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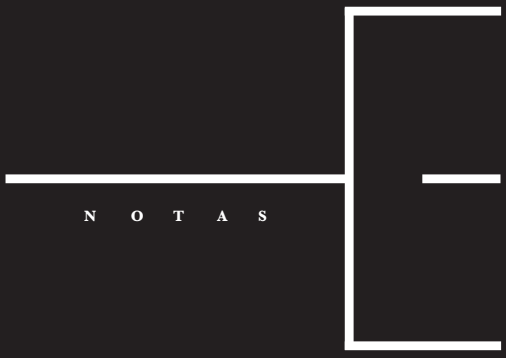

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Export-Led Growth after COVID-19: The Case of Portugal

Crescimento com Base nas Exportações depois da COVID-19: O Caso Português

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Martin Cameron

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ABSTRACT
The COVID-19 pandemic has disrupted trade and global value chains. Small open economies such as Portugal are particularly vulnerable. In this paper we consider the impact of the pandemic on the country's exports, arguing that an export-led recovery is possible. The challenge is to identify viable export opportunities: one of the consequences of the COVID-19 pandemic is to have closed and narrowed export opportunities globally. Despite this we show that there are still significant under-utilized export opportunities for Portugal. We use the large UN-COMTRADE and CEPII BACI data sets to which we apply four sets of filters to identify 42,593 realistic export opportunities. These opportunities are worth €286,6 billion in untapped revenue potential. The major markets for these products are countries such as United States, Germany, China, United Kingdom, France and Japan. We discuss the trade facilitation and industrial policy implications for utilizing these opportunities in the context of the relevant literature on trade and development.
Keywords: COVID-19; trade; exports; economic growth; Portugal.

JEL Classifications: F17; F14; I15; L52

RESUMO
A pandemia COVID-19 foi disruptiva para o comércio internacional e as cadeias de valor globais. Pequenas economias abertas como a Portuguesa são particularmente vulneráveis. Neste artigo consideramos o impacto da pandemia nas exportações do país, argumentando que uma recuperação liderada pelas exportações é possível. O desafio é o de identificar oportunidades de exportação viáveis, uma vez que uma das consequências da pandemia COVID-19 é a de ter fechado e restringido as oportunidades de exportação globalmente. Não obstante, nós mostramos que ainda há oportunidades de exportação subutilizadas em Portugal. Usamos as grandes bases de dados UN_COMTRADE e CEPII BACI às quais aplicámos 4 filtros

para identificar 45.593 oportunidades de exportação realistas. Estas oportunidades foram avaliadas em €286,6 mil milhões de euros em receitas potenciais inexploradas. Os maiores mercados para estes produtos estão em países como os Estados Unidos, Alemanha, China, Reino Unido, França e Japão. Discutem-se ainda implicações para políticas de facilitação do comércio e industriais que possam utilizar estas oportunidades no contexto da literatura relevante em comércio e desenvolvimento.
Palavras-chave: COVID-19; comércio; exportações; crescimento económico; Portugal.

Acknowledgements: We are grateful to the co-editor Tiago Neves Sequeira for his comments on an earlier draft and his guidance. All errors and shortcomings are our own responsibility.

1. Introduction

The COVID-19 disease was declared a global pandemic by the World Health Organization (WHO) on 11th March 2020. Worldwide, countries responded with non-pharmaceutical interventions (NPIs) – "lockdown measures" – to limit the spread of the disease. As a result of these and its own NPIs, the Portuguese economy contracted by 3,8% in the first quarter of 2020 (Trypsteen, 2020). Estimates are that it would contract by 9,4% in 2020 if there is no second wave of infections (OECD, 2020). Moreover, the world economy is expected to contract by 6% in 2020 (Boone, 2020), that of the Eurozone by 9,1% (World Bank, 2020) and the economies of its largest trading partners, Spain and Germany, by respectively 12,8% and 7,8% (IMF, 2020). Unemployment is expected to increase from 6,5% to between 14,6% and 17,6% by the end of 2020[1].

To mitigate these economic impacts, the Portuguese government provided fiscal stimulus measures announced during April and May and valued at a (modest) 2,5% of GDP. Whereas the stimulus package provides an important temporary role in mitigation, the ultimate recovery from COVID-19 will require a recovery in aggregate demand. In this respect, there is substantial uncertainty more generally in Europe, but particularly in Portugal. Private consumption is projected to fall by 8% in 2020, investment spending by 11% (Trypsteen, 2020). Private consumption over the longer run is likely to me muted due to the ageing demographics of Portuguese society: its old-age dependency ratio is at 40% already 10% higher than the OECD average (OECD, 2019). Furthermore, apart from the fiscal stimulus, further contributions to aggregate demand stimulation from the government is restricted, given that government debt was before the crisis already amongst the highest of OECD countries, and likely to exceed 130% of GDP by the end of 2020 (OECD, 2019; Trypsteen, 2020).

This leaves foreign demand as a potential source of aggregate demand. Indeed, as we show in section 3 of the paper, exports have been a significant driver of economic growth in Portugal over the past decade, contributing 44% to GDP in 2019. The question that we try to answer in this paper is, can exports continue to be a driver of growth in Portugal, and in particular, can exports contribute to recovery from the COVID-19 crisis?

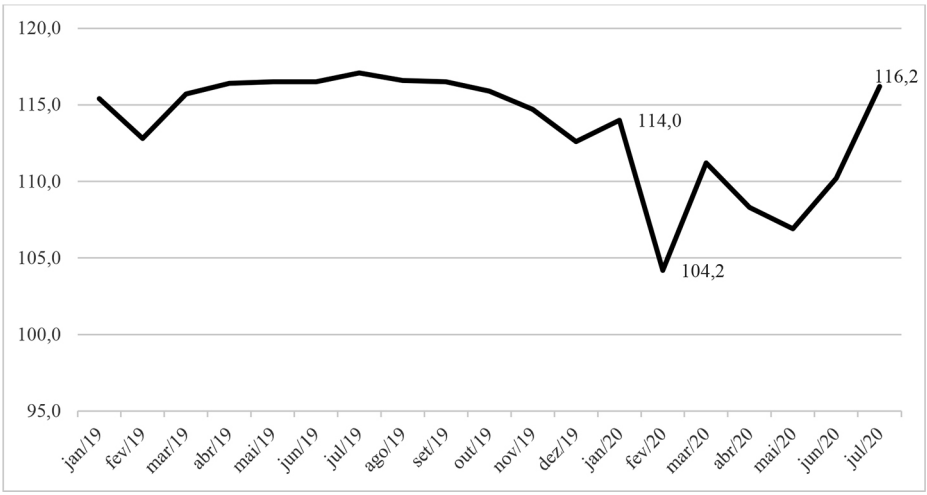
The challenge to an export-led growth path out of the current crisis is the fact that economic activity has contracted across the globe, particularly in Portugal's most important trading partners - as was mentioned in the preceding paragraphs. Thus, across the globe, export demand has declined significantly. This is clear for instance in the World Bank's estimation that global trade will contract by 13,4% in 2020, the worst decline since the 2nd World War, and more than the 10,4% decline during the global financial crisis in 2009[2] (World Bank, 2020). On the face of it, it would seem that recommending that Portugal export its way out of the crisis is unrealistic.

[1] From the OECD's country scenario's at: http://www.oecd.org/economic-outlook/june-2020/#Country-scenarios.

[2] Global trade tends to contract by more than global GDP during a major international crisis. Eaton et al. (2016), with reference to the 2009 global financial crisis, ascribes this to shifts in expenditure away from tradeable to non--tradable and non-durable goods. However, in the 2020 COVID-19 crisis, there has not been a similar relative shift in expenditures towards services, as services sectors were generally worst affected by lockdown measures (Brinca et al., 2020). One might thus a priori expect trade to recover faster than during the 2009 crisis.

