optimality. Even though many people have protested that current levels of economic inequality and wealth disparity are too large, there is no theoretical basis on which to judge their arguments.

To shed light on the arguments, I take a different approach in this paper. I focus not on the nature of the social welfare function but instead on the nature of the utility possibility frontier, because if the shape of the utility possibility frontier has some special characteristics, particularly if it is very constrained by some factors, it may be

able to narrow the opportunities for a socially optimal allocation, regardless of any differences in the social welfare functions.

In particular, this paper examines social optimality in dynamic models with a heterogeneous population and the condition for the state where all of the optimality conditions of all heterogeneous households are satisfied in these models. Intuitively, knowing whether the state where all of the optimality conditions of all heterogeneous households are satisfied is achieved seems to provide useful information for social optimality, but it is meaningless if we use static models because any competitive equilibrium naturally and always achieves this state even if the population is heterogeneous. It is also meaningless when dynamic models are used if the models use homogeneous populations, because such a state is naturally and always achieved and a homogeneous population generates no income inequality or wealth differential. Thus, the only remaining type of model to study is a dynamic model with a heterogeneous population. However, Becker (1980) showed that, in such models, the magnitudes of income inequality and wealth disparity eventually reach the limit; that is, the most patient household eventually will own all capital. All of the other households cannot satisfy their optimality conditions and will go bankrupt and, as it were, perish when even a very small negative shock occurs unless the authority intervenes. Consequently, examining social optimality in a heterogeneous population by using dynamic models has been regarded to be a meaningless task. As a result, little attention has been paid in the analyses of social optimality to the state where all of the optimality conditions of all heterogeneous households are satisfied.

Harashima (2010, 2012) shows that, in dynamic models with a heterogeneous population, there exists a state where all of the optimality conditions of all heterogeneous households are satisfied (i.e., "sustainable heterogeneity"), although this state is not guaranteed to be naturally and always achieved, and it is influenced by the behavior of the most advantaged household. Even though it is not naturally achievable, it can be always achieved with appropriate government intervention. The existence of this state is very important because, unlike the case with static and dynamic models with homogeneous populations, we can obtain additional meaningful and useful information about social optimality. Dynamic models with a heterogeneous population have another advantage—they describe the nature of economy far more realistically than static and dynamic models with homogeneous populations. Because little attention has been given to sustainable heterogeneity in analyses of social optimality, discoveries derived from such analyses add a new analytical tool and may help solve the previously discussed problem of the unspecifiability of social optimality. In this paper, the endogenous growth model in Harashima (2012) is modified to an exogenous growth model (a Ramsey type growth model), and social optimality is examined based on this modified model in the same manner as Harashima (2012).

A distinct feature of the models presented in this paper and Harashima (2012) is that a common nature of utility across the population is assumed to exist as a result of human evolution. Although utility functions are different across a population, some common features have been assumed, for example, a diminishing marginal rate of substitution. In this paper, an additional common nature is assumed such that extreme disutility is generated if all of the optimality conditions are not satisfied. The reason for this assumption, as described in more detail in Section 5, is that only humans who have this nature could have survived the process of natural selection. This additional common nature of utility plays an important role in the analyses of social optimality presented in this paper.

The model shows that sustainable heterogeneity is the unique socially optimal allocation for almost all generally usable (i.e., preferences are complete, transitive, and continuous) social welfare functions. This result is very important because the socially optimal allocation is uniquely determined without having to specify the shape of the social welfare function. This result therefore implies that, with the additional information provided by sustainable heterogeneity in dynamic models with a heterogeneous population, the problem of unspecifiability of social optimality can be solved.

The paper is organized as follows. In Section 2, a multi-economy endogenous growth model with heterogeneous population is constructed, and sustainability of heterogeneity is examined by using it. The existence of a unique balanced growth path on which all optimality conditions of all heterogeneous households are satisfied is shown. In Section 3, the endogenous model is degenerated to an exogenous growth model. The similar results as the endogenous growth model are obtained. Section 4 shows that sustainable heterogeneity is always achievable with appropriate government intervention even if the most advantaged household behaves unilaterally. In Section 5, extreme disutility to unsustainable heterogeneity is examined based on the gene theory of evolution. Section 6 introduces a utility possibility frontier and social welfare function modified to dynamic models and shows that sustainable heterogeneity represents the unique socially optimal allocation. Finally, some concluding remarks are offered.

## 2. Sustainable heterogeneity in an endogenous growth model

### *2.1. The model*

#### *2.1.1. The base model*

##### *2.1.1.1. Production of technologies*

Outputs $Y_t$ are the sum of consumption $C_t$, the increase in capital, and the increase in technology such that: $Y_t = C_t + \dot{K}_t + v\dot{A}_t$. Thus, $\dot{k}_t = y_t - c_t - \frac{v\dot{A}_t}{L_t} - n_t k_t$, *where* $v(>0)$ is a constant, and a unit of $K_t$ and $v^{-1}$ of a unit of $A_t$ are equivalent; that is, they are produced using the same quantities of inputs (capital, labor, and technology). This means that technologies are produced with capital, labor, and technology in the same way as consumer goods and services and capital. Unlike most idea-based growth models, no special mechanism is required for the production of technology because endogenous balanced growth (i.e., constant $\frac{A_t}{k_t}$) is not materialized by any special property of the production function of technology but by uncompensated knowledge spillovers and arbitrage between investments in capital and technology.

Because balanced growth paths are the focal point of this paper, Harrod-neutral technical progress is assumed.[41] Hence, the production function is $Y_t = K_t^{1-\alpha}(A_t L_t)^{\alpha}$; thus, $y_t = A_t^{\alpha} k_t^{1-\alpha}$.

It is assumed for simplicity that the population growth rate ($n_t$) is constant and not negative such that $n_t = n \geq 0$.

##### *2.1.1.2. Substitution between investments in $K_t$ and $A_t$*

For any period,

$$m = \frac{M_t}{L_t}, \tag{1}$$

*where*: $M_t$ is the number of firms (which are assumed to be identical) and m (> 0) is a constant. Eq. (1) presents a natural assumption that the population and number of firms are proportional to each other. Eq. (1) therefore indicates that any firm consists of the same number of employee regardless of $L_t$. Note that, unlike the arguments in Young (1998), Peretto (1998), Aghion and Howitt (1998), and Dinopoulos and Thompson (1998), $M_t$ is not implicitly assumed to be proportional to the number of sectors or researchers in the economy (see also Jones, 1999). Eq. (1) merely indicates that the average number of employees per firm in an economy is independent of the population. Hence, $M_t$ is not essential for the amount of production of $A_t$. As will be showen by Eqs. (2) and (3), production of $A_t$ does not depend on the number of researchers but on investments in technology. In contrast, $M_t$ plays an important role in the amount of uncompensated knowledge spillovers.

The constant m implicitly indicates that the size of a firm is, on average, unchanged even if the population increases. This assumption can be justified by Coase (1937) who argued that the size of a firm is limited by the overload of administrative information. In addition, Williamson (1967) argued that there can be efficiency losses in larger firms (see also Grossman and Hart, 1986 and Moore, 1992). Their arguments equally imply that there is an optimal firm size that is determined by factors that are basically independent of population.

Next, for any period,

$$\frac{\partial Y_t}{\partial K_t} = \frac{\varpi}{M_t^{1-\rho}} \frac{\partial Y_t}{\partial (vA_t)}; \tag{2}$$

thus,

$$\frac{\partial y_t}{\partial k_t} = \frac{\varpi L_t^{\rho}}{m^{1-\rho} v} \frac{\partial y_t}{\partial A_t} \tag{3}$$

[41] As is well known, only Harrod-neutral technological progress matches the stylized facts presented by Kaldor (1961). As Barro and Sala-i-Martin (1995) argue, technological progress must take the labour-augmenting form in the production function if the models are to display a steady state.

is always kept, where $\varpi(>1)$ and $\rho(0 \le \rho < 1)$ are constants. The parameter ρ describes the effect of uncompensated knowledge spillovers, and the parameter $\varpi$ indicates the effect of patent protection. With patents, incomes are distributed not only to capital and labor but also to technology. For simplicity, the patent period is assumed to be indefinite, and no capital depreciation is assumed.

Eqs. (2) and (3) indicate that returns on investing in capital and technology for the investing firm are kept equal. The driving force behind the Eqs. is that firms exploit all opportunities and select the most profitable investments at all times. Through arbitrage, this behavior leads to equal returns on investments in capital and technology. With substitution between investments in capital and technology, the model exhibits endogenous balanced growth.

Because $\frac{\varpi}{mv}\frac{\partial y_t}{\partial A_t} = \frac{\partial y_t}{\partial k_t} \Leftrightarrow \frac{\varpi L_t^{\rho}\alpha}{m^{1-\rho}v} A_t^{\alpha-1} k_t^{1-\alpha} = (1-\alpha) A_t^{\alpha} k_t^{-\alpha}$, $A_t = \frac{\varpi L_t^{\rho}\alpha}{m^{1-\rho}v(1-\alpha)} k_t$ by Eqs. (1) and (2), which lucidly indicates that $\frac{A_t}{k_t}$ = constant, and the model can therefore show balanced endogenous growth.

#### *2.1.1.3. Uncompensated knowledge spillovers*

Eqs. (2) and (3) also indicate that the investing firm cannot obtain all of the returns on its investment in technology. That is, although investment in technology increases $Y_t$, the investing firm's returns are only a fraction of the increase in $Y_t$, such that $\frac{\varpi}{M_t^{1-\rho}}\frac{\partial Y_t}{\partial(vA_t)}$, because knowledge spills over to other firms without compensation and other firms possess complementary technologies.

Broadly speaking, there are two types of uncompensated knowledge spillovers: intra-sectoral knowledge spillovers (MAR externalities: Marshall, 1890; Arrow, 1962; Romer, 1986) and inter-sectoral knowledge spillovers (Jacobs externalities: Jacobs, 1969). MAR theory assumes that knowledge spillovers between homogenous firms are the most effective and that spillovers will primarily emerge within sectors. As a result, uncompensated knowledge spillovers will be more active if the number of firms within a sector is larger. On the other hand, Jacobs (1969) argues that knowledge spillovers are most effective among firms that practice different activities and that diversification (i.e., a variety of sectors) is more important in influencing spillovers. As a result, uncompensated knowledge spillovers will be more active if the number of sectors in the economy is larger. If all sectors have the same number of firms, an increase in the number of firms in the economy results in more knowledge spillovers in any case, as a result of either MAR or Jacobs externalities.

As uncompensated knowledge spillovers increase, the investing firm's returns on investment in technology decrease. $\frac{\partial Y_t}{\partial A_t}$ indicates the total increase in $Y_t$ in the economy by an increase in $A_t$, which consists of increases in both outputs of the firm that invested in the new technologies and outputs of other firms that utilize the newly invented technologies, regardless of whether the firms obtained the technologies by compensating the originating firm or through uncompensated knowledge spillovers. If the number of firms increases and uncompensated knowledge spillovers increase, the compensated fraction in $\frac{\partial Y_t}{\partial A_t}$ that the investing firm can obtain becomes smaller, as do its returns on the investment in technology. The parameter ρ describes the magnitude of this effect. If ρ = 0, the investing firm's returns are reduced at the same rate as the increase of the number of firms. $0 < \rho < 1$ indicates that the investing firm's returns diminish as the number of firms increase but not to the same extent as when ρ = 0.

Both types of externalities predict that uncompensated knowledge spillovers will increase as the number of firms increases, and scale effects have not actually been observed (Jones, 1995), which implies that scale effects are almost canceled out by the effects of MAR and Jacobs externalities. Thus, the value of ρ is quite likely to be very small. From the point of view of a firm's behavior, a very small ρ appears to be quite natural. Because firms intrinsically seek profit opportunities, newly established firms work as hard as existing firms to profit from knowledge spillovers. An increase in the number of firms therefore indicates that more firms are trying to obtain the investing firm's technologies.

Because of the non-rivalness of technology, all firms can equally benefit from uncompensated knowledge spillovers, regardless of the number of firms. Because the size of firms is independent of population and thus constant as argued in Section 2.1.1.2, each firm's ability to utilize the knowledge that has spilled over

from each of the other firms will not be reduced by an increase in population. In addition, competition over technologies will increase as the number of firms increases, and any firm will completely exploit all opportunities to utilize uncompensated knowledge spillovers as competition increases.[42] Hence, it is quite likely that the probability that a firm can utilize a unit of new technologies developed by each of the other firms without compensation will be kept constant even if the population and the number of firms increase. As a result, uncompensated knowledge spillovers will increase eventually to the point that they increase at the same rate as the increase in the number of firms.

The investing firm's fraction of $\frac{\partial Y_t}{\partial A_t}$ that it can obtain will thereby be reduced at the same rate as the increase in the number of firms, which means that ρ will naturally decrease to zero as a result of firms' profit-seeking behavior. Based on ρ = 0,

$$\frac{\partial Y_t}{\partial K_t} = \frac{\varpi}{M_t}\frac{\partial Y_t}{\partial (vA_t)} \tag{4}$$

by Eqs. (2) and (3); thus,

$$\frac{\partial y_t}{\partial k_t} = \frac{\varpi}{mv}\frac{\partial y_t}{\partial A_t} \tag{5}$$

is always maintained.

Complementary technologies also reduce the fraction of $\frac{\partial Y_t}{\partial A_t}$ that the investing firm can obtain. If a new technology is effective only if it is combined with other technologies, the returns on investment in the new technology will belong not only to the investing firm but also to the firms that possess the other technologies. For example, an innovation in computer software technology generated by a software company increases the sales and profits of computer hardware companies. The economy's productivity increases because of the innovation but the increased incomes are attributed not only to the firm that generated the innovation but also to the firms that possess complementary technologies. A part of $\frac{\partial Y_t}{\partial A_t}$ leaks to these firms, and the leaked income is a kind of rent revenue that unexpectedly became obtainable because of the original firm's innovation. Most new technologies will have complementary technologies. Because of both complementary technologies and uncompensated knowledge spillovers, the fraction of $\frac{\partial Y_t}{\partial A_t}$ that an investing firm can obtain on average will be very small; that is, $\varpi$ will be far smaller than $M_t$ except when $M_t$ is very small.[43]

#### 2.1.1.4. The optimization problem

Because $A_t = \frac{\varpi\alpha}{mv(1-\alpha)}k_t$, then $y_t = \left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}k_t$ and $\dot{A}_t = \frac{\varpi}{mv}\dot{k}_t\left(\frac{\alpha}{1-\alpha}\right)$. Hence, $\dot{k}_t = y_t - c_t - \frac{v\dot{A}_t}{L_t} - n_t k_t = \left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}k_t - c_t - \frac{\varpi}{mL_t}\dot{k}_t\left(\frac{\alpha}{1-\alpha}\right) - n_t k_t$ and

---

[42] Moreover, a larger number of firms indicates that firms are more specialized. More specialized and formerly neglected technologies may become valuable to the larger number of specialized firms. Hence, knowledge spillovers will increase.

[43] If $M_t$ is very small, the value of $\varpi$ will be far smaller than that for sufficiently large $M_t$ because the number of firms that can benefit from an innovation is constrained owing to the very small $M_t$. The very small number of firms indicates that the economy is not sufficiently sophisticated, and thereby the benefit of an innovation cannot be fully realized. This constraint can be modeled as $\varpi = \tilde{\varpi}\left[1-\left(1-\tilde{\varpi}^{-1}\right)^{M_t}\right]$, where $\tilde{\varpi}(\geq 1)$ is a constant. Nevertheless, for sufficiently large $M_t$ (i.e., in sufficiently sophisticated economies), the constraint is removed such that $\lim_{M_t\to\infty}\tilde{\varpi}\left[1-\left(1-\tilde{\varpi}^{-1}\right)^{M_t}\right] = \tilde{\varpi} = \varpi$.

$$\dot{k}_t = \frac{mL_t(1-\alpha)}{mL_t(1-\alpha)+\varpi\alpha}\left[\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}k_t - c_t - n_t k_t\right]. \quad (6)$$

As a whole, the optimization problem of the representative household is to maximize the expected utility $E\int_0^{\infty} u(c_t)\exp(-\theta t)dt$ subject to Eq. (6) where u(•) is a constant relative risk aversion (CRRA) utility function and E is the expectation operator.

### 2.1.2. A model with heterogeneous households

Heterogeneous time preference is examined in an endogenous growth model, which is a modified version of the model shown in Section 2.1.1 (See Harashima (2012) for other heterogeneities—risk aversion and productivity). First, suppose that there are two economies— economy 1 and economy 2—that are identical except for time preference. The population growth rate is zero (i.e., $n_t = 0$). The economies are fully open to each other, and goods, services, and capital are freely transacted between them, but labor is immobilized in each economy.

Each economy can be interpreted as representing either a country (the international interpretation) or a group of identical households in a country (the national interpretation). Because the economies are fully open, they are integrated through trade and form a combined economy. The combined economy is the world economy in the international interpretation and the national economy in the national interpretation. In the following discussion, a model based on the international interpretation is called an international model and that based on the national interpretation is called a national model. Usually, the concept of the balance of payments is used only for the international transactions. However, because both national and international interpretations are possible, this concept and terminology are also used for the national models in this paper.

In this section, a model in which the two economies are identical except for time preference is constructed.[44] The rate of time preference of the representative household in economy 1 is $\theta_1$ and that in economy 2 is $\theta_2$, and $\theta_1 < \theta_2$. The production function in economy 1 is $y_{1,t} = A_t^{\alpha} f(k_{1,t})$ and that in economy 2 is $y_{2,t} = A_t^{\alpha} f(k_{2,t})$, where $y_{i,t}$ and $k_{i,t}$ are, respectively, output and capital per capita in economy i in period t for i = 1, 2. The population of each economy is $\frac{L_t}{2}$; thus, the total for both is $L_t$, which is sufficiently large. Firms operate in both economies, and the number of firms is $M_t$. The current account balance in economy 1 is $\tau_t$ and that in economy 2 is $-\tau_t$. Because a balanced growth path requires Harrod neutral technological progress, the production functions are further specified as: $y_{i,t} = A_t^{\alpha}k_{i,t}^{1-\alpha}$ thus, $Y_{i,t} = K_{i,t}^{1-\alpha}(A_tL_t)^{\alpha}$ $(i = 1,2)$.

Because both economies are fully open, returns on investments in each economy are kept equal through arbitration such that

$$\frac{\partial y_{1,t}}{\partial k_{1,t}} = \frac{\varpi}{2mv}\frac{\partial(y_{1,t}+y_{2,t})}{\partial A_t} = \frac{\partial y_{2,t}}{\partial k_{2,t}} \quad (7)$$

Eq. (7) indicates that an increase in $A_t$ enhances outputs in both economies such that $\frac{\partial Y_{i,t}}{\partial K_{i,t}} = \frac{\varpi}{M_t}\frac{\partial(Y_{1,t}+Y_{2,t})}{\partial(vA_t)}$, and because the population is equal $(\frac{L_t}{2})$, $\frac{\partial Y_{i,t}}{\partial K_{i,t}} = \frac{\partial y_{i,t}}{\partial k_{i,t}} = \frac{\varpi}{M_t}\frac{\partial(Y_{1,t}+Y_{2,t})}{\partial(vA_t)} = \frac{\varpi}{mL_t}\frac{\partial(y_{1,t}+y_{2,t})}{\partial(vA_t)}\frac{L_t}{2} = \frac{\varpi}{2mv}\frac{\partial(y_{1,t}+y_{2,t})}{\partial A_t}$.

[44] This type of endogenous growth model of heterogeneous time preference was originally shown by Harashima (2009).

Therefore, $A_t = \frac{\varpi\alpha\left[f\left(k_{1,t}\right)+ f\left(k_{2,t}\right)\right]}{2mvf'\left(k_{1,t}\right)} = \frac{\varpi\alpha\left[f\left(k_{1,t}\right)+ f\left(k_{2,t}\right)\right]}{2mvf'\left(k_{2,t}\right)}$. Because Eq. (7) is always held through arbitration, Eqs. $k_{1,t} = k_{2,t}$, $\dot{k}_{1,t} = \dot{k}_{2,t}$, $y_{1,t} = y_{2,t}$ and $\dot{y}_{1,t} = \dot{y}_{2,t}$ are also held. Hence, $A_t = \frac{\varpi\alpha f\left(k_{1,t}\right)}{mvf'\left(k_{1,t}\right)} = \frac{\varpi\alpha f\left(k_{2,t}\right)}{mvf'\left(k_{2,t}\right)}$.

In addition, because $\frac{\partial\left(y_{1,t}+y_{2,t}\right)}{\partial A_{1,t}} = \frac{\partial\left(y_{1,t}+y_{2,t}\right)}{\partial A_{2,t}}$ through arbitration, then $\dot{A}_{1,t} = \dot{A}_{2,t}$ is held.

The accumulated current account balance $\int_0^t \tau_s\, ds$ mirrors capital flows between the two economies. The economy with current account surpluses invests them in the other economy. Since $\frac{\partial y_{1,t}}{\partial k_{1,t}}\left(= \frac{\partial y_{2,t}}{\partial k_{2,t}}\right)$ are returns on investments, $\frac{\partial y_{1,t}}{\partial k_{1,t}}\int_0^t \tau_s ds$ and $\frac{\partial y_{2,t}}{\partial k_{2,t}}\int_0^t \tau_s ds$ represent income receipts or payments on the assets that an economy owns in the other economy. Hence,

$$\tau_t - \frac{\partial y_{2,t}}{\partial k_{2,t}}\int_0^t \tau_s ds$$

is the balance on goods and services of economy 1, and

$$\frac{\partial y_{1,t}}{\partial k_{1,t}}\int_0^t \tau_s ds - \tau_t$$

is that of economy 2. Because the current account balance mirrors capital flows between the economies, the balance is a function of capital in both economies such that

$$\tau_t = \kappa\left(k_{1,t}, k_{2,t}\right).$$

The government (or an international supranational organization) intervenes in activities of economies 1 and 2 by transferring money from economy 1 to economy 2. The amount of transfer in period t is $g_t$ and it is assumed that $g_t$ depends on capitals such that

$$g_t = \bar{g}k_{1,t}$$

where $\bar{g}$ is a constant. Because $k_{1,t} = k_{2,t}$ and $\dot{k}_{1,t} = \dot{k}_{2,t}$,

$$g_t = \bar{g}k_{1,t} = \bar{g}k_{2,t}.$$

The representative household in economy 1 maximizes its expected utility

$$E\int_0^\infty u_1\left(c_{1,t}\right)\exp\left(-\theta_1 t\right)dt,$$

subject to

$$\dot{k}_{1,t} = y_{1,t} + \frac{\partial y_{2,t}}{\partial k_{2,t}} \int_0^t \tau_s \, ds - \tau_t - c_{1,t} - g_t - v\dot{A}_{1,t}\left(\frac{L_t}{2}\right)^{-1}$$

$$= y_{1,t} + \frac{\partial y_{2,t}}{\partial k_{2,t}} \int_0^t \tau_s \, ds - \tau_t - c_{1,t} - \bar{g}k_{1,t} - v\dot{A}_{1,t}\left(\frac{L_t}{2}\right)^{-1} \quad (8)$$

and the representative household in economy 2 maximizes its expected utility

$$E\int_0^\infty u_2(c_{2,t})\exp(-\theta_2 t)dt \ ,$$

subject to

$$\dot{k}_{2,t} = y_{2,t} - \frac{\partial y_{1,t}}{\partial k_{1,t}} \int_0^t \tau_s ds + \tau_t - c_{2,t} + g_t - v\dot{A}_{2,t}\left(\frac{L_t}{2}\right)^{-1}$$

$$= y_{2,t} - \frac{\partial y_{1,t}}{\partial k_{1,t}} \int_0^t \tau_s ds + \tau_t - c_{2,t} + \bar{g}k_{2,t} - v\dot{A}_{2,t}\left(\frac{L_t}{2}\right)^{-1} \quad (9)$$

where $u_{i,t}$, $c_{i,t}$, and $\dot{A}_{i,t}$, respectively, are the utility function, per capita consumption, and the increase in $A_t$ by R&D activities in economy i in period t for i = 1, 2; E is the expectation operator; and $\dot{A}_t = \dot{A}_{1,t} + \dot{A}_{2,t}$. Eqs. (8) and (9) implicitly assume that each economy does not have foreign assets or debt in period t = 0.

Because the production function is Harrod neutral and because $A_t = \frac{\varpi\alpha f(k_{1,t})}{mvf'(k_{1,t})} = \frac{\varpi\alpha f(k_{2,t})}{mvf'(k_{2,t})}$ and $f = k_{i,t}^{1-\alpha}$, then $A_t = \frac{\varpi\alpha}{mv(1-\alpha)}k_{i,t}$ and $\frac{\partial y_{i,t}}{\partial k_{i,t}} = \left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{1-\alpha}$. Since $\dot{A}_{1,t} = \dot{A}_{2,t}$ and $\frac{\partial y_{1,t}}{\partial k_{1,t}} = \frac{\partial y_{2,t}}{\partial k_{2,t}}$, then $\dot{k}_{1,t} = y_{1,t} + \frac{\partial y_{1,t}}{\partial k_{1,t}} \int_0^t \tau_s ds - \tau_t - c_{1,t} - \bar{g}k_{1,t} - \frac{v\dot{A}_t}{2}\left(\frac{L_t}{2}\right)^{-1}$

$$= \left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{-\alpha}k_{1,t} + \left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{1-\alpha}\int_0^t \tau_s ds - \tau_t - c_{1,t} - \bar{g}k_{1,t} - \frac{\varpi\alpha}{mL_t(1-\alpha)}\dot{k}_{1,t}$$

and

$$\dot{k}_{1,t} = \frac{mL_t(1-\alpha)}{mL_t(1-\alpha)+\varpi\alpha}\left[\left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{-\alpha}k_{1,t} + \left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{1-\alpha}\int_0^t \tau_s ds - \tau_t - c_{1,t} - \bar{g}k_{1,t}\right].$$

Because $L_t$ is sufficiently large and $\varpi$ is far smaller than $M_t$, the problem of scale effects vanishes and thereby $\frac{mL_t(1-\alpha)}{mL_t(1-\alpha)+\varpi\alpha} = 1$. Putting the above elements together, the optimization problem of economy 1 can be rewritten as $Max\ E\int_0^\infty u_1(c_{1,t})\exp(-\theta_1 t)dt$, subject to

$$\dot{k}_{1,t} = \left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{-\alpha}k_{1,t} + \left(\frac{\varpi\alpha}{mv}\right)^\alpha (1-\alpha)^{1-\alpha}\int_0^t \tau_s ds - \tau_t - c_{1,t} - \bar{g}k_{1,t} \ .$$

Similarly, that of economy 2 can be rewritten as: $Max\ E\int_0^{\infty} u_2(c_{2,t})\exp(-\theta_2 t)dt$, subject to: $\dot{k}_{2,t}=\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}k_{2,t}-\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\int_0^t\tau_s ds+\tau_t-c_{2,t}+\bar{g}k_{2,t}$.