In this paper we make a case that not only is it not unrealistic but may in fact be the best way forward for a small open economy with an ageing population, such as Portugal. We make the case, based on a decision-support model that we apply to the "big data" from UN-COMTRADE, that there is, despite the COVID-19 pandemic, scope for Portugal to diversify its exports towards new products and new trading partners. COVID-19 has certainly resulted in a large decline in global trade but has still left a huge volume of trade intact. Moreover, it may be the case that trade, especially in goods, as opposed to services, is more resilient and quicker to recover. We see this already in indicators of goods trade such as the RWI/ISL Container-Throughput Index[3]. This index makes use of data from 51 ports. As can be seen in Figure 1, this indicator declined significantly in 2020, by 8,6% between January and February 2020, and again by 4% between March and May 2020. However, what is clear is that according to this indicator, world trade in goods have made a substantial recovery by July 2020, with the index value exceeding that reached in 2019. According to the Institute of Shipping Economics and Logistics[4], "Cargo handling in Chinese ports again reached an all-time high".

Figure 1: Recovery in World Trade as measured by the RWI/ISL Container-Throughput Index, January 2019 to July 2020 (2015 =100)



Source: Authors' compilation on data from the Institute of Shipping Economics and Logistics.

Thus, we are arguing that despite the recessionary conditions in the world economy and in particular in Portugal' s main trading partners in the EU, that the country, being dependent on exports, should make use of the fact that world trade in goods at least, seem to be recovering.

[3] Available at: https://www.isl.org/en/containerindex/july-2020

[4] See: https://www.isl.org/en/containerindex/july-2020

There are also further reasons why we argue here for a recovery led by promotion of exports and in particular on the identification and pursuit of new and alternative (but realistic[5]) export opportunities (REOs). The first is that in addition to providing a shorter-term demand stimulus to an economy that has suffered a large demand-side shock, the promotion of exports in order to make use of new/ alternative export opportunities offers further benefits, also over the longer-run, that will help Portuguese recovery after the pandemic. These benefits are due to the positive association that exists between exports on the one hand, and productivity and innovation on the other (Melitz, 2003; Aghion et al., 2018). Both market-size and learning-by-doing effects have been noted to be responsible for this positive association (Atkin et al., 2017). Note that in the case of COVID-19, there is not only a need to find new export opportunities, but that the improved access to imports will benefit the utilisation of any new or alternative exports to the extent that sourcing cheaper inputs is a source of competitive advantage for export firms. As concluded by Shu and Steinwender (2018, p. 6) from a survey of the literature in this regard, "export opportunities and access to imported intermediates are generally found to have positive effects on firm productivity and innovation across different countries."

A second reason for arguing for an export-led recovery is that expansion of export opportunities affects not only the productivity and innovation of firms that export (through the market-size effect) but has a general effect of enhancing domestic firm entry and entrepreneurship. This is known as an "induced" competition effect and is due to the fact that the existence of better export opportunities signals a larger market available to Portuguese firms and hence stimulate market entry (Shu and Steinwender, 2018).

A third reason is that diversification into new export products and markets can help improve the resilience of the Portuguese economy and provide insurance against future shocks, including future pandemics, given that these are more likely due to continued changes in land-use patterns and climate change (Gibb et al., 2020). The association between greater trade diversification and reduced trade volatility has been confirmed in the literature (e.g., Bennett et al., 2019; Cadot et al., 2013). Moreover, given that the COVID-19 pandemic will likely exacerbate the stagnating growth of the main trading partners of Portugal since the global financial crisis (Jean, 2020), a diversification into new export markets may reduce the risk or exposure to further demand shocks in future.

The rest of the paper is structured as follows. Section 2 details the impact of COVID-19 in Portugal, discusses the policy responses and the impacts of the pandemic on the country's exports. Section 3 contains a survey of the relevant strands of literature. In section 4 we first explain our methodology and then present the export opportunities for Portugal that we derive from it. Section 5 concludes.

[5] Realistic in this context refers to opportunities that are deemed feasible subject to constraints applied through the TRADE-DSM methodology such as described in section 4 of this paper.

2. Covid-19 in Portugal: extent, policy responses and impact on exports

2.1. Extent and policy responses

The COVID-19 disease originated in China in November 2019 and was declared a global pandemic by the World Health Organization (WHO) on 11th March 2020. Portugal registered its first cases on 2nd March 2020. Six months later, by 1 September 2020, it had 58,012 confirmed cases and 1,849 deaths[6]. The government responded fairly rapidly by declaring a state of emergency on 18th March 2020. Within this state of emergency, it resorted to various nonpharmaceutical interventions (NPIs) aimed at containing the spread of the virus and avoiding overburdening the capacity of hospitals. These NPIs included social-distancing, quarantines and lockdowns.

To mitigate the adverse economic consequences of the lockdown, the Portuguese government provided fiscal stimulus measures announced during April and May and valued at a (modest) 2,5% of GDP[7], which includes an immediate fiscal impulse of €5,2 billion mainly aimed at distressed firms and protecting jobs, deferrals on payments worth €23,3 billion and €11,7 billion in other liquidity measures and guarantees[8]. A moratorium (until March 2021) has been put on repayment of bank loans[9].

The NPIs imposed by Portugal following the outbreak of its first COVID-19 cases were fairly stringent. Figure 9 in Appendix A compares the lockdown stringency in Portugal with that of Spain, France and Germany, showing that in general, Portugal's lockdown was more stringent than that of its close neighbours and major trading partners. The lockdown measures were most stringent in the first two weeks of April 2020, when the peak of new infections was reached. By 14 April 2020 some measures were relaxed, however, as a second wave started in mid-September 2020 more stringent measures were introduced. By the first week of December 2020 Portugal's lockdown measures were more stringent than that of either Spain, France or Germany.

Figure 2 depicts the confirmed daily fatalities per million population, as well as the stringency of the government's response as measured by the Oxford University's *Stringency Index*. It also shows that the number of new cases peaked on 11 April 2020 then declined until around the middle of September, after which a second wave started, which resulted in daily fatalities even exceeding that of the first wave – by the first week of December 2020 the daily fatality rate was double that experienced during the peak of the first wave – and hence the need for more stringent lockdown measures was clear.

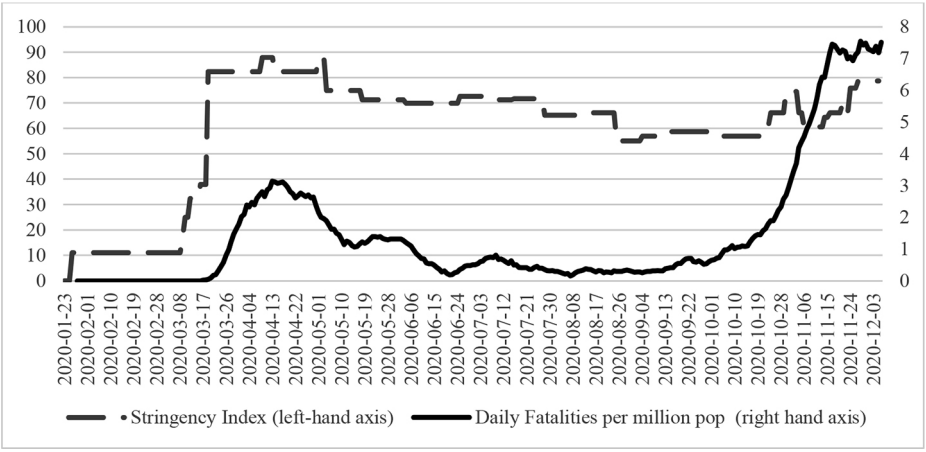
[6] Data on COVID-19 and the lockdown response by the government is sourced from the *Our World in Data* COVID-19 dataset, available on GitHub at: https://github.com/owid/covid-19-data/tree/master/public/data.

[7] The fiscal stimuli in Portugal's main trading partners, Spain, Germany and the UK have been much higher, respectively 3,7%, 8,3% and 8,0%; see Bruegel at: https://www.bruegel.org/publications/datasets/covid-national-dataset/.