### *2.2. The multilateral path*

Heterogeneity is defined as being sustainable if all the optimality conditions of all heterogeneous households are satisfied indefinitely. Although the previously discussed state of Becker (1980) is Pareto efficient, by this definition, the heterogeneity is not sustainable because only the most patient household can achieve optimality. Sustainability is therefore the stricter criterion for welfare than Pareto efficiency.

In this section, the growth path that makes heterogeneity sustainable is examined. First, the basic natures of the models presented in Section 2.1 when the government does not intervene, i.e., $\bar{g}=0$ are examined.

#### *2.2.1. Sustainability*

Because balanced growth is the focal point for the growth path analysis, the following analyses focus on the steady state such that $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}$, $\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$, $\lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}}$, $\lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}}$, and $\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}$ are constants. The balanced growth path in the heterogeneous time preference model has the following properties.

*Lemma 1:* In the model of heterogeneous time preference, if $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=$ constant, then

$$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=\lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}}=\lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}}=\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}=\lim_{t\to\infty}\frac{\frac{d\left(\int_0^t\tau_s ds\right)}{dt}}{\int_0^t\tau_s ds}.$$

*Proof:* See Harashima (2010)

*Proposition 1:* In the model of heterogeneous time preference, if and only if $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=$ constant, all the optimality conditions of both economies are satisfied at steady state. The path on which $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=$ constant has the following properties.

*Proof:* See Harashima (2010)

*Corollary 1:* In the model of heterogeneous time preference, if and only if $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=$ constant, then

$$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=\lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}}=\lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}}=\lim_{t\to\infty}\frac{\dot{y}_{1,t}}{y_{1,t}}=\lim_{t\to\infty}\frac{\dot{y}_{2,t}}{y_{2,t}}=\lim_{t\to\infty}\frac{\dot{A}_t}{A_t}=\text{constant}.$$

*Proof:* See Harashima (2010)

Note that the limit of the growth rate on this path is

$$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=\varepsilon^{-1}\left[\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}-\frac{\theta_1+\theta_2}{2}\right].^{45} \quad (10)$$

*Corollary 2:* In the model of heterogeneous time preference, if and only if $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=$ constant,

$$\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}=\lim_{t\to\infty}\frac{d\int_0^t\tau_s ds/dt}{\int_0^t\tau_s ds}=\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=\lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}}=\lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}}$$

$$=\lim_{t\to\infty}\frac{\dot{y}_{1,t}}{y_{1,t}}=\lim_{t\to\infty}\frac{\dot{y}_{2,t}}{y_{2,t}}=\lim_{t\to\infty}\frac{\dot{A}_t}{A_t}=\text{constant}$$

*Proof:* See Harashima (2010)

Because current account imbalances eventually grow at the same rate as output, consumption, and capital on the multilateral path, the ratios of the current account balance to output, consumption, and capital do not explode, but they stabilize as shown in the proof of Proposition 1; that is, $\lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}=\lim_{t\to\infty}\frac{\tau_t}{k_{2,t}}=\Xi$.

On the balanced growth path satisfying Proposition 1 and Corollaries 1-1 and 2-1, heterogeneity in time preference is sustainable by definition because all the optimality conditions of the two economies are indefinitely satisfied. The balanced growth path satisfying Proposition 1 and Corollaries 1-1 and 2-1 is called the "multilateral balanced growth path" or (more briefly) the "multilateral path" in the following discussion. The term "multilateral" is used even though there are only two economies, because the two-economy models shown can easily be extended to the multi-economy models shown in Section 2.2.6.

Because technology will not decrease persistently (i.e., $\lim_{t\to\infty}\frac{\dot{A}_t}{A_t}>0$), only the case such that $\lim_{t\to\infty}\frac{\dot{A}_t}{A_t}>0$ (i.e., $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}>0$ on the multilateral path by Corollary 1) is examined in the following discussion.

### 2.2.2. The balance of payments

As shown in the proof of Proposition 1, $\lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}=\lim_{t\to\infty}\frac{\tau_t}{k_{2,t}}=\Xi$ and $\lim_{t\to\infty}\frac{\int_0^t\tau_s ds}{k_{1,t}}=\lim_{t\to\infty}\frac{\int_0^t\tau_s ds}{k_{2,t}}=\Xi\left(\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}\right)^{-1}$ on the multilateral path. Because $k_{i,t}$ is positive, if the sign of Ξ is negative, the current account of economy 1 will eventually show permanent deficits and vice versa.

*Lemma 2:* In the model of heterogeneous time preference,

$$\Xi=\frac{\theta_1-\theta_2}{2}\left\{\varepsilon\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\left[\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}-\frac{\theta_1+\theta_2}{2}\right]^{-1}-1\right\}^{-1}.$$

[45] See Harashima (2010)

*Proof:* See Harashima (2010)

Lemma 2 indicates that the value of Ξ is uniquely determined on the multilateral path, and the sign of Ξ is also therefore uniquely determined.

*Proposition 2:* In the model of heterogeneous time preference, $\Xi < 0$ if $\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}\left[1-(1-\alpha)\varepsilon\right] < \frac{\theta_1+\theta_2}{2}$.

*Proof:* See Harashima (2010)

Proposition 2 indicates that the current account deficit of economy 1 and the current account surplus of economy 2 continue indefinitely on the multilateral path. The condition $\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}\left[1-(1-\alpha)\varepsilon\right] < \frac{\theta_1+\theta_2}{2}$ is generally satisfied for reasonable parameter values.

Conversely, the opposite is true for the trade balance.

*Corollary 3:* In the model of heterogeneous time preference, $\lim_{t\to\infty}\left(\tau_t - \frac{\partial y_{2,t}}{\partial k_{2,t}}\int_0^t \tau_s ds\right) > 0$ if $\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}\left[1-(1-\alpha)\varepsilon\right] < \frac{\theta_1+\theta_2}{2}$.

*Proof:* See Harashima (2010)

Corollary 3 indicates that, on the multilateral path, the trade surpluses of economy 1 continue indefinitely and vice versa. That is, goods and services are transferred from economy 1 to economy 2 in each period indefinitely in exchange for the returns on the accumulated current account deficits (i.e., debts) of economy 1.

Nevertheless, the trade balance of economy 1 is not a surplus from the beginning. Before Corollary 3 is satisfied, negative $\int_0^t \tau_s ds$ should be accumulated. In the early periods, when $\int_0^t \tau_s ds$ is small, the balance on goods and services of economy 1 ($\tau_t - \frac{\partial y_{2,t}}{\partial k_{2,t}}\int_0^t \tau_s ds$) continues to be a deficit. After a sufficient negative amount of $\int_0^t \tau_s ds$ is accumulated, the trade balances of economy 1 shift to surpluses.

Current account deficit of economy 1 means for example that a firm that is owned by economy 1 borrows money from a bank in which economy 2 deposits money. Economy 1 indirectly borrows money from economy 2. This situation can be easily understood if you see the current account deficit of the United States.

### *2.2.3. A model with heterogeneities in multiple elements*

Three heterogeneities—heterogeneous time preference, risk aversion, and productivity—are not exclusive. It is particularly likely that heterogeneities in time preference and productivity coexist. Many empirical studies conclude that the rate of time preference is negatively correlated with income (e.g., Lawrance, 1991; Samwick, 1998; Ventura, 2003); this indicates that the economy with the higher productivity has a lower rate of time preference and vice versa. In this section, the models are extended to include heterogeneity in multiple elements. Suppose that there are H economies that are identical except for time preference. Let the degree of relative risk aversion of economy i be $\varepsilon_i = -\frac{c_{i,t}\,u_i''}{u_i'}$, the production function of economy i be $y_{i,t} = \omega_i^{\alpha} A_t^{\alpha} f\left(k_{i,t}\right)$, and $\tau_{i,j,t}$ be the current account balance of economy i with economy j, where i = 1, 2, … , H, j = 1, 2, … , H, and i ≠ j.

*Proposition 3:* If and only if

$$\lim_{t\to\infty}\frac{\dot{c}_{i,t}}{c_{i,t}}=\left(\frac{\sum_{q=1}^{H}\varepsilon_q\omega_q}{\sum_{q=1}^{H}\omega_q}\right)^{-1}\left\{\left[\frac{\varpi\alpha\sum_{q=1}^{H}\omega_q}{Hmv(1-\alpha)}\right]^{\alpha}-\frac{\sum_{q=1}^{H}\theta_q\omega_q}{\sum_{q=1}^{H}\omega_q}\right\} \tag{11}$$

for any i (= 1, 2, … , H), all the optimality conditions of all heterogeneous economies are satisfied at steady state such that $\lim_{t\to\infty}\frac{\dot{c}_{i,t}}{c_{i,t}}$, $\lim_{t\to\infty}\frac{\dot{k}_{i,t}}{k_{i,t}}$, and $\lim_{t\to\infty}\frac{\dot{\tau}_{i,j,t}}{\tau_{i,j,t}}$ are constants, and

$$\lim_{t\to\infty}\frac{\dot{c}_{i,t}}{c_{i,t}}=\lim_{t\to\infty}\frac{\dot{k}_{i,t}}{k_{i,t}}=\lim_{t\to\infty}\frac{\dot{y}_{i,t}}{y_{i,t}}=\lim_{t\to\infty}\frac{\dot{A}_t}{A_t}=\lim_{t\to\infty}\frac{\dot{\tau}_{i,j,t}}{\tau_{i,j,t}}=\lim_{t\to\infty}\frac{\frac{d\int_0^t\tau_{i,j,s}ds}{dt}}{\int_0^t\tau_{i,j,s}ds}$$

for any i and j ($i\neq j$).

*Proof*: See Harashima (2012)

*Proposition 3* implies that the concept of the representative household in a heterogeneous population implicitly assumes that all households are on the multilateral path.

### *2.3. The unilateral path*

The multilateral path satisfies all the optimality conditions, but that does not mean that the two economies naturally select the multilateral path. Ghiglino (2002) predicts that it is likely that, under appropriate assumptions, the results of Becker (1980) still hold in endogenous growth models. Farmer and Lahiri (2005) show that balanced growth equilibria do not exist in a multi-agent economy in general, except in the special case that all agents have the same constant rate of time preference. How the economies behave in the environments described in Sections 2.1 and 2.3 when the government does not intervene, i.e., $\bar{g}=0$. is examined in this section.

The multilateral path is not the only path on which all the optimality conditions of economy 1 are satisfied. Even if economy 1 behaves unilaterally, it can achieve optimality, but economy 2 cannot.

*Lemma 3:* In the heterogeneous time preference model, if each economy sets $\tau_t$ without regarding the other economy's optimality conditions, then it is not possible to satisfy all the optimality conditions of both economies.

*Proof:* See Harashima (2010)

Since $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=\varepsilon^{-1}\left\{\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{-\alpha}+\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}\left(\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}\right)^{-1}-\lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}-\theta_1\right\}$ at steady state, all the optimality conditions of economy 1 can be satisfied only if either

$$\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}=\lim_{t\to\infty}\frac{\frac{d\left(\int_0^t\tau_s ds\right)}{dt}}{\int_0^t\tau_s ds}=\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} \tag{12}$$

or

$$\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}=\lim_{t\to\infty}\frac{\frac{d\left(\int_0^t\tau_s ds\right)}{dt}}{\int_0^t\tau_s ds}=\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha} \tag{13}$$

That is, $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}$ can be constant only when either Eq. (12) or (13) is satisfied. Conversely, economy 1 has two paths on which all its optimality conditions are satisfied. Eq. (12) indicates that $\lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}=$constant, and Eq. (13) indicates that $\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\left(\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}\right)^{-1}-1=0$ for any $\lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}$. Eq. (12) corresponds to the multilateral path. On the path satisfying Eq. (13), $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}\neq\lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}=\lim_{t\to\infty}\frac{\frac{d\left(\int_0^t\tau_s ds\right)}{dt}}{\int_0^t\tau_s ds}$, and $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}>\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$. Here, by Eqs. (8) and (9),

$$c_{1,t}-c_{2,t}=2\left(\frac{\partial y_{1,t}}{\partial k_{1,t}}\int_0^t\tau_s ds-\tau_t\right)=2\left[\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\int_0^t\tau_s ds-\tau_t\right],\ \text{and}\ \lim_{t\to\infty}\left(c_{1,t}-c_{2,t}\right)=0$$

is required because $\lim_{t\to\infty}\frac{\tau_t}{\int_0^t\tau_s ds}=\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}$. However, because $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}>\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$, economy 2 must initially set consumption such that $c_{2,0}=\infty$, which violates the optimality condition of economy 2. Therefore, unlike with the multilateral path, all the optimality conditions of economy 2 cannot be satisfied on the path satisfying Eq. (13) even though those of economy 1 can. Hence, economy 2 has only one path on which all its optimality conditions can be satisfied—the multilateral path. The path satisfying Eq. (13) is called the "unilateral balanced growth path" or the "unilateral path" in the following discussion. Clearly, heterogeneity in time preference is not sustainable on the unilateral path.