[8] See the analysis of the Bruegel think tank at: https://www.bruegel.org/publications/datasets/covid-national-dataset/#portugal.

[9] See the IMF's Policy Tracker at: https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#P.

Figure 2: Two Waves: Confirmed daily fatalities (per million population) from COVID-19 and the Stringency Index in Portugal, 23 January – 6 December 2020



Source: Authors' compilation based on data from Our World in Data, available on GitHub.

2.2. Impact on Portugal's exports

From a health-disaster point of view, the impact of COVID-19 on trade in general and countries' export in particular is likely to be small, if not negligible. While there have not been many empirical studies, to the best of our knowledge, that have investigated the health impacts, in terms of deaths, on exports, the related literature on the relationship between natural disasters and exports, have seen a number of attempts to do this. This literature is surveyed in El Hadri et al. (2019, p. 2669) who conclude that "When pooling all countries, all products and all types of disasters, we do not find any statistical impact on exports, whichever the database at hand." Given the relative low proportion of deaths per country as percentage of the total labor force, it is therefore clear that the impact of the COVID-19 pandemic on exports is through the non-pharmaceutical measures (lockdown measures) taken to curb the spread of the pandemic.

COVID-19 thus represents a significant shock to Portugal's trade. The extent and nature of this shock on domestic firms can be analysed along the conceptual model set out in Shu and Steinwender (2018, p. 3) depicted in Figure 3.

Figure 3: Channels of Impact of the COVID-19 Shock on Trade

		Direction	
		Increased competition in domestic market	Increased access to foreign market
Target market	Output market	**Import competition**	**Export opportunities**
	Input market	**Foreign input competition**	**Access to imported intermediates**

Source: Based on Shu and Steinwender, 2018, p. 3.

In Figure 3, domestic Portuguese firms will be affected in both their sales markets (domestic and international) as well as in their input markets (from domestic and international sources). The top two blocks indicate that both the nature of import competition that Portuguese firms will face in the domestic market will change, as well as the export opportunities that they face in international markets. The bottom two blocks indicate that as far as their access to inputs are concerned, they will face changes in the domestic market to the extent that foreign firms will compete with them for domestically sources inputs (other firms' exports) and that their access to imported intermediate goods will be affected.

Consider for instance that as a result of the economic impacts of the measures taken against COVID-19 that domestic firms in Portugal will face possible higher import competition, as foreign firms try to increase their sales in Portugal due to a reduction in demand elsewhere. Likewise, Portuguese firms will find that export opportunities will shrink. The immediate impact of measures to stem the spread of the virus was to halt or delay logistics – for instance in delaying the processing of goods through various ports, due to amongst others health checks and quarantining of port workers. However, once the logistical blockages eased, there will still be at least three ways in which the pandemic will reduce export opportunities. The first is due to a reduction in demand as a result of an income effect, and secondly as result of a substitution effect as domestic competitors in foreign markets lower their prices in the face of excess demand. At the same time, domestic firms will likely face less competition in source inputs domestically and will find easier and cheaper access to intermediate inputs.

There will also be a third effect which could shrink export opportunities: uncertainty. Uncertainty in export markets have been shown, both theoretically and empirically, to affect firms' exports in both the extensive (whether or not to export new products or to new markets) and intensive (degree of exports of existing products into existing markets) margins of exporting (De Sousa et al., 2020). It is in particular the most productive firms, including firms with foreign presences, that are most sensitive to uncertainty in global export markets (Fillat and Garetto, 2015). In the case of Portugal, it has substantial foreign presence in traditional markets such as Angola and Brazil, which are two of its most important export destinations outside the EU. Given that Brazil at least, is one of the countries that are most

significantly affected by COVID-19 and hence is subject to potentially high uncertainty, it could be that Portuguese firms would like to diversify the risk of their exports exposed to these markets, at least over the shorter-term.

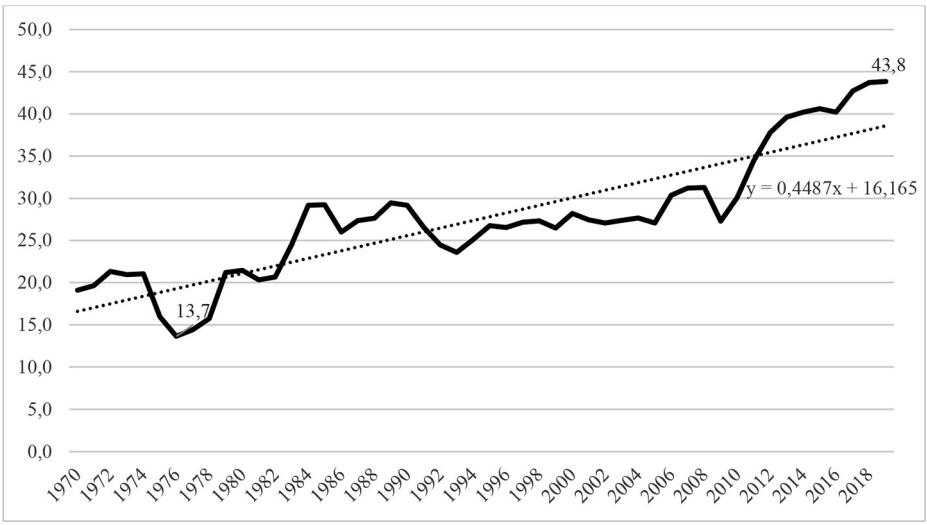
That the above negative impacts on exports can be very negative ex ante, is also clear from the fact that Portugal is a very open economy, and it depends significantly on exports as a source of aggregate demand. Teixeira and Fortuna (2010) provide a historical overview of the evolution of Portugal economic development since the 1930s, and its relationship with trade openness. Historically, economic growth and trade openness are closely associated. They document that the country's shift towards an open economy and growth driven by internationalization started in earnest in 1960/1961 when it joined the EFTA and GATT and was accelerated after 1986 when it became a member of the EU. As the authors note, this internationalization, which lead to growth in trade and FDI, contributed to a fairly rapid rise in GDP per capita during the initial phases of opening up, finding that "Between 1960 and 1973, Portuguese GDP per capita grew from one third to half that of the most developed European countries" (Teixeira and Fortuna, 2010: 337).

The country has recently enjoyed significant success in exporting, and exports have become an important engine of growth[10] (OECD, 2019; Felke and Eide, 2014). Between 1975 and 2019, the share of exports in GDP rose from 13% to 44% (see Fig 4). It was in particular after the 2009 global financial crisis, that Portugal saw an acceleration in the growth of exports- with an average annual growth rate in exports of 5,8% between 2010--2019 and export volumes increasing by 33% over this period. Both exports at the extensive and intensive margins[11] increased significantly. Since 2012 the country also, for the first time since the 1970s, enjoyed a positive trade balance. The export success since 2011 was in large part the result of a successful internal devaluation, which lowered per unit labor costs, following a Memorandum of Understanding (MoU) reached with its creditors (The European Commission, The European Central Bank and the International Monetary Fund) following the global financial crisis (Doulos et al., 2020; Felke and Eide, 2014).

[10] Between 2009 and 2019 for instance, real GDP per capita increased from US$ 22,125 to US$24,590. In the five years before the COVID-19 pandemic broke out (2015-2019), average annual GDP growth was 2,4%, in comparison to average change in real GDP of -1,8% between 2009 and 2013. Unemployment declined from 16,2% in 2013, to 6,5% in 2019.

[11] The extensive margin of exports refers on the country level to "the number of product categories exported" and the intensive margin of exports refers to "the value traded per product category or per transaction" (Visser, 2019:41).

Figure 4: Exports as % of GDP, Portugal, 1970 – 2019



Source: Authors' compilation based on World Development Indicators Online.

Around 23% of export receipts (in 2018) are from tourism, and tourism contributed 16,5% to GDP in 2019, more than the Euro-area average of 10% (World Bank, 2020). Between 2014 and 2018, international tourist arrivals in the country increased by 54%, from 10 million to almost 17 million. Three quarters of these tourists are from the European Union[12].