How should economy 2 respond to the unilateral behavior of economy 1? Possibly, both economies negotiate for the trade between them, and some agreements may be reached. If no agreement is reached, however, and economy 1 never regards economy 2's optimality conditions, economy 2 generally will fall into the following unfavorable situation.

*Remark 1*: In the model of heterogeneous time preference, if economy 1 does not regard the optimality conditions of economy 2, the ratio of economy 2's debts (owed to economy 1) to its consumption explodes to infinity while all the optimality conditions of economy 1 are satisfied.

The reasoning behind Remark 1 is as follows. When economy 1 selects the unilateral path and sets $c_{1,0}$ so as to achieve this path, there are two options for economy 2. The first option is for economy 2 to also pursue its own optimality without regarding economy 1: that is, to select its own unilateral path. The second option is to adapt to the behavior of economy 1 as a follower. If economy 2 takes the first option, it sets $c_{2,0}$ without regarding $c_{1,0}$. As the proof of Lemma 3 indicates, unilaterally optimal growth rates are different between the two economies and $\frac{\dot{c}_{1,t}}{c_{1,t}}>\frac{\dot{c}_{2,t}}{c_{2,t}}$; thus, the initial consumption should be set as $c_{1,0}<c_{2,0}$. Because $\frac{\partial y_{1,t}}{\partial k_{1,t}}=\frac{\varpi}{2mv}\frac{\partial\left(y_{1,t}+y_{2,t}\right)}{\partial A_t}=\frac{\partial y_{2,t}}{\partial k_{2,t}}$ and $k_{1,t}=k_{2,t}$ must be kept, capital and technology are equal and grow at the same rate in both economies. Hence, because $c_{1,0}<c_{2,0}$, more capital is initially produced in economy 1 than in economy 2 and some of it will need to be exported to economy 2. As a result, $\frac{\dot{c}_{1,t}}{c_{1,t}}>\frac{\dot{k}_{1,t}}{k_{1,t}}=\frac{\dot{k}_{2,t}}{k_{2,t}}>\frac{\dot{c}_{2,t}}{c_{2,t}}$, which means that all the optimality conditions of both economies cannot be satisfied. Since

$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} > \lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}} = \lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}} > \lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$, capital soon becomes abundant in economy 2, and excess goods and services are produced in that economy. These excess products are exported to and utilized in economy 1. This process escalates as time passes because $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} > \lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}} = \lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}} > \lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$, and eventually almost all consumer goods and services produced in economy 2 are consumed by households in economy 1. These consequences will be unfavorable for economy 2.

If economy 2 takes the second option, it should set $c_{2,0} = \infty$ to satisfy all its optimality conditions, as the proof of Lemma 3 indicates. Setting $c_{2,0} = \infty$ is impossible, but economy 2 as the follower will initially set $c_{2,t}$ as large as possible. This action gives economy 2 a higher expected utility than that of the first option, because consumption in economy 2 in the second case is always higher. As a result, economy 2 imports as many goods and services as possible from economy 1, and the trade deficit of economy 2 continues until $\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\int_0^t \tau_s ds = \tau_t$ is achieved; this is, $\frac{\dot{\tau}_t}{\tau_t} = \frac{d\left(\int_0^t \tau_s ds\right)}{dt}\Big/\int_0^t \tau_s ds$ is achieved. The current account deficits and the accumulated debts of economy 2 will continue to increase indefinitely. Furthermore, they will increase more rapidly than the growth rate of outputs ($\lim_{t\to\infty}\frac{\dot{y}_{2,t}}{y_{2,t}}$) because, in general, $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} < \lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}$; that is, $(1-\varepsilon)\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha} < \theta_1 (< \theta_2)$. If no disturbance occurs, the expansion of debts may be sustained forever, but economy 2 becomes extremely vulnerable to even a very tiny negative disturbance. If such a disturbance occurs, economy 2 will lose all its capital and will no longer be able to repay its debts. This result corresponds to the state shown by Becker (1980), and it will also be unfavorable for economy 2. Because $\lim_{t\to\infty}\left[\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\int_0^t \tau_s ds - \tau_t\right] = 0$, inequality (27) holds, and the transversality condition for economy 1 is satisfied. Thus, all the optimality conditions of economy 1 are satisfied if economy 2 takes the second option.

As a result, all the optimality conditions of economy 2 cannot be satisfied in any case if economy 1 takes the unilateral path. Both options to counter the unilateral behavior of economy 1 are unfavorable for economy 2. However, the expected utility of economy 2 is higher if it takes the second option rather than the first, and economy 2 will choose the second option. Hence, if economy 1 does not regard economy 2's optimality conditions, the debts owed by economy 2 to economy 1 increase indefinitely at a higher rate than consumption.

## 3. Sustainable heterogeneity in an exogenous growth model

The multilateral paths in the endogenous growth models (heterogeneous time preference, risk aversion, and productivity models) shown in Section 2 imply that similar sustainable states exist in exogenous growth models. However, this is true only for the heterogeneous time preference model, because, in exogenous growth models, the steady state means that $\frac{\partial y_t}{\partial k_t} = \theta$; that is, the heterogeneity in risk aversion is irrelevant to the steady state, and the heterogeneous productivities do not result in permanent trade imbalances due to $\frac{\partial y_{1,t}}{\partial k_{1,t}} = \frac{\partial y_{2,t}}{\partial k_{2,t}}$. Thereby, only heterogeneous time preference is relevant to sustainable heterogeneity in exogenous growth models.

### *3.1. The model*

The endogenous growth model of heterogeneous time preference in Section 2 is degenerated to an exogenous growth model. If technology is exogenously given and constant ($A_t = A$), Hamiltonians for the heterogeneous time preference model shown in Section 2.2.1 degenerate to

$$H_1 = u_1(c_{1,t})\exp(-\theta_1 t) + \lambda_{1t}\left[A^{\alpha}k_{1,t}^{1-\alpha} + (1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\int_0^t \tau_s ds - \tau_t - c_{1,t} - \bar{g}k_{1,t}\right]$$ for economy 1,

and $H_2 = u_2(c_{2,t})\exp(-\theta_2 t) + \lambda_{2,t}\left[A^{\alpha}k_{2,t}^{1-\alpha} - (1-\alpha)A^{\alpha}k_{2,t}^{-\alpha}\int_0^t \tau_s ds + \tau_t - c_{2,t} + \bar{g}k_{2,t}\right]$ for economy 2.

### *3.2. Sustainable heterogeneity*

First, the natures of the model when the government does not intervene, i.e., $\bar{g} = 0$ are examined. The growth rate of consumption in economy 1 is

$$\frac{\dot{c}_{1,t}}{c_{1,t}} = \varepsilon^{-1}\left\{(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha} + (1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\frac{\partial\int_0^t \tau_s ds}{\partial k_{1,t}} - \alpha(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha-1}\int_0^t \tau_s ds - \frac{\partial\tau_t}{\partial k_{1,t}} - \theta_1\right\}.$$

Hence,

$$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} =$$

$$\varepsilon^{-1}\lim_{t\to\infty}\left\{(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha} + (1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\frac{\partial\int_0^t \tau_s ds}{\partial k_{1,t}} - \alpha(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha-1}\int_0^t \tau_s ds - \frac{\partial\tau_t}{\partial k_{1,t}} - \theta_1\right\} = 0$$

and thereby

$$\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\left[1 + (1-\alpha)\Psi\right] - \Xi - \theta_1 = 0,$$

where $\Xi = \lim_{t\to\infty}\frac{\tau_t}{k_{1,t}} = \lim_{t\to\infty}\frac{\tau_t}{k_{2,t}}$ and $\Psi = \lim_{t\to\infty}\frac{\int_0^t \tau_s ds}{k_{1,t}} = \lim_{t\to\infty}\frac{\int_0^t \tau_s ds}{k_{2,t}}$. $\lim_{t\to\infty}\frac{\dot{y}_{1,t}}{y_{1,t}} = \lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} = \lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}} = \lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t} = 0$, and Ψ is constant at steady state because $k_{1,t}$ and $\tau_t$ are constant and thus $\Xi = \lim_{t\to\infty}\frac{\tau_t}{k_{1,t}}$ is constant at steady state. For Ψ to be constant at steady state, it is necessary that $\lim_{t\to\infty}\tau_t = 0$ and thus $\Xi = 0$. Therefore,

$$\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\left[1 + (1-\alpha)\Psi\right] - \theta_1 = 0, \quad (14)$$

and

$$\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{2,t}^{-\alpha}\left[1 - (1-\alpha)\Psi\right] - \theta_2 = 0 \quad (15)$$

because

$$\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}} =$$

$$\varepsilon^{-1}\lim_{t\to\infty}\left\{(1-\alpha)A^{\alpha}k_{2,t}^{-\alpha} - (1-\alpha)A^{\alpha}k_{2,t}^{-\alpha}\frac{\partial\int_0^t \tau_s ds}{\partial k_{2,t}} + \alpha(1-\alpha)A^{\alpha}k_{2,t}^{-\alpha-1}\int_0^t \tau_s ds + \frac{\partial\tau_t}{\partial k_{2,t}} - \theta_2\right\} = 0. \quad (16)$$

Because $\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\left[1+(1-\alpha)\Psi\right]=\theta_1$, $\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{2,t}^{-\alpha}\left[1-(1-\alpha)\Psi\right]=\theta_2$, and $\frac{\partial y_{1,t}}{\partial k_{1.t}}=\frac{\partial y_{2,t}}{\partial k_{2.t}}=A^{\alpha}k_{1,t}^{-\alpha}=A^{\alpha}k_{2,t}^{-\alpha}$, then

$$\Psi=\frac{\theta_1-\theta_2}{2(1-\alpha)\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}} \quad (17)$$

By Eqs. (14) and (17),

$$\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}+\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}(1-\alpha)\Psi=\theta_1 \ ;$$

Thus $\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}=\frac{\theta_1+\theta_2}{2}=\lim_{t\to\infty}\frac{\partial y_{2,t}}{\partial k_{2.t}}$ . (18)

If Eq. (18) holds, all the optimality conditions of both economies are indefinitely satisfied. This result is analogous to Eq. (29) and corresponds to the multilateral path in the endogenous growth models. The state indicated by Eq. (18) is called the "multilateral steady state" or "multilateral state" in the following discussion. By similar procedures as those used for the endogenous growth models in Section 2, the condition of multilateral steady state for H economies is shown as

$$\lim_{t\to\infty}\frac{\partial y_{i,t}}{\partial k_{i.t}}=\frac{\sum_{q=1}^{H}\theta_q}{H}$$

for any i where i = 1, 2, … , H.

Because,

$$\Psi=\frac{\theta_1-\theta_2}{2(1-\alpha)\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}}=\frac{\theta_1-\theta_2}{(1-\alpha)(\theta_1+\theta_2)}<0$$

by Eq. (18), then, by $\lim_{t\to\infty}\frac{\int_0^t\tau_s ds}{k_{1,t}}=\Psi<0$,

$$\lim_{t\to\infty}\int_0^t\tau_s ds<0 \ ;$$

that is, economy 1 possesses accumulated debts owed to economy 2 at steady state, and economy 1 has to export goods and services to economy 2 by

$$\left|(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\int_0^t\tau_s ds\right|$$

in every period to pay the debts. Nevertheless, because $\lim_{t\to\infty}\tau_t=0$ and $\Xi=0$, the debts do not explode but stabilize at steady state.

If both economies are not open and are isolated, $\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}=\theta_1$ and $\lim_{t\to\infty}\frac{\partial y_{2,t}}{\partial k_{2.t}}=\theta_2$ at steady state instead of the conditions shown in Eq. (18). Hence, at the multilateral steady state with $\theta_1<\theta_2$, the amount of capital in economy 1 is smaller than when the economy is isolated and vice versa. As a result, output and consumption in economy 1 are also smaller in the multilateral steady state with $\theta_1<\theta_2$ than when the economy is isolated.

### *3.3. The unilateral state*

In the multilateral state, all the optimality conditions of both economies are satisfied, and heterogeneity is therefore sustainable. However, this state will be economically less preferable for economy 1 as compared with the state of Becker (1980), because consumption is smaller and debts are owed. The behaviors of the economies in the environments described in Sections 3.1 when the government does not intervene, i.e., $\bar{g} = 0$. is examined in this section.

The multilateral state is not the only state on which all the optimality conditions of economy 1 are satisfied. Even if economy 1 behaves unilaterally, it can achieve optimality, but economy 2 cannot.

*Lemma 5:* In the heterogeneous time preference model, if each economy sets $\tau_t$ without regarding the other economy's optimality conditions, then it is not possible to satisfy all the optimality conditions of both economies.

*Proof:* See Harashima (2010)

Economy 1 has another path that satisfies Eq. (14) other than the path that satisfies Eq. (17). Even if economy 1 does not consider the optimality conditions of economy 2 (i.e., economy 1 behaves unilaterally), the behavior that satisfies the following condition also makes all the optimality conditions of economy 1 satisfied:

$$\Psi = \frac{\theta_1 \left[\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\right]^{-1} - 1}{1-\alpha} \tag{19}$$

Eq. (19) is easily obtained by transposition in Eq. (14). By Eq. (19),

$$\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}} = \lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha} = \frac{\theta_1}{1+(1-\alpha)\Psi} \tag{20}$$

If Ψ = 0,

$$\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}} = \lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha} = \theta_1 \ ,$$

which is the familiar condition for steady state in the Ramsey growth model. Economy 1 selects one of the two steady states (the multilateral state that satisfies Eq. [17] and the unilateral state that satisfies Eq. [19]) at which all its optimality conditions are satisfied.

On the path that satisfies Eq. (19),

$$\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}} == \varepsilon^{-1}\left\langle \lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{2,t}^{-\alpha}\left\{2-\theta_1\left[\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\right]^{-1}\right\}-\theta_2\right\rangle$$

by Eq.s (16) and (19). Because $A^{\alpha}k_{2,t}^{-\alpha} = A^{\alpha}k_{1,t}^{-\alpha}$,

$$\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}} = \varepsilon^{-1}\left[2\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha} - \theta_1 - \theta_2\right].$$

By Eq. (20),

$$\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}} = \varepsilon^{-1}\left[\theta_1\frac{1-(1-\alpha)\Psi}{1+(1-\alpha)\Psi} - \theta_2\right]$$

If economy 1 initially sets its consumption unilaterally so as to make $\Psi = \lim_{t\to\infty}\frac{\int_0^t \tau_s ds}{k_{1,t}} \geq 0$, then $\frac{1-(1-\alpha)\Psi}{1+(1-\alpha)\Psi} \leq 1$, and therefore $\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}} = \varepsilon^{-1}\left[\theta_1\frac{1-(1-\alpha)\Psi}{1+(1-\alpha)\Psi} - \theta_2\right] < 0$ because $\theta_1 < \theta_2$ as assumed in

Section 2.1.2. Furthermore, even though Ψ < 0, if $\frac{\theta_1-\theta_2}{(\theta_1+\theta_2)(1-\alpha)}<\Psi$ , $\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}<0$. Hence, if economy 1 behaves unilaterally and sets its initial consumption so as to make $\frac{\theta_1-\theta_2}{(\theta_1+\theta_2)(1-\alpha)}<\Psi$, the consumption of economy 2 continues to decline indefinitely, i.e., $c_{2,t} = 0$ at steady state while $c_{1,t}$ is positive and constant at steady state. Unless economy 2 initially sets its consumption such that $c_{2,0}=\infty$, which is however impossible, the optimality condition of economy 2 is violated. This is the case Becker (1980) describes.

There are various steady states that satisfy Eq. (19) depending on the value of $\Psi=\lim_{t\to\infty}\frac{\int_0^t\tau_s ds}{k_{1,t}}$ (i.e., the initial consumption set by economy 1). At any steady state that satisfies Eq. (19), all optimality conditions of economy 1 are satisfied. For economy 1, all such steady states are equally optimal. Economy 1 selects one of these steady states (in other words, sets a certain value of the initial consumption). For example, it may select the one that gives the highest expected utility, the highest steady state consumption, or some values of other criteria.

Unlike with the multilateral state, all the optimality conditions of economy 2 cannot be satisfied on the path satisfying Eq. (19) even though those of economy 1 can. Hence, economy 2 has only one path on which all its optimality conditions can be satisfied—the multilateral state. The state satisfying Eq. (19) is called the "unilateral steady state" or the "unilateral state" in the following discussion. Clearly, heterogeneity in time preference is not sustainable on the unilateral state.

How should economy 2 respond to the unilateral behavior of economy 1? Possibly, both economies negotiate for the trade between them, and some agreements may be reached. If no agreement is reached, however, and economy 1 never regards economy 2's optimality conditions, economy 2 generally will fall into the following unfavorable situation.

*Remark 2:* In the model of heterogeneous time preference, if economy 1 does not regard the optimality conditions of economy 2, the ratio of economy 2's debts (owed to economy 1) to its consumption explodes to infinity while all the optimality conditions of economy 1 are satisfied.

The reasoning behind Remark 2 is as follows. When economy 1 selects the unilateral state and sets $c_{1,0}$ so as to achieve this path, there are two options for economy 2. The first option is for economy 2 to also pursue its own optimality without regarding economy 1: that is, to select its own unilateral state. The second option is to adapt to the behavior of economy 1 as a follower. If economy 2 takes the first option, it sets $c_{2,0}$ without regarding $c_{1,0}$. As the proof of Lemma 5 indicates, unilaterally optimal growth rates are different between the two economies and $\frac{\dot{c}_{1,t}}{c_{1,t}}>\frac{\dot{c}_{2,t}}{c_{2,t}}$; thus, the initial consumption should be set as $c_{1,0}<c_{2,0}$. Because $\frac{\partial y_{1,t}}{\partial k_{1,t}}=\frac{\varpi}{2mv}\frac{\partial(y_{1,t}+y_{2,t})}{\partial A_t}=\frac{\partial y_{2,t}}{\partial k_{2,t}}$ and $k_{1,t}=k_{2,t}$ must be kept, capital and technology are equal and grow at the same rate in both economies. Hence, because $c_{1,0}<c_{2,0}$, more capital is initially produced in economy 1 than in economy 2 and some of it will need to be exported to economy 2. As a result, $\frac{\dot{c}_{1,t}}{c_{1,t}}>\frac{\dot{k}_{1,t}}{k_{1,t}}=\frac{\dot{k}_{2,t}}{k_{2,t}}>\frac{\dot{c}_{2,t}}{c_{2,t}}$, which means that all the optimality conditions of both economies cannot be satisfied.

Since $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}>\lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}}=\lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}}>\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$, capital soon becomes abundant in economy 2, and excess goods and services are produced in that economy. These excess products are exported to and utilized in economy 1. This process escalates as time passes because $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}>\lim_{t\to\infty}\frac{\dot{k}_{1,t}}{k_{1,t}}=\lim_{t\to\infty}\frac{\dot{k}_{2,t}}{k_{2,t}}>\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}$, and eventually almost all consumer goods and services produced in economy 2 are consumed by households in economy 1. These consequences will be unfavorable for economy 2.

If economy 2 takes the second option, it should set $c_{2,0} = \infty$ to satisfy all its optimality conditions, as the proof of Lemma 5 indicates. Setting $c_{2,0} = \infty$ is impossible, but economy 2 as the follower will initially set $c_{2,t}$ as large as possible. This action gives economy 2 a higher expected utility than that of the first option, because consumption in economy 2 in the second case is always higher. As a result, economy 2 imports as many goods and services as possible from economy 1, and the trade deficit of economy 2 continues until $\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\int_0^t \tau_s ds = \tau_t$ is achieved; this is, $\frac{\dot{\tau}_t}{\tau_t} = \frac{d\left(\int_0^t \tau_s ds\right)}{dt}\Big/\int_0^t \tau_s ds$ is achieved. The current account deficits and the accumulated debts of economy 2 will continue to increase indefinitely. Furthermore, they will increase more rapidly than the growth rate of outputs ($\lim_{t\to\infty}\frac{\dot{y}_{2,t}}{y_{2,t}}$) because, in general, $\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} < \lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t}$; that is, $(1-\varepsilon)\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha} < \theta_1 (< \theta_2)$. If no disturbance occurs, the expansion of debts may be sustained forever, but economy 2 becomes extremely vulnerable to even a very tiny negative disturbance. If such a disturbance occurs, economy 2 will lose all its capital and will no longer be able to repay its debts. This result corresponds to the state shown by Becker (1980), and it will also be unfavorable for economy 2. Because $\lim_{t\to\infty}\left[\left(\frac{\varpi\alpha}{mv}\right)^{\alpha}(1-\alpha)^{1-\alpha}\int_0^t \tau_s ds - \tau_t\right] = 0$, inequality (27) holds, and the transversality condition for economy 1 is satisfied. Thus, all the optimality conditions of economy 1 are satisfied if economy 2 takes the second option.

As a result, all the optimality conditions of economy 2 cannot be satisfied in any case if economy 1 takes the unilateral state. Both options to counter the unilateral behavior of economy 1 are unfavorable for economy 2. However, the expected utility of economy 2 is higher if it takes the second option rather than the first, and economy 2 will choose the second option. Hence, if economy 1 does not regard economy 2's optimality conditions, the debts owed by economy 2 to economy 1 increase indefinitely at a higher rate than consumption.

### *3.4. Doom of the less advantaged economies*

Remark 2 indicate that economy 2's ratio of debt to consumption continues to increase indefinitely on the unilateral state. Such an indefinitely increasing ratio may not matter if there is no shock or disturbance. However, if even a very tribunal negative shock occurs, economy 2 will be ruined because the huge amount of accumulated debts cannot be refinanced. In this case, "ruin" means that economy 2 will go bankrupt or be exterminated because its consumption has to be zero unless the authority intervenes to some extent (e.g., debt relief after personal bankruptcy). Even if economy 2 continues to exist by the mercy of economy 1, it will fall into a slave-like state indefinitely without the authority's intervention.

## 4. Sustainable heterogeneity with government intervention

Sustainable heterogeneity, as described in this paper, is a very different state from what Becker (1980) described. The difference emerges because, on a multilateral state, economy 1 behaves fully considering economy 2's situation. The multilateral state therefore will not be naturally selected by economy 1, and the path selection may have to be decided politically (Harashima, 2010). On the other hand, when economy 1 behaves unilaterally, the government may intervene in economic activities so as to achieve, for example, social justice.

In this section, I show that even if economy 1 behaves unilaterally, sustainable heterogeneity can always be achieved with appropriate government intervention.

### *4.1. Heterogeneous time preference model*

Government intervention is first considered in the two-economy model constructed in Section 3. If the government intervenes (i.e., $\bar{g} > 0$),

$$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}} \neq \lim_{t\to\infty}\frac{\dot{\tau}_t}{\tau_t} = \lim_{t\to\infty}\frac{\dfrac{d\left(\int_0^t \tau_s ds\right)}{dt}}{\int_0^t \tau_s ds} .$$

Because $\bar{g} > 0$, Eqs. (14) and (15) are changed to ,

$$\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\left[1+(1-\alpha)\Psi\right]-\theta_1-\bar{g}=0 , \tag{21}$$

and

$$\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{2,t}^{-\alpha}\left[1-(1-\alpha)\Psi\right]-\theta_2+\bar{g}=0 \tag{22}$$

If economy 1 behaves unilaterally such that Eq. (21) is satisfied, then

$$\lim_{t\to\infty}\frac{\dot{c}_{1,t}}{c_{1,t}}=0 \text{ and } \Psi=\frac{(\theta_1+\bar{g})\left[\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}\right]^{-1}-1}{1-\alpha} .$$

At the same time, if economy 2 behaves unilaterally such that Eq. (22) is satisfied, then $\lim_{t\to\infty}\frac{\dot{c}_{2,t}}{c_{2,t}}=0$.

By Eqs. (21) and (22) $\bar{g}=\frac{\theta_2-\theta_1}{2}+\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}(1-\alpha)\Psi$ because $k_{1,t}=k_{2,t}$. In addition,

$$\lim_{t\to\infty}(1-\alpha)A^{\alpha}k_{1,t}^{-\alpha}=\frac{\theta_1+\theta_2}{2}=\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}=\lim_{t\to\infty}\frac{\partial y_{2,t}}{\partial k_{2.t}} .$$

This Eq. is identical to Eq. (18) and is satisfied at the multilateral steady state. Therefore,

$$\bar{g}=\frac{\theta_2-\theta_1}{2}+(1-\alpha)\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}\Psi=\frac{\theta_2-\theta_1}{2}+(1-\alpha)\frac{\theta_1+\theta_2}{2}\lim_{t\to\infty}\frac{\int_0^t\tau_s ds}{k_{1,t}} \tag{23}$$

If $\bar{g}$ is set equal to Eq. (23), all optimality conditions of both economies 1 and 2 are satisfied even though economy 1 behaves unilaterally.

There are various values of Ψ depending on the initial consumption economy 1 sets. If economy 1 behaves in such a way as to make $\lim_{t\to\infty}\int_0^t\tau_s ds<0$, particularly, make $\bar{g}$ = 0 such that

$$\bar{g}=\frac{\theta_2-\theta_1}{2}+(1-\alpha)\frac{\theta_1+\theta_2}{2}\lim_{t\to\infty}\frac{\int_0^t\tau_s ds}{k_{1,t}}=0 ,$$

then

$$\Psi=\frac{\theta_1-\theta_2}{2(1-\alpha)\lim_{t\to\infty}\frac{\partial y_{1,t}}{\partial k_{1.t}}} \tag{24}$$

by Eq. (23). Eq. (24) is identical to Eq. (17), that is, the state where Eq. (24) is satisfied is identical to the multilateral state (with no government intervention, i.e., $\bar{g}$ = 0). On the other hand, if economy 1 behaves in such a way as to make $\lim_{t\to\infty}\int_0^t\tau_s ds=0$, $\bar{g}=\frac{\theta_2-\theta_1}{2}>0$ .

This condition is identical to that for sustainable heterogeneity with government intervention in the endogenous growth model shown in Harashima (2012). Furthermore, if economy 1 behaves in such a way as to make $\lim_{t\to\infty}\int_0^t\tau_s ds>0$, $\bar{g}$ is positive and given by Eq. (23).

There are various steady states depending on the values of $\Psi = \lim_{t\to\infty} \frac{\int_0^t \tau_s ds}{k_{1,t}}$ and thus the initial consumption set by economy 1. Nevertheless, at any steady state that satisfies Eq. (24), all optimality conditions of economy 1 are satisfied. In addition, by government's appropriate intervention, all optimality conditions of economy 2 are also satisfied. For economy 1, all steady states are equally optimal. Economy 1 selects one of steady states (in other words, it sets the initial consumption). For example, it may select the one that gives the highest expected utility, the highest steady state consumption, or some values of other criteria. Note however that too large positive Ψ requires zero initial consumption and thus a certain upper bound of Ψ will exist.