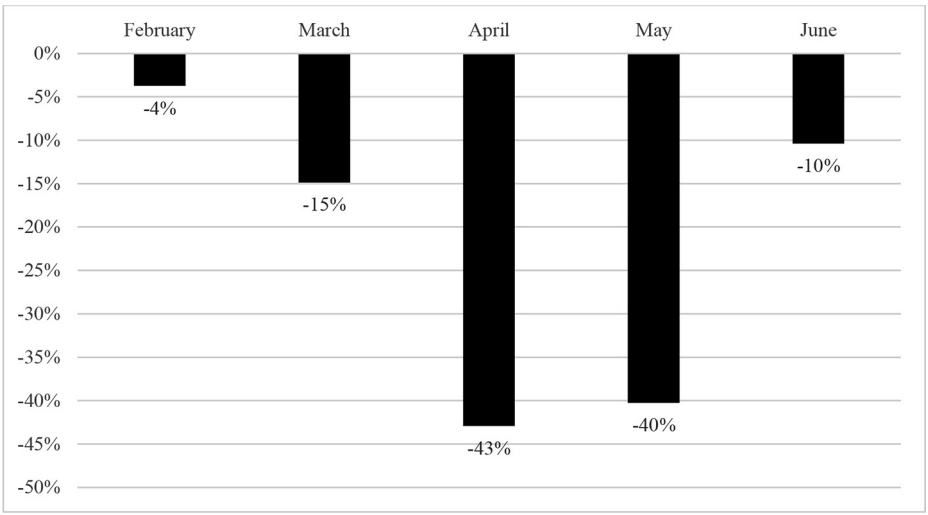
As far as goods (merchandise) exports are concerned, Portugal most heavily exports manufactured goods (76%) and agricultural products (14%), with machinery and transport equipment and chemicals comprising the bulk of manufactured exports.

The COVID-19 pandemic has had a particularly deleterious effect on world trade, and also on the exports of Portugal. Figure 5 depicts the decline in merchandise exports for the first and second quarters of 2020, in comparison with 2019. Note: while many countries instituted restrictions on exports of personal and protective equipment (PPE) and other medical supplies, Portugal has not instituted such measures, although it is bound by a European Commission regulation[13] of 19 March 2020 that requires prior authorization for PPE exports to third countries. We do not consider this to have had a significant impact on the country's exports.

[12] Source of data on tourism: *UN World Tourism Organization.*

[13] See: http://www.wcoomd.org/en/topics/facilitation/activities-and-programmes/natural-disaster/list-of--countries-coronavirus.aspx

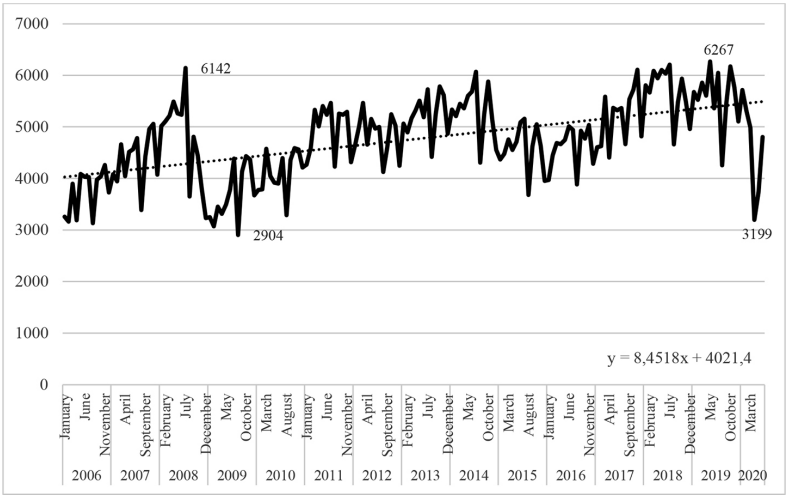
Figure 5: Portugal: % Change in Monthly Merchandise Exports, 2020 compared to 2019



Source: Authors' compilation based on data from the World Trade Organization, at https://data.wto.org.

Figure 6 provides a longer snapshot of Portuguese exports – monthly figures from January 2006 to June 2020.

Figure 6: Portugal: Monthly Merchandize Exports, 2006 - 2019 (US$ millions)

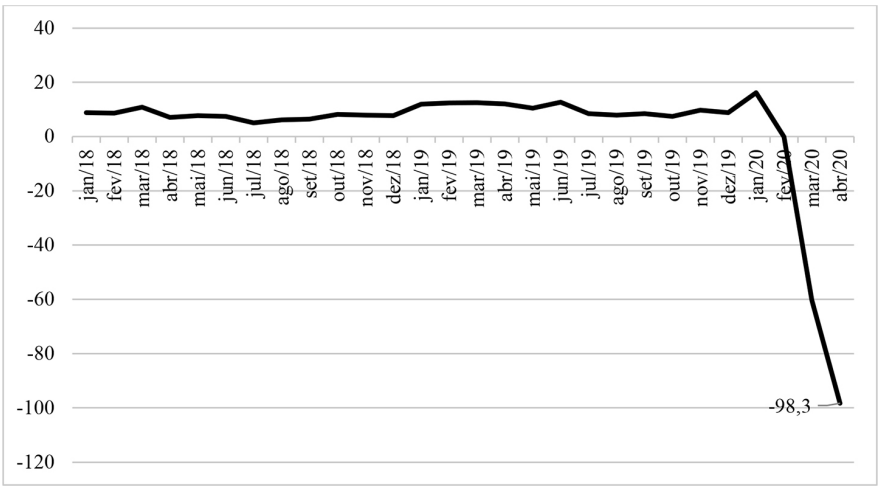


Source: Authors' compilation based on data from the World Trade Organization, at https://data.wto.org.

Figure 6 confirms first the upward trajectory in Portugal's exports, as can be seen in the upward sloping trend line. It furthermore clearly shows the dramatic impact that the COVID-19 pandemic has had, in a recent historical context, with exports contracting much more than in 2009 during the global financial crisis, both absolutely and relatively to the trend line. Figure 6 also shows that after the 2009 global financial crisis, it took the country until the first half of 2011 to recover exports to the level of the trend line and moreover it took until July 2018 before exports exceeded the monthly high-point level of US$6142 million achieved in July 2008. From this the conclusions are clear: the COVID-19 pandemic has been extremely detrimental to Portuguese exports, with a worse impact than that of the global financial crisis; the pandemic broke out just as Portugal was starting to enjoy the fruits from an upward trajectory in exports and export-led growth; and moreover, that it may take at least a year or two to recover exports to its trend level, of course depending on the duration of the pandemic and the nature of the global economic recovery.

Since almost a quarter of traditional Portuguese export revenue is from tourism and given that the tourism and travel industries have been amongst the worst affected by the COVID-19 pandemic, the decline in total exports will be much higher than only the decline in merchandise exports. Best case estimates are that the European tourism industry will suffer a US$ 770 billion loss in 2020 (worst case is US$ 1608 billion), with Portugal's tourism revenue declining by more than 40%[14]. Figure 7 shows the dramatic decline in tourist arrivals in advanced economies during the first months of 2020 – dropping 98,3% compared to the 2015 monthly average.

Figure 7: Monthly tourism arrivals: Deviation from 2015 average for 22 advanced economies, January 2018 to April 2020



Source: Authors' compilation based on data from the World Bank, 2020, p.12.

[14] See the estimates of the World Travel and Tourism Council at: https://wttc.org/Research/Economic-Impact/Recovery-Scenarios-2020-Economic-Impact-from-COVID-19.

The decline in merchandise exports and tourism is one of the reasons for the expected significant decline in economic growth that Portugal is expected to suffer in 2020 as a result the COVID-19 pandemic and the efforts to contain it.