### *4.2. Multi-economy models*

In this section, only the case of $\Psi = \lim_{t\to\infty} \frac{\int_0^t \tau_s ds}{k_{1,t}} = 0$ is considered for simplicity. As was assumed in Section 2, there are H economies that are identical except for time preference. If H = 2, when sustainable heterogeneity is achieved, economies 1 and 2 consist of a combined economy (economy 1+2) with twice the population and a rate of time preference of $\frac{\theta_1 + \theta_2}{2}$. Suppose there is a third economy with a time preference of $\theta_3$. Because economy 1+2 has twice the population of economy 3, if: $\bar{g} = \frac{\theta_3 - \frac{\theta_1 + \theta_2}{2}}{3}$, *then* $\lim_{t\to\infty} \frac{\dot{c}_{1,t}}{c_{1,t}} = \lim_{t\to\infty} \frac{\dot{c}_{2,t}}{c_{2,t}} = \lim_{t\to\infty} \frac{\dot{c}_{3,t}}{c_{3,t}} = 0$. By iterating similar procedures, if the government's transfers between economy H and economy 1+2+ · · · + (H – 1) is such that: $\bar{g} = \frac{\theta_H - \frac{\sum_{q=1}^{H-1} \theta_q}{H-1}}{H}$, *then* $\lim_{t\to\infty} \frac{\dot{c}_{i,t}}{c_{i,t}} = 0$ *for any* i (= 1, 2, · · ·, H).

## 5. Evolutionary origin of utility

### 5.1. Genes and utility

The gene-centered view of evolution indicates that evolution is the result of the differential survival of competing genes (see, e.g., Hamilton 1964a; b, Williams, 1966), and the gene is the unit of selection. Genes compete to survive, and only genes that "won" the competition have survived the evolutionary process by fully utilizing their phenotypic effects. The gene-centered view implies that species are governed by an extremely strong desire for the indefinite continuation of their genes. Although some mutations may have existed that made an individual lack such a desire, such mutations must eventually be exterminated through natural selection. A strong desire to survive as a phenotypic effect indicates that humans are extremely motivated to avoid of being exterminated.

Altruistic behaviors of individuals in a group that shares a common pool of genes may be observed, but the gene-centered view implies that the group as a whole will demonstrate an extremely strong desire to escape the possibility of being exterminated. Some individuals may even die to save the group, but the group will never willingly choose to be destroyed because the common pool of genes would be lost.

The concept of utility should be consistent with the theory of evolution, and the above arguments indicate that the prospect of being exterminated should produce extreme fear (i.e., extreme disutility) in human beings. As Becker (1980) showed, unless sustainable heterogeneity is achieved, less advantaged households will perish when even a very small negative shock occurs, so the possibility of extinction does occur in dynamic models with a heterogeneous population. The possibility of extinction should result in a situation of extreme disutility for households in an economy, and human beings are "programmed" to take extreme actions to try to escape this result, thereby enabling the common pool of genes to survive. The gene-centered view of evolution indicates that the extreme disutility experienced in this situation is a natural outcome of evolution.

### 5.2. Extreme disutility to unsustainable heterogeneity

Sections 3.3 and 3.4 indicate that, on a unilateral state without government intervention, less advantaged economies are exterminated or, at best, fall into a slave-like state. The slave-like state can be seen as equivalent to being exterminated in the sense that the members of those economies are treated more like disposable materials. As discussed in Section 5.1, either extermination or living in a slave-like state should generate extreme fear and disutility in residents of these economies. Hence, the unilateral state without government intervention will generate extreme disutility in the less advantaged economies.

Note that households are assumed to live infinitely long in this paper; thus, extermination does not mean the death of an individual with a finite lifespan. It is the extinction of a dynasty, and in biological terms, indicates that all group members who share a common pool of genes perish.

It could be argued that being forced to live in a slave-like state does not generate extreme disutility because the common pool of genes is preserved. However, the members of these economies can be exterminated at will at any time by the most advantaged economy. Therefore, such states merely mean that extermination is postponed, and the expectations of either being exterminated or falling into in a slave-like state will equally generate extreme disutility.

### 5.3. The utility of being exterminated

The utility function $u_i(c_{i,t})$ is modified to $u_i(\sigma_{i,t},c_{i,t})$, *where*: $\sigma_{i,t}$ takes two values, 1 and 0. $\sigma_{i,t} = 0$ if economy i is exterminated, and $\sigma_{i,t} = 1$ if economy i is not exterminated (extermination includes falling in a slave-like state). The utility function allows negative values of utility. Being exterminated (i.e., $\sigma_{i,t} = 0$) generates extreme disutility such that $u_i(0,c_{i,t}) = -\infty$ for any $c_{i,t}$; that is, extreme disutility is expressed as infinite disutility. If economy i expects to be exterminated in some future period t' such that $E(\sigma_{i,t}) = 0$ for $t > t'$, then $Eu_i(\sigma_t,c_{i,t}) = -\infty$ for $t > t'$. If economy i does not expect to be exterminated in the future such that $E(\sigma_{i,t}) = 1$ for any t, then $Eu_i(\sigma_t,c_{i,t}) = Eu_i(1,c_{i,t})$ .

Note that infinite disutility may indicate that utility is cardinal. Nevertheless, the infinite disutility of $u_i(0,c_{i,t})$ expressed here as $u_i(0,c_{i,t}) = -\infty$ can be defined by an ordinal expression such that $u_i(0,c_{i,t})$ is identical for any $c_{i,t}$, and $u_i(1,0) \succ u_i(0,c_{i,t})$ *for any* $c_{i,t}$ [e.g., $u_i(1,0) \succ u_i(0,\infty)$], where $u_i(1,c_{i,t,1}) \succ u_i(1,c_{i,t,2})$ when $c_{i,t,1} > c_{i,t,2}$ .

## 6. Sustainable heterogeneity as the unique socially optimal allocation

### 6.1. The utility possibility frontier

A modified utility possibility frontier is needed for analyses using dynamic models with a heterogeneous population.

#### 6.1.1. The utility possibility frontier for an endogenous growth model

Because the model used in this paper is a dynamic one, streams of utilities have to be compared. The utility possibility frontier, therefore, does not consist of period-utilities but of discounted sums of expected utilities. For simplicity, the two-economy model is used where economy 1 has a lower rate of time preference than economy 2. Let:

$$\tilde{U}\left[E\int_{t=0}^{\infty} u_1(\sigma_{1,t},c_{1,t})\exp(-\theta_1 t)dt\ ,\ E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt\right] = 0$$

be the utility possibility frontier of economies 1 and 2, where $\sigma_{i,t}$ is σ of economy i (= 1, 2) in period t and $\tilde{U}(\bullet)$ is a two-dimensional function.

The summation of expected period-utilities indicates that period-utilities are cardinal over time in an economy. Nevertheless, the discounted sums of expected utilities derived from different future paths are not required to be cardinal. They merely express ordinal rankings; for example, a higher value of $E\int_{t=0}^{\infty} u_i(1,c_{i,t})\exp(-\theta_i t)dt$ simply means that economy i prefers the path that leads to the higher value over another path with a lower value, and

$$E\int_{t=0}^{\infty} u_i(1,0)\exp(-\theta_i t)dt \succ E\int_{t=0}^{\infty} u_i(\sigma_{i,t},c_{i,t})\exp(-\theta_i t)dt$$

for any $c_{i,t}$ if $E(\sigma_{i,t}) = 0$ for $t > t'$ ( $E\int_{t=0}^{\infty} u_i(\sigma_{i,t},c_{i,t})\exp(-\theta_i t)dt$ is expressed here as $-\infty$ in this case). In addition, comparability of utilities among different economies is not required; that is, the utilities of economies 1 and 2 do need not to be comparable in this model. Note however that although an ordinal expression is possible, a cardinal expression is used for simplicity in the following examinations.

As shown in Section 3, the value of ψ indicates the degree of unilateral behavior of economy 1. $\Psi = \dfrac{\theta_1 - \theta_2}{2(1-\alpha)\lim\limits_{t\to\infty}\dfrac{\partial y_{1,t}}{\partial k_{1.t}}}$ indicates that economy 1 selects the multilateral state. Conversely, if economy 1 selects the most extreme unilateral state, ψ takes its upper bound value. Let $\bar{c}_{i,\psi,t}$ be the consumption of economy i (= 1, 2) corresponding to a given degree of unilateral behavior of economy 1 (ψ). The points on the utility possibility frontier that achieve sustainable heterogeneity are expressed by

$$\left[E\int_{t=0}^{\infty} u_1(1,\bar{c}_{1,\psi t})\exp(-\theta_1 t)dt\ ,\ E\int_{t=0}^{\infty} u_2(1,\bar{c}_{2,\psi t})\exp(-\theta_2 t)dt\right].$$

### 6.1.2. The shape of the utility possibility frontier

The analyses in Sections 2 and 3 indicate that the points on the utility possibility frontier that achieve sustainable heterogeneity consist only of the curve segment AB in Figure 1. Point A indicates the multilateral state, and point B indicates the upper bound of the unilateral state with appropriate government intervention. As the degree of unilateral behavior of economy 1 (ψ) continuously moves, unilateral states with government's intervention continuously move and thus curve segment AB is continuous. Whether the curve segment AB slopes downward or upward is not important for the results shown below. The results depend not on the direction but on the monotonicity of the curve segment, that is, the monotonous relationship between ψ and $E\int_{t=0}^{\infty} u_i(1,\bar{c}_{i,\psi t})\exp(-\theta_i t)dt$.

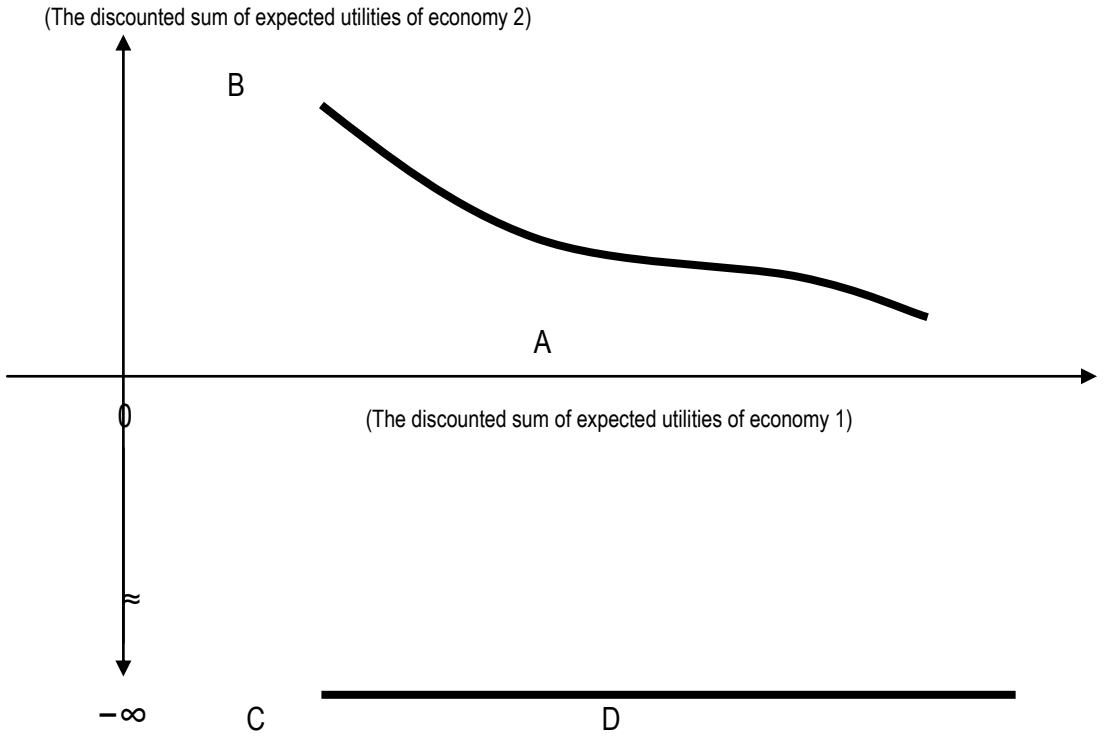


**Figure 1.** The utility possibility frontiers of sustainable and unsustainable heterogeneity

The government's responses to the unilateral behaviors of economy 1, by which sustainable heterogeneity is achieved, are very limited—only responses corresponding to unilateral states that are chosen. Given a degree of unilateral behavior of economy 1 (i.e., given a value of ψ), only one government response, which is indicated by Eq. (25), correspondingly can successfully achieve sustainable heterogeneity. Therefore only one point on curve segment AB consists of the utility possibility frontier for any given value of ψ.

For simplicity, the possibility of too much government intervention is not considered, and $\bar{g}$ never exceeds the value for sustainable heterogeneity. Hence, all other responses result in a disutility of −∞ for economy 2 because it expects to be exterminated in future such that

$Eu_2(0,c_{2,t}) = -\infty$ after a finite period of time; thus, $E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt = -\infty$.

The utility possibilities of such unsustainable heterogeneity for all values of ψ are depicted by the line CD in Figure 1. Given a value of ψ, a part of the line CD correspondingly consists of the utility possibility frontier of unsustainable heterogeneity. Let such part of the line CD be "the line C(ψ)D(ψ)," where point C(ψ) indicates the insufficient intervention that gives the smallest discounted sum of expected utility of economy 1 and point D(ψ) indicates the insufficient intervention that gives the largest. Each point on the line C(ψ)D(ψ) has a corresponding value of $\bar{g}$ , all of which are insufficient to achieve sustainable heterogeneity for the given ψ.