3. Literature review

In this literature review we focus on three strands of relevant literatures. First, we provide a short overview of the arguments for the importance of exports, and export diversification, for growth and development. Secondly, we discuss the strand of literature that has tried to answer the question: what determines the exports of a country? And thirdly, we summarize the (smaller) strand of literature that has dealt with the promotion of exports, particularly trade facilitation. These three strands of literature are relevant as it provides the theoretical underpinnings of our approach that we apply to the case of Portugal.

The first strand is relevant because we are arguing that Portugal should base its economic recovery from the COVID-19 pandemic on an outward-looking, export-led growth (ELG) path, in particular expanding its exports on the extensive margin – i.e., along new product--destination combinations. The second strand is relevant as we are interested in identifying these potentially new product-destination export opportunities for Portugal, by using a unique decision-support model. In this model we use various filters applied to the CEPII BACI data set that is derived from UN-COMTRADE data to eliminate product-destination combinations that do not conform to the determinants of exports. The third strand is relevant given that our model is based on an understanding that reducing of informational gaps and knowledge about exporting, is at the core of trade facilitation.

3.1. Why do exporting, and export diversification, matter?

In the introduction of this paper, we motivated the need for Portugal to base its economic recovery from the COVID-19 pandemic on an outward-looking, export-led growth (ELG) path. This is based not only on practical considerations given the observed impacts of the COVID-19 recession on dampening demand, but also based on a substantial literature that establishes the positive relationship between ELG and economic growth, and which recognizes the contribution of an expansion of exports on the extensive margin (export diversification) to economic development. Exporting (and importing) allows countries to accumulate knowledge, through for instance sharing of ideas, obtaining scale economies for innovations, and by directly sourcing technologically embodied knowledge (Grossman and Helpman, 2015). Exporting firms also tend to be more productive than non-exporters (Wagner, 2007), which has also been found to be the case in Portugal (Neves et al., 2016). Moreover, expanding exports on the extensive margin can help reduce risk from volatility in demand (Bennett et al., 2019).

A large literature has empirically tested whether and how the export-led growth (ELG) hypothesis is valid. Hagemejer and Mućk (2019) briefly reviews this literature, concluding that the weight of evidence seems in favor of ELG, in particular when the endogeneity of

exports is taken into account. The literature also tends to support bi-directional causality, i.e., economic growth and development can also lead countries to export more, for instance by enabling them to produce a greater variety and better quality of products (Baldwin and Harrigan, 2011; Hummels and Klenow, 2005).

Hagemejer and Mućk (2019) conduct their own empirical investigation, using data covering 1994 to 2014 on the Central and Eastern Europe countries (CEECs), finding that indeed there is a significant positive and causal relationship between export growth and economic growth. Moreover, they found that "export-related growth is associated mainly with capital deepening" which could indicate that exports drive growth by facilitating a country's structural upgrading (Hagemejer and Mućk, 2019, p. 1996). Other evidence from small, open economies comes from Greece and the Gulf Cooperation Council countries, where respectively Tsitouras (2016) and Kalaitzi and Chamberlain (2020) found evidence of significant long-run relationships between economic development and export growth.

In the specific case of Portugal, Andraz and Rodrigues (2010) using data covering 1977 to 2004, found that in Portugal exports is a significant determinant of long-run growth. Teixeira and Fortuna (2010), relatedly found for Portugal, using macro-economic data over the period 1960 - 2001, that trade is a significant contributor to total productivity growth and hence GDP per capita. Neves et al. (2016) found, using a large dataset of over 300,000 firms in Portugal between 2006 and 2012, that firms that export are likely to invest more in R&D and that firms that export obtain better productivity through learning-by-doing. This suggest that the economies of scale through exporting can stimulate innovation, especially if innovation is subject to significant fixed costs, and takes place within a small domestic market, as in Portugal (Bastos et al., 2018).

The literature has also been concerned whether the nature of export growth matters, for instance whether growth of export at the intensive margin is sufficient or whether there are additional or special advantages from export growth at the extensive margin? This question has been motivated by the observation that countries with most rapid export growth and large export shares tend to be very specialized in product and exports, for e.g., oil and other commodity producing countries (see e.g., Easterly et al., 2009). Typically, most export growth is at the intensive margin (Brenton and Newfarmer, 2007), although growth at the extensive margin is not negligible – according Cadot et al. (2013, p. 794) between 14% and 40% of export growth are at the extensive margin. This may be of particular value when traditional exports are under pressure, such as after a global shock. In this case of Portugal after the COVID-19 crisis, we are arguing that the extensive margin is indeed important for recovery and future resilience, moreover without unduly putting downward pressure on real wages. Furthermore, breaking into new markets and new products will indeed require overcoming of informational asymmetries – and utilising data-intensive analytical tools to reduce these informational inadequacies – which we provide in section 4 of this paper.

Regarding the question of whether growth of exports at the extensive margin is important for economic growth and development, it can be concluded that both theory and empirical evidence support this idea. For instance, Funke and Ruhwedel (2002) provided an endogenous growth model wherein increasing export variety leads to faster GDP per capita growth via dynamic economies of scale. Export diversification, such as has been experienced in Portugal, is furthermore good for development as it is associated with reduced export

volatility[15] and hence less GDP volatility, especially in small, open economies (Bennett et al., 2019; Cadot et al., 2013). Del Rosal (2018) found this also in the case of 28 EU countries, including Portugal[16]. A growing literature has found empirical evidence supporting the relationship between export diversification and growth, amongst others Herzer et al. (2006), Naudé and Rossouw (2011), Agosin et al. (2007) and Kaitila (2018). Funke and Ruhwedel (2002) moreover also found that export diversification improves not only economic growth, but also overall export performance in OECD countries. Kaitila (2018) found that also in the case of Portugal that there is a significant relationship between the increase in the number of different export products and GDP growth.

Second, regarding the related questions whether the kind of goods that a country produces and export, and the destination to which it exports, matters, both theory and empirics support the notion. From a theoretical perspective, Hausmann et al. (2007) argued that the type of goods that a country exports differs in terms of productivity implications, and that therefore the composition of a country's exports can determine its overall productivity and economic growth. Given the idea that what a country exports matters for its productivity and GDP growth, they constructed a measure of the "productivity level" associated with a country's basket of exports and found that "countries with initially high levels of EXPY subsequently experience higher growth in exports" (Hausmann et al., 2007, p. 23). A reason is that the kind of goods that are associated with high levels of productivity face a highly elastic price elasticity in world markets. Whether and how countries can upgrade and move into producing and exporting goods associated with a higher productivity level, is another question altogether. Hidalgo et al. (2007) proposed that this depends on what they term a country's product space, which will determine how related its current products are to higher quality/ higher productivity products. They explain the concept of product space as follows: "a country with the ability to export apples will probably have most of the conditions suitable to export pears. They would certainly have the soil, climate, packing technologies, and frigorific trucks […] if instead we consider a different product such as copper wires or home appliance manufacture, all or most of the capabilities developed for the apple business render useless" (Hidalgo et al., 2007, p. 484).

It is not only the type of good that countries export that may be important for their growth, but also the destination of their exports (Bastos and Silva, 2010). For example, Brambilla et al. (2012) found from a sample of Argentine firms that those who export to high-income countries would tend to employ better skilled labour. This has been taken to indicate that they are concerned to compete on better quality products in these high-income destinations. Bastos et al. (2018) calls this an "income-based quality-choice channel" and finds evidence that this is also the case for Portuguese firms - that they use higher priced and better-quality inputs when producing for exporting to high-income destinations. Thus, both what a country export and to whom it exports, may matter for its economic growth and development.

[15] Measured for instance by the standard deviation of annual export growth.

[16] According to Del Rosal (2018, p. 329) Portugal's exports became slightly less concentrated in the top between 2002-2004 and 2012-2014, as reflected in the Theil Index of export concentration declining from 2,554 to 2,322.

Portugal's export performance in recent times shows evidence indeed of increased diversity. For example, Kaitila (2018) found that in the case of Portugal between 1995 and 2015 that there has been significant growth in the extensive margin of its exports, measured by its share of all the possible export products as per the HS8 classification. And according to Felke and Eide (2014, p. 173) Portugal also diversified the destinations to which it exports, reporting that the diversity of exports by destination country "as measured by the Herfindahl index, increased from 0.88 to 0.91 in the 2008-2012 period"[17]. Consistent with these studies, Portugal's export does not reflect concentration of exports by only a few large "global" firms as is often found (see the next section). According to Kaitila (2018, p. 719) in 2015 the share of the top 10 export products as % of the total value of goods exports in Portugal was 12,7%, which was amongst the lowest of their sample of EU countries, and much lower than that of other peripheral small open EU countries such as Ireland (47,1%) or Greece (32,5%), or its main trading partners, Spain (17,9%) and Germany (17,8%).

Note however, that there might seem to be tension between the strong evidence and theoretical case for export diversification, and the observations that export volumes and export specialization tend to be correlated, and that the distribution of countries' exports follows a power law (Easterly et al., 2009). Del Rosal (2018) confirms this "power law" of export concentration for the EU including Portugal.

The "big hits" model of Easterly et al. (2009) is based on this empirical observation that in terms of product-destinations most countries export only a few products to a very limited number of destinations, with most export success being reflecting in scoring one "big hit" in terms of a product-destination. As they describe the concept of a "big hit" in exporting: "Out of 2985 possible manufacturing products in our dataset and 217 possible destinations, Egypt gets 23 percent of its total manufacturing exports from exporting one product [...] Ceramic bathroom kitchen sanitary items not porcelain […] to one destination, Italy, capturing 94 percent of the Italian import market for that product" (Easterly et al., 2009, pp. 1-2). Moreover, they note that this results in very high export concentration ratio's and that successful export countries differ from unsuccessful countries in terms of the degree of export concentration and the size of their big export hits: "a significant part of South Korea's greater success than Tanzania as a manufacturing exporter is exemplified by South Korea earning $13 billion from its top 3 manufacturing exports, while Tanzania earned only $4 million from its top 3" (Ibid, p. 2).

This explanation of export specialization can be consistent with the empirical patterns across levels of development, that countries tend to specialize in exports at low levels of development, then as they develop through middle income range their exports tend to diversify, often to increase again in specialization as they become richer (e.g. Parteka, 2013 for the case of the EU) – although not always (see Mau, 2015). The point is, as the literature also finds in terms of learning-by-doing effects and the productivity levels associated with various baskets of exports (Hausmann et al., 2007), that finding "big hits' requires export diversification as a form of experimentation and learning – and luck – before being able to find a particular product-destination niche where the country is good in – akin to the

[17] In the context of exports, the Herfindahl index reflects the degree of diversification of exports. An index value of 1 represents perfect diversification (equal market shares for all countries), while an outcome closer to 0 means a very low level of diversification (so concentration).

entrepreneurial knowledge-spillover mechanism described in Hausmann and Rodrik (2003). As they remark "In addition to the possible knowledge externality to a successful export, there is also a knowledge problem about the discovery itself" (Easterly et al., 2009, p. 4). In section 4 below, we will introduce a data-driven decision-support model to help address this "knowledge problem about the discovery' of export opportunities.

3.2. What determines export growth and diversification?

The previous sub-section has made a case that export growth and export diversification matters for growth and development. As such, a relevant question is what determines export growth and diversification? The theoretical and empirical literature on this topic is very rich, the former going back at least to Adam Smith, who considered exports to be a vital mechanism for longer-term growth and development, by facilitating productivity growth (Myint, 1977) and providing a useful "vent-for-surplus" in that it allowed that "at least some of the products that are available in excess supply may be exchanged for goods produced abroad for which there is a domestic demand" (Kurz, 1992, p. 480). While Smith's views on trade have been subject of controversy (Schumacher, 2015), less controversially classical trade theories, including the Ricardian model and the Hecksher-Ohlin-Samuelson (H-O-S) model, described exports being determined by a country's comparative costs and technology (the Ricardian comparative advantage model) or relative factor endowments (H-O-S). According to Feenstra (2016, p. 1) the Ricardian model, by emphasizing technological differences between countries as determinant of their exports, is "as relevant as it has ever been," while the H-O-S model is "hopelessly inadequate" to explain exports empirically.

Classical trade theories have at least two significant flaws for present purposes. One, they neglect trade costs, and the determinants thereof, such as distance. Trade costs typically refer to "all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself: transportation costs (both freight costs and time costs), policy barriers (tariffs and nontariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail)" (Anderson and van Wincoop, 2004, pp. 691-692). And distance, a determinant of trade costs, which can be measured as a population-weighted average of distance between major cities, also include aspects of "institutional distance" such as "common language, common legal system, common colonial origins, membership of the same FTA "(Carrère et al., 2020, p. 886).

One dimension of trade costs and distance is time. For most countries, the majority of their exports are transported via ocean shipping or road transport (Cristea et al., 2013). The longer the distance, the more expensive these transport modes are in terms of time value of exports because it takes more time, which in turn requires more inventory to be held, increased depreciation costs, and possible adverse impacts on the perceived quality of the product (Hummels and Schaur, 2013). Especially time-sensitive exports, such as fresh produce, would therefore be less likely to be traded across large distances, and if so, it will be through air freight, which is however much more expensive. Hummels and Schaur (2013, p. 2936) stress that "timeliness is potentially important in the presence of demand

uncertainty," and suggest that this may be one reason that explains the gradual increase in the volume of exports through air freight in recent years. If demand uncertainty is a factor, and competition based on product quality differentiation important, then this would suggest that export volumes will be very sensitive to delivery times.

Trade costs, distance and time, critical determinants of exports, were given attention in the so-called New Trade Theory, where market size, scale economies, networks and monopolistic competition are key determinants of exports (see e.g. Krugman, 1979;1980) and in the New Economic Geography (e.g. Krugman, 1991) where agglomeration advantages and "iceberg" transport costs (following from Samuelson, 1952) are key determinants of both location and trade patterns. For example, a central result in new economic geography is that when transport costs fall enough, firms will tend to engage in more product differentiation and locate closer to their consumers. A recent review of geography and trade is by Redding (2020).

A second significant shortcoming of Classical trade theory is that it focusses on exports between countries, and between industries in countries, and assumes a representative firm. It is of course individual firms that engage in the production and exporting (and importing) of goods and services, and these firms are very heterogeneous. As a result and facilitated by growing volumes of firm level data[18] becoming available, the last two decades have seen the development of what has been termed New New Trade Theory, theories that jettisons the assumption of a representative firm, and focuses on the role of heterogeneous firms in trade – see for instance the seminal contribution by Melitz (2003) as well as Bernard and Jensen (2004), and overviews in Bernard et al. (2007), Redding (2011), and Ranjan and Raychaudhuri (2016).

These "new new" theories of trade, or heterogeneous firms in trade (HFT) theories attempt to explain some of the key empirical facts characterising world trade. These are that "only some firms export, exporters are more productive than non-exporters, and trade liberalization is accompanied by an increase in aggregate industry productivity" (Bernard et al., 2018, p. 565). Moreover, a salient fact of international trade, and in particular exports, is that it is relatively concentrated. Recent heterogeneous firms in trade models are concerned also to explain why most exporting tends to be by a few "global firms". Bernard et al. (2018, p. 566) defines these as "firms that participate in the international economy along multiple margins and account for substantial shares of aggregate trade."