As a result, given a degree of unilateral behavior of economy 1 (i.e., given a value of ψ), the utility possibility frontier is composed of the two parts: a point on the curve segment AB and the line C(ψ)D(ψ).

### 6.2. The social welfare function

Here, a social welfare function is assumed to be adopted by the society consisting of the all economies. The assumptions in Arrow (1951) are modified (e.g., the assumption that every individual has a single-peaked preference is added). The social welfare function that is defined on the same space as the utility possibility frontier is

$$\tilde{W}\left[E\int_{t=0}^{\infty} u_1(\sigma_{1,t},c_{1,t})\exp(-\theta_1 t)dt\ ,\ E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt\right] = W\ ,$$

where $\tilde{W}(\bullet)$ is a two-dimensional function and W is a variable. Its shape is not specified but it at least satisfies the following typical features: completeness, transitivity, and continuity. Thus, its indifference curves do not cross and are sloping downward to the right. The social welfare function's indifference curves are either convex or concave to the origin. In addition, on any indifference curve, as $c_{i,t} \to 0$ for any t, $c_{i,t} \to \infty$ for any t ($i \neq j$). I call this type of social welfare function a "general type social welfare function."

Next, suppose a continuous function such that:

$$\tilde{V}\left[E\int_{t=0}^{\infty} u_1(\sigma_{1,t},c_{1,t})\exp(-\theta_1 t)dt\ ,\ E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt\right] = 0$$

defined on the same space as the utility possibility frontier is. Points satisfying this function are indicated by $(v_1,v_2)$, where $\frac{dv_2}{dv_1} > 0$ and $v_2 = 0$ when $v_1 = 0$, as shown as the dotted line in Figure 2. The indifference curve that crosses the function $\tilde{V}(\bullet) = 0$ at point $(v_1,v_2)$ is

$$\tilde{W}(v_1,v_2) = \tilde{W}\left[E\int_{t=0}^{\infty} u_1(\sigma_{1,t},c_{1,t})\exp(-\theta_1 t)dt\ ,\ E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt\right].$$

Suppose another type of social welfare function such that, for any point $(v_1,v_2)$, $\tilde{W}(v_1,v_2) = \tilde{W}\left[v_1\ ,\ E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt\right]$ for any $E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt \le v_2$. That is, the indifference curves are vertical if $E\int_{t=0}^{\infty} u_2(\sigma_{2,t},c_{2,t})\exp(-\theta_2 t)dt \le v_2$, as shown as the solid lines in Figure 2. I call this type of social welfare function a "Nietzsche type social welfare function." This type of social welfare

function is completely different from the general type social welfare function because it does not possess the nature that as $c_{i,t} \to 0$ for any t, $c_{i,t} \to \infty$ for any t ($i \neq j$) on any indifference curve. The Nietzsche type social welfare function may be loathed by many people because it indicates that a society should not care about its members being exterminated and does not exclude the social preference that only the strongest should prevail. Although a few people may support the Nietzsche type social welfare function, the probability of violent political conflicts will become extremely high if a society adopts it (see Harashima, 2010).

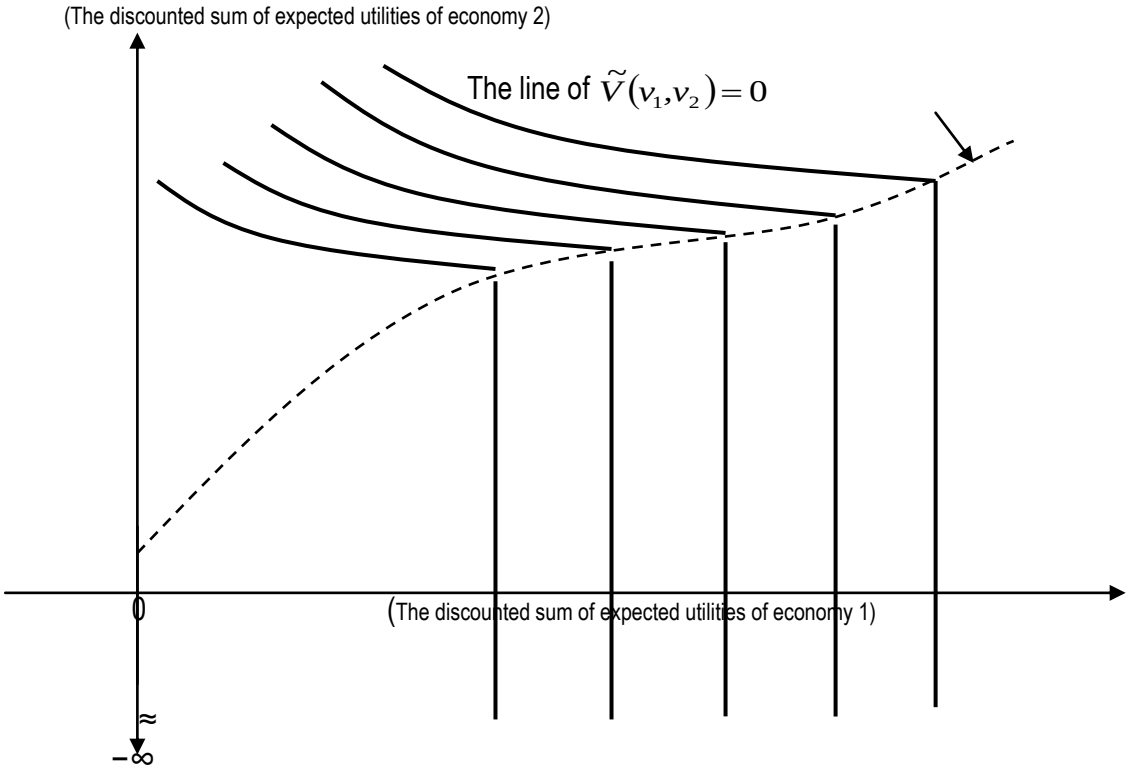


**Figure 2.** Indifference curves of a Nietzsche type social welfare function

### 6.3. The almost unique socially optimal allocation

The socially optimal state is given by the point where the utility possibility frontier and an indifference curve of the social welfare function come in contact with each other. As shown in Section 6.1, however, the utility possibility frontier's shape is not simple. Given a degree of unilateral behavior of economy 1, it is composed of a point on the curve segment AB and the line C(ψ)D(ψ).

Given a value of ψ, let the corresponding point on the curve segment AB be indicated by ($\varsigma_{1,\psi}$, $\varsigma_{2,\psi}$). Let also W(ς) be W of the indifference curve that crosses the point ($\varsigma_{1,\psi}$, $\varsigma_{2,\psi}$), and ($\gamma_{1,W(\varsigma)}$, $\gamma_{2,W(\varsigma)}$) indicate points on the indifference curve W(ς). In addition, let the point D(ψ) be indicated by ($\delta_1$, $\delta_2$), W(δ) be W of the indifference curve that crosses the point D(ψ), and ($\gamma_{1,W(\delta)}$, $\gamma_{2,W(\delta)}$) indicate points on the indifference curve W(δ). As argued in Sections 5.3 and 6.1.1, $\delta_2$ is expressed as $-\infty$. Because of the nature of the point of sustainable heterogeneity ($\varsigma_{1,\psi}$, $\varsigma_{2,\psi}$), the following proposition is self-evident.

*Proposition 4:* If the social welfare function is a general type and its indifference curves are convex to the origin, then only the point ($\varsigma_{1,\psi}$, $\varsigma_{2,\psi}$) is optimal.

Because it is highly likely that social welfare functions in most societies are general type functions and their indifferent curves are convex to the origin, Proposition 4 indicates that generally the point of sustainable heterogeneity ($\varsigma_{1,\psi}$, $\varsigma_{2,\psi}$) is uniquely socially optimal. I next examine social optimality when the social welfare function's indifference curves are concave to the origin.

*Lemma 6:* If the social welfare function is a general type and its indifference curves are concave to the origin, then only the point ($\varsigma_{1,\psi}$, $\varsigma_{2,\psi}$) is optimal.

*Proof:* Because the social welfare function is a general type and its indifference curves are concave to the origin, then $\gamma_{1,W(\varsigma)} > \varsigma_{1,\psi}$ if $\gamma_{2,W(\varsigma)} < \varsigma_{2,\psi}$, and as $\gamma_{1,W(\varsigma)}$ becomes larger, $\gamma_{2,W(\varsigma)}$ becomes smaller. Let $\gamma_{2,W(\varsigma),\,D}$ be $\gamma_{2,W(\varsigma)}$ when $\gamma_{1,W(\varsigma)} = \delta_1$. Because the social welfare function is not a Nietzsche type, then $\gamma_{2,W(\varsigma),\,D} > \delta_2 = -\infty$. Therefore, $W(\varsigma) > W(\delta)$. Because the values of W of the indifference curves that cross any other point on the line $C(\psi)D(\psi)$ than the point $D(\psi)$ are less than $W(\delta)$, then only the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is optimal.

*Lemma 6* shows that even though the social welfare function's indifference curves are concave to the origin, the point of sustainable heterogeneity $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is uniquely determined to be socially optimal if the social welfare function is a general type.

Next, I examine social optimality when the social welfare function is a Nietzsche type. Let $(v_{1,W(\varsigma)}, v_{2,W(\varsigma)})$ be $(v_1, v_2)$ on the indifference curve $W(\varsigma)$. When the social welfare function is Nietzsche type, then $\gamma_{1,W(\varsigma)} \leq v_{1,W(\varsigma)}$, where $\gamma_{1,W(\varsigma)} < v_{1,W(\varsigma)}$ if $\gamma_{2,W(\varsigma)} > v_{2,W(\varsigma)}$ and $\gamma_{1,W(\varsigma)} = v_{1,W(\varsigma)}$ if $\gamma_{2,W(\varsigma)} \leq v_{2,W(\varsigma)}$.

*Lemma 7*: If the social welfare function is a Nietzsche type, and
(a) if $v_{1,W(\varsigma)} < \delta_1$, then only the point $(\delta_1, \delta_2)$ is optimal,
(b) if $v_{1,W(\varsigma)} > \delta_1$, then only the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is optimal, and
(c) if $v_{1,W(\varsigma)} = \delta_1$, then only the points $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ and $(\delta_1, \delta_2)$ are optimal.

*Proof:* Because the social welfare function is a Nietzsche type and thus its indifference curves are concave to the origin, then $\delta_1 = \gamma_{1,W(\delta)}$ and if $\gamma_{2,W(\varsigma)} = \delta_2 = -\infty$, then $v_{1,W(\varsigma)} = \gamma_{1,W(\varsigma)}$. Hence, the following statements apply:

(a) If $v_{1,W(\varsigma)} < \delta_1$, then $\gamma_{1,W(\varsigma)} < \gamma_{1,W(\delta)}$ for $\gamma_{2,W(\varsigma)} = \delta_2 = -\infty$, and thus $W(\varsigma) < W(\delta)$. Because the values of W of the indifference curves that cross any other point on the line $C(\psi)D(\psi)$ than the point $D(\psi)$ are less than $W(\delta)$, then only the point $(\delta_1, \delta_2)$ is optimal.
(b) If $v_{1,W(\varsigma)} > \delta_1$, then $\gamma_{1,W(\varsigma)} > \gamma_{1,W(\delta)}$ for $\gamma_{2,W(\varsigma)} = \delta_2 = -\infty$, and thus $W(\varsigma) > W(\delta)$. By the same reason as the latter part of (a), only the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is optimal.
(c) If $v_{1,W(\varsigma)} = \delta_1$, then $\gamma_{1,W(\varsigma)} = \gamma_{1,W(\delta)}$ for $\gamma_{2,W(\varsigma)} = \delta_2 = -\infty$, and thus $W(\varsigma) = W(\delta)$. Again, by the same reason as the latter part of (a), only points $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ and $(\delta_1, \delta_2)$ are optimal.

*Lemma 7* indicates that Nietzsche type social welfare functions are distinguished into the following three categories:

Category (i): only point $(\delta_1, \delta_2)$ is socially optimal (corresponding to the case $v_{1,W(\varsigma)} < \delta_1$).
Category (ii): only point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is only socially optimal (corresponding to the case $v_{1,W(\varsigma)} > \delta_1$).
Category (iii): only points $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ and $(\delta_1, \delta_2)$ are socially optimal (corresponding to the case $v_{1,W(\varsigma)} = \delta_1$).

*Proposition 5*: If the social welfare function is either a general or Nietzsche type, the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is only socially optimal allocation for any social welfare function except categories (i) and (iii) Nietzsche type social welfare functions,

*Proof:* First, by Proposition 4, if the social welfare function is a general type and its indifferent curves are convex to the origin, the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is optimal. Second, by Lemma 6, if the social welfare function is a general type and its indifferent curves are concave to the origin, the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is optimal. Finally, by Lemma 7, if the social welfare function is a category (ii) Nietzsche type, the point $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is optimal, whereas if it is either a category (i) or (iii) Nietzsche type, the point $(\delta_1, \delta_2)$ can be socially optimal.