In HFT models, as in Melitz (2003) and Chaney (2008), firms have different levels of productivity. Due to the presence of significant fixed trade costs in exporting (Anderson and van Wincoop, 2004), only the most productive firms will export. Bernard and Jensen (2004) found empirical evidence from the USA supporting this notion. A change in variable trade costs will affect the volumes of existing exports, i.e., exports at the intensive margin. In contrast, a change in fixed costs will affect the threshold level of productivity necessary for exporting, and hence affect exporting at the extensive margin (Persson, 2013; Helpman et al., 2008; Hummels and Klenow, 2005; Dennis and Shepherd, 2011). More generally, in the Melitz (2003) model, trade openness, financial access, human capital, trade costs

[18] Reviews of the growing number of empirical studies that attempt to identify the firm-level determinants of exports include Sousa et al. (2008).

(e.g., as a result of distance, or exchange rate volatility) and terms of trade changes will all determine the extent of new exporters entering the market and this export diversification.

There have been a number of tests of these predictions of HFT models, which have found some support for some of these predictions. For example, Agosin et al. (2012) found that export diversification across a sample of 79 countries between 1962 and 2000 were significantly associated only with human capital, distance and exchange rate volatility. They concluded that policies such as trade openness and financial development do not seem to be significant in determining export diversification, and recommend instead efforts to improve human capital, alleviate the impact of distance (location), and avoiding exchange rate volatility. Kehoe and Ruhl (2013) also found that trade openness stimulates exports at the extensive margin, reporting evidence from the case of the NAFTA.

In these models, different export destinations will be associated with different levels of profitability, depending on the costs and prices and demand in each market. Mayer et al. (2014) shows that when multi-product exporting firms face increased competition (and reduced mark-ups) in destination markets, that they will tend to shift their exports towards their better performing export products. The result is a reshuffle of their product mix, the combinations and extent of exports which will result in firms' export product range becoming narrower and more concentrated. As they put it (p. 496) "firms respond to increased competition by dropping their worst performing products". This could lead to firms getting more productive. Thus, competition in foreign markets could give rise to export firm productivity improving.

Naudé et al. (2015) provide a theoretical model wherein the presence of fixed trade costs gives exporting a similar decision-making structure as investment, and that as such the timing of when to export will matter. Thus, it is– not only the firm's productivity, but whether or not rates of return from entering the export market at a particular point in time will be considered. This may mean that even productive firms may postpone entry into export markets if they face high uncertainty – which is the case in the current global pandemic. Thus, in the Naudé et al. (2015) model, the kind of systemic uncertainty implied by the COVID-19 pandemic will reduce export growth at the extensive margin due to this postponement effect of investment under uncertainty.

Trade theory, from Adam Smith to Classical Models, to New Trade Theory and Heterogeneous Firms in Trade (HFT) theories, have thus identified a wide range of factors that determines the exports from a country and its firms along the intensive and extensive margins. While these theories provide much insight into explaining exports, their ability to describe and predict actual exports between countries, have remained a challenge – trade theories and trade data are not perfectly matched (Baldwin and Harrigan, 2011). The most successful model to describe the actual data of exports from one country to another, has been the Gravity Equation. The Gravity Equation has been "hugely successful in predicting trade flows" (Armenter and Koren, 2014, p. 2131).

A Gravity Equation can be derived from "a wide range of canonical trade models" (Carrère et al. 2020, p. 887), see also Haveman and Hummels (2004), Feenstra et al., (2001) and Baldwin and Harrigan (2011) on the theoretical bases of the Gravity Equation.

A typical Gravity Equation, which would specify the value of exports from country j to country k (following Carrère et al. (2020, p. 889) can be written as follows:

$$V_{jk} = \left(\frac{t_{jk}}{\Pi_j P_k} \right)^{1-\sigma} \frac{Y_j E_k}{Y_w} \quad (1)$$

where

$$\left(\Pi_j\right)^{1-\sigma} = \Sigma_{h=1}^{n} \left(\frac{t_{jh}}{P_h} \right)^{1-\sigma} \frac{E_h}{Y_w} \quad (2)$$

and

$$\left(P_k\right)^{1-\sigma} = \Sigma_{h=1}^{n} \left(\frac{t_{hk}}{\Pi_h} \right)^{1-\sigma} \frac{Y_h}{Y_w} \quad (3)$$

Equation (1) is a structural gravity equation denoting that the value of exports from country j to country k (V_{jk}) is a function of expenditure in the importing country k weighted by the relative size of the exporting country j in the world economy $\left(\frac{Y_j}{Y_w}\right)$ as well as of the trade costs (t_{jk}) of transporting the product from j to k, expressed as a fraction of the product of indices of the cost of living in countries j and k respectively (equations 2 and 3). The import demand elasticity is denoted by $(1 - \sigma)$. It results from assuming the consumer preferences following a Constant Elasticity of Substitution (CES) specification (Carrère et al., 2020).

This shows that both trade costs and the incomes (market size) and consumer preferences in destination countries matters for export volumes (Bastos et al., 2018). As was discussed above, these determinants have their deeper theoretical bases in new trade theory and HFT models.

For present purposes, while our decision-support model that will be used to identify new product-destination export opportunities for Portugal is data-driven, like the Gravity Equation it can be seen to reconcile the volumes of trade data with theoretical and structural determinants of exports. Moreover, the Gravity Equation, consistently with HFT models, provides a motivation for our approach to provide inputs into trade facilitation by reducing informational frictions that are part of trade costs. Thus, as per the Gravity Equation described here, trade costs, includes informational frictions (Artopoulos et al., 2013; Chaney, 2014; Kim et al., 2018).

The importance of informational frictions in exports are illustrated by Chaney (2014) who models and find empirical evidence for the significance of informational frictions in explaining the geography of French trade. In his model, existing exporters are more likely to start exporting to a different country than a non-exporter is to start exporting, due to the fact that the former will have a foreign network to provide information about export opportunities. So, for instance, his model shows that "if a French firm export to country a in year t, it is then more likely to enter in year t + 1 a country b geographically close to

a, even if b is not close to France" (Chaney, 2014, p. 3601). In other words, in order to overcome gravity and export over larger distances, firms need more information, which in Chaney's (2014) model they obtain through networks.

They could also of course, increasingly obtain this information through data analytics, the increased connectivity that progress in cloud and mobile computing has enabled. In fact, there are many aspects of trade facilitation practices that either implicitly or explicitly aim to reduce the information aspects of trade costs / trade frictions. Reducing informational fractions may be particularly important for growing exports at the extensive margin, and not only by helping to match individual exporting / importing firms, but in general expanding the export possibility or opportunity set that a country face. In this respect, an intriguing perspective is provided by the "balls-and-bins" model of trade of Armenter and Koren (2014).

In the "balls and bins" model, Armenter and Koren (2014) models international trade – and exporting – as products being akin to balls and destinations akin to bins. Thus, at any point in time, the total product-destination combinations that can be filled, depends on the number of products traded and the number of countries that take part in trade. From the country's perspective, say of Portugal, some bins (destinations) are empty, and some bins contain more balls than others. Armenter and Koren (2014) perform various simulations on their model. Finding that on the extensive margin, the number of firms that export, will depend on the number of available bins. As they put it "By shutting down no more than one-fifth of the exporting bins the share of exporters drops below 70 percent" (Armenter and Koren, 2014, p. 2150). The aim of the model that we use in this paper is to "open" more export bins for Portuguese firms through lowering some of the informational friction, hence providing the basis for an increase in the extensive margin of the country's trade.

Given that the implications from the theoretical and Gravity models discussed in this sub-section converge on the conclusion that there is a role for trade facilitation, the next sub-section will provide a short review of the potential value of trade facilitation, particularly in the current global pandemic.

3.3. What is the value of trade facilitation?

In the previous sub-section, it was discussed that the various theories of international trade suggest that the extent to which a country can export (and as such the opportunities that is available to its exporters) will be determined by price competitiveness, the extent and nature of foreign demand, domestic "non-price competitiveness" determinants[19], as well as the respective elasticities of export demand to price, income and non-income determinants (Algieri, 2014). Non-price competitiveness is often taken to be determined by the quality and variety of a country's products which may be proxied via the capital stock (Algieri, 2014; see also Muscatelli et al., 1995). It may also be determined by the knowledge base of the economy – in other words its intangible capital, which includes brands, networks, information, and relationships, all which would be associated with a larger export opportunity set

[19] See e.g. Goldstein and Kahn (1985) and Funke and Ruhwedel (2002) for a discussion on the need for non-price competitiveness determinants to be included in a gravity equation / export equation so that it is not miss-specified.