Proposition 5 is important because it indicates that, for almost all generally usable (i.e., preferences are complete, transitive, and continuous) social welfare functions, the point of sustainable heterogeneity $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is the only socially optimal allocation. In addition, it is highly likely that very few people actually support category (i) or (iii) Nietzsche type social welfare functions because they will generate violent political conflicts (see Harashima, 2010), and they will almost certainly always be in the minority. Hence these types of welfare functions will be rarely adopted in democratic societies where policies are decided by majority.[46] In other words, category (i) or (iii) Nietzsche type social welfare functions would only be adopted by a democratic society when its economic and social situations were extraordinary abnormal. If the situation is not extraordinarily abnormal, category (i) and (iii) Nietzsche type social welfare functions can be excluded, and we can assert that for any generally usable social welfare function, the point of sustainable heterogeneity $(\varsigma_{1,\psi}, \varsigma_{2,\psi})$ is uniquely socially optimal.

[46] As shown in Section 6.2, it is assumed that the assumptions in Arrow (1951) are modified.

Proposition 5 provides a clue to solve an important problem in studies of social welfare, that is, the unspecifiability of socially optimal allocation resulting from the difficulty in specifying the shape of the social welfare function. Proposition 5 escapes this problem because the socially optimal allocation is uniquely determined no matter the shape of the social welfare function. Therefore, it is no longer necessary to form a specific social ordering to determine the socially optimal growth path in a heterogeneous population.

## Conclusion

Historically, it has been difficult to universally agree upon a criterion for socially optimal allocation because of utility's interpersonal incomparability, Arrow's general possibility theorem, and other factors. This paper examined social optimality in dynamic models with a heterogeneous population and showed that a state exists in which all of the optimality conditions of a heterogeneous population are satisfied. The existence of such a state provides us with additional meaningful information for studying social optimality.

The endogenous growth model in Harashima (2012) shows that sustainable heterogeneity, which is defined as the state at which all optimality conditions of all heterogeneous households are satisfied, is uniquely determined to be the socially optimal allocation for almost all generally usable social welfare functions. The exogenous growth model in this paper shows the same result. The only exceptions are some variants of a Nietzsche type social welfare function, which will rarely be adopted in democratic societies unless the economic and social situations are extraordinarily abnormal. Sustainable heterogeneity is achievable even if the most advantaged household behaves unilaterally if the government appropriately intervenes. The uniquely determined socially optimal allocation in a heterogeneous population can be accomplished without specifying the shape of the social welfare function, and therefore, the problem of unspecifiability of social optimality can be solved.

Sustainable heterogeneity as the unique socially optimal allocation will have important implications to currently passionately disputed issues such as the Occupy Wall Street movement, anti-globalization (e.g., Klein, 2000; Stiglitz, 2002), anti-market fundamentalism (e.g., Gray, 1998; Stiglitz, 2002, 2009; Soros, 2008), and true measures of happiness (e.g., Sen, 1976; Arrow *et al*., 1995). In addition, sustainable heterogeneity will provide additional theoretical foundations for debt relief, wealth taxes, progressive taxation, and international aid. On the other hand, sustainable heterogeneity also indicates that there is a unique sustainable level of inequality in consumption.

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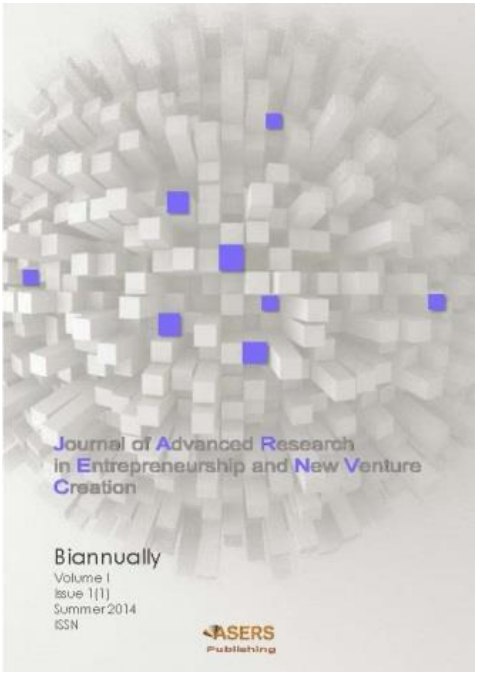


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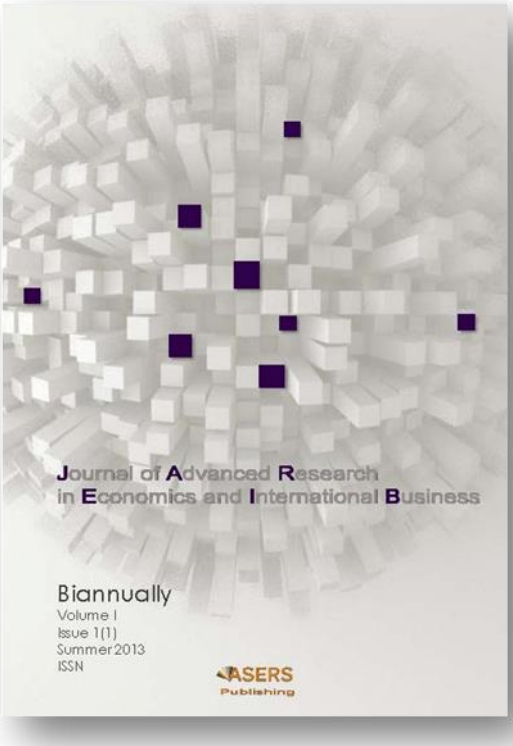




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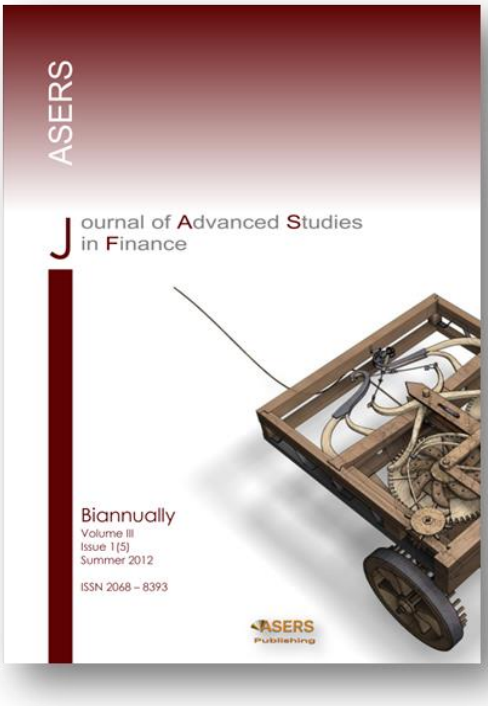




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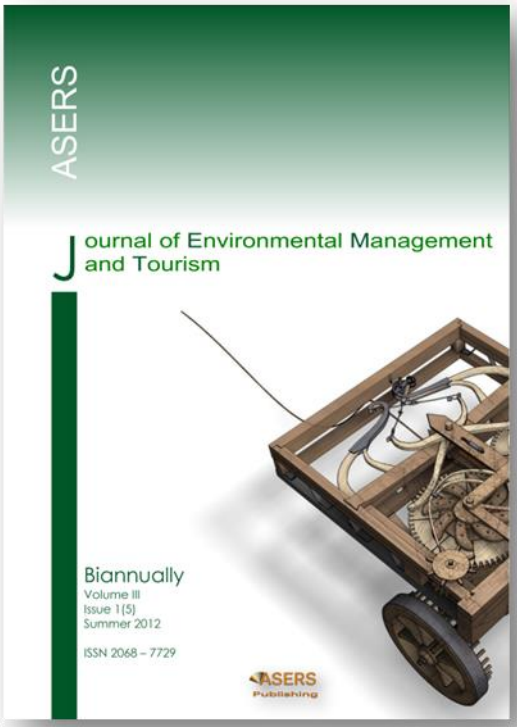


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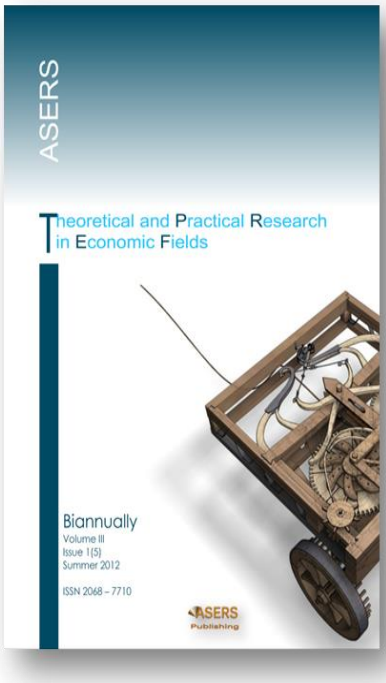




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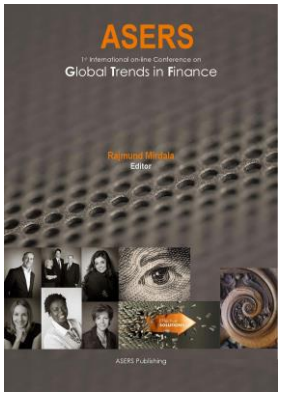


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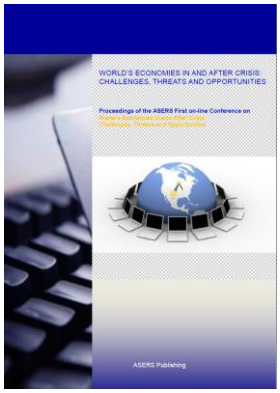


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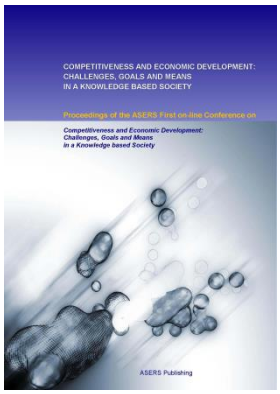


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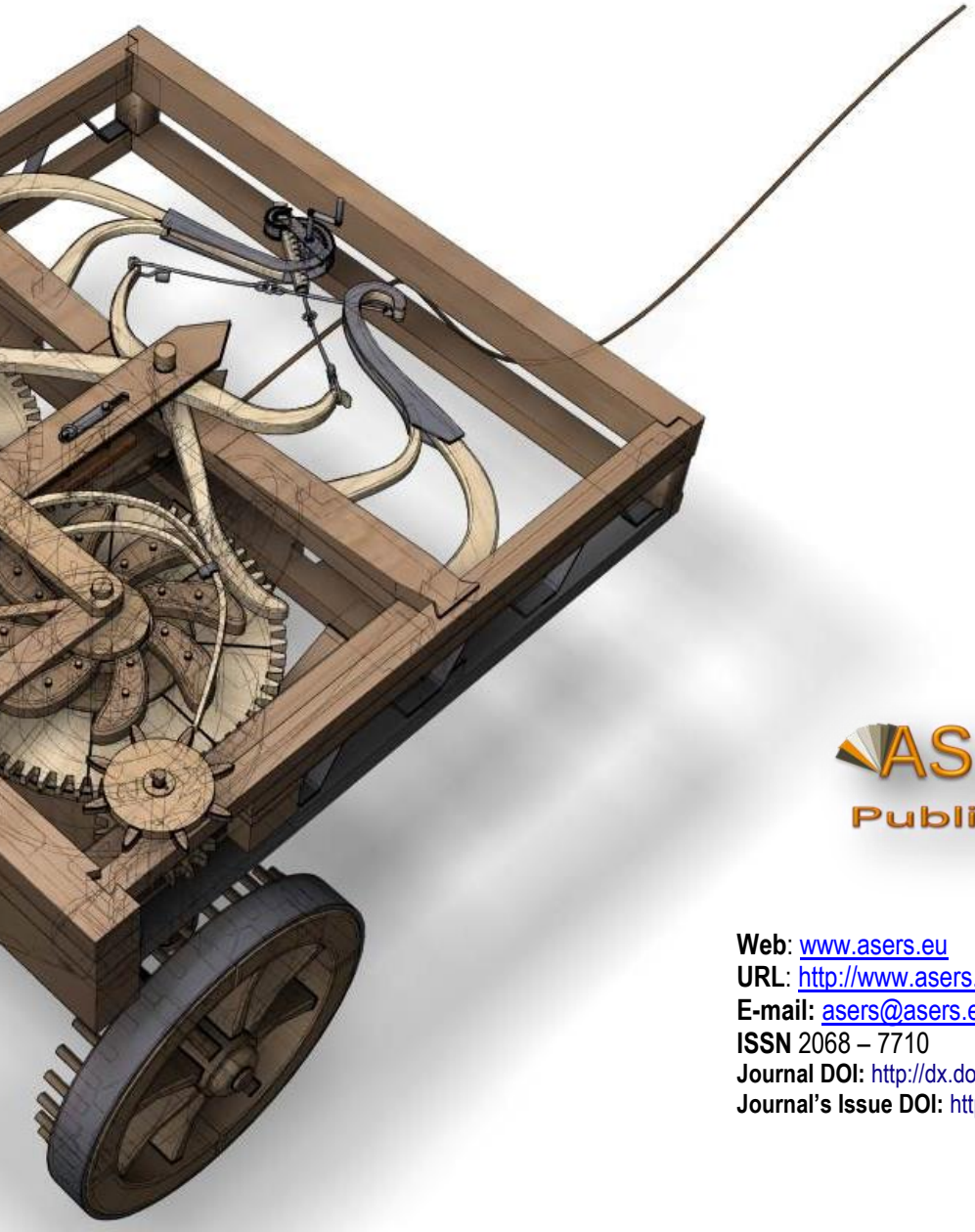

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