(Haskel and Westlake, 2018). Non-price determinants of exports seem particularly important for export diversification, where countries extend their trade along the extensive margin, and not such much on the intensive margin (Krugman, 1989).

This is relevant in the case of Portugal, as the country's membership of the eurozone precludes it from promoting exports through setting its nominal exchange rate. As in the recent past, if the country wishes to expand exports through devaluation (assuming the demand for its exports are price elastic[20]) then it can only do so by reducing or keeping growth in domestic prices slow, for instance by moderating wage growth. However, over the medium to longer-term, particularly given the COVID-19 shock to household income, it would not be sustainable to continue to promote exports through a real exchange rate devaluation keeping wage growth low. Rather, an approach focusing on non-price competitiveness and expanding exports on the extensive margin, seems more appropriate.

Given that firms export, and that most firms are small and medium enterprises (SMEs), the challenge for any government wishing to stimulate growth through exports, is to create an environment for SMEs conducive to overcome obstacles to export. It is well known that exporting, and more generally firm internationalization, is a complex and risky process, as for instance described in the process model of internationalization and its elaborations and which means as was stressed in the previous sub-section, that only the most productive firms will export (Melitz, 2003).

Therefore, governments have resorted to trade facilitation to stimulate firm exports – both on the intensive and extensive margins. Trade facilitation refers to "any policy that reduces the transaction costs of international trade" (Dennis and Shepherd, 2011, p. 102). It includes specifically designed export promotion policies (EPP), including "brochures, websites and seminars that provide information on foreign markets and export procedures to lower informational barriers" (Kim et al., 2018, p. 2954). According to Feenstra and Ma (2014: 158) trade facilitation measures include "actions that allow for enhanced exports, though, for example, infrastructure development, foreign marketing opportunities and institutions." Given that trade facilitation could help expand the extensive margin of exports, it could be a welfare enhancing policy.

Trade facilitation may reduce the fix and sunk costs involved in exporting, and hence improve exports at the extensive margin – e.g., through reducing the administrative burden on exporting (Persson, 2013). By reducing fixed costs in exporting, trade facilitation aims to make it possible for less productive firms to export. Trade facilitation could also consist of measures to improve the productivity of firms so as to enable them to overcome the hurdles and thresholds to exporting. In this respect, as was pointed out in section 3.1, innovation is a determinant of exports (Damijan et al., 2010; Neves et al., 2016). The promotion of innovation will be consistent with productivity and competitiveness improvements which would be needed for expansion of exports on both the extensive and intensive margins. Innovation, moreover, and the adoption of new technologies in production, is what drives labour productivity improvements, which are crucial in the case of Portugal, where labour

[20] Algieri (2014) estimates, using quarterly data from 1980 to 2012, that in the case of Portugal a depreciation of the real exchange rate by 10% will lead to an increase in exports of between 11% and 15%, suggesting a relatively price-elastic export demand. In contrast, he estimates that the income elasticity of demand for Portugal's exports has a relatively low elasticity of 1,03.

productivity has traditionally been a weakness (Teixeira, 2010) and is still below that of most of its European trading partners.

Trade facilitation can also, implicitly through many of the above-mentioned measures, or explicitly, e.g., through providing export subsidies, try to reduce some of the uncertainty and risk attached to exporting. An important result from the literature is that exporting is akin to an investment decision under uncertainty (Naudé and Gries, 2015), and that when foreign demand uncertainty is reduced, that exports will increase predominantly through the extensive margin (De Sousa et al., 2020). Hence, uncertainty reduction is a valuable objective to facilitate the entry of more firms into exporting. De Sousa et al. (2020) in the case of France that if all destination countries have the lowest demand volatility, in other words demand uncertainty is reduced, that exports will increase by 18%, and primarily at the extensive margin.

What is the evidence for the efficacy of EPP/ trade facilitation? Dennis and Shepherd (2011, p.102) finds that "reducing by 10 per cent the costs of exporting, international transport or market entry can increase export diversification by 3, 4 and 1 per cent, respectively." Similarly, Persson (2013) found, using data on 130 developing countries, that if the costs of exporting (measured by the time to export) would decline by 1 per cent, that trade at the extensive margin would increase by 0,6% and at the intensive margin by 0,3 %. Malca et al. (2020) discusses the types of EPP and examine their efficacy in the case of Peru. They found that export support programmes such as "trade shows, trade missions, and support from trade offices in the foreign market" had a positive effect on the export performance of firms, and that firms who were successful in increasing exports, were more motivated to invest more resources in exploring foreign markets (Ibid, p. 833). Kim et al. (2018) performed one of the rare randomized control trails (RCTs) to evaluate the impact of export support policies. Specifically, they tested whether information seminars on export opportunities and process for Vietnamese textile firms would lead to more exports. They found that (p. 2956) "large participants were encouraged by the seminars to start exporting directly in the short run (i.e., 4 months later). Because larger firms are more likely to exhibit higher productivity and absorptive capacity, our results suggest that information provision is effective only when firms are equipped with sufficiently high productivity to compete in foreign markets […] our study implies that the provision of information is effective for productive firms, whereas policies for productivity improvement are also needed for underdeveloped firms".

ICT, and in particular the use of the internet, has been found to play a facilitating role in increasing exports, for instance by lowering information costs, improving communication and allowing better matching between exporters and importers (Visser, 2019). For example, Visser (2019) reports that empirical studies have found that a 10% increase in internet penetration can raise exports by 0,2% to 0,4%. The growing digitization of the economy has enabled what is termed "lean internationalization" indicating that even small businesses can now more easily enter into exporting and experiment through digital channels in order to match their product or service to foreign consumer demands (Autio and Zander, 2016).

In terms of the Digital Economy and Society Index[21] (DESI) of the European Commission (EC), Portugal ranked 16th out of 28 EU member states in 2018. The EC (2018) noted that in 2018 Portugal had done well in improving broadband access but that room for improvement remains, and moreover noted that "the share of e-commerce in corporate turnover (16 %) is almost 2 percentage points below the EU average, and the proportion of companies selling online seems to be flattening out. SMEs are significantly less active in both respects than their larger counterparts" (EC, 2018, p. 11). The IMD's World Digital Competitiveness Ranking 2019 (IMD, 2019) similarly ranked Portugal in the middle - 34 – out of 63 countries. It noted that the country's relative weaknesses were in mobile broadband subscribers (rank 59 out of 63), its relatively low % of high-tech exports (56 out of 63), and the agility of its business sector (54 out of 63).

In order however to upgrade export production into product-destination combinations that are associated with higher development, i.e., bridging the product space and exporting to high-income countries, is challenging. As Bastos et al. (2018, p. 357) observes "increasing exports to high income destinations may require quality upgrading of entire complexes of suppliers and downstream producers, not just of particular exporters."

In such a context, information on realistic export opportunities, quantified by potential monetary value, and focusing on new product-country combinations, are an essential input into not only the short-term demand-side recovery from the COVID-19 pandemic, but moreover for the longer-term restructuring and improved resilience of the Portuguese economy.

4. New export opportunities for Portugal, post covid-19

4.1. Identification of export opportunities

Easterly et al. (2009, p.4) raised an important question regarding the identification of export opportunities: "Our analysis raises a new issue. In addition to the possible knowledge externality to a successful export, there is also a knowledge problem about the discovery itself. Who is more likely to discover the successful product-destination category: the public or private sector?"

They argue that the private sector, through entrepreneurial discovery as also proposed by Hausmann and Rodrik (2003) and Hausmann et al. (2017) would be best to find a big hit in terms of product-destination combinations but qualified this by recognizing that "in the end it is an empirical question which approaches work."

Whether it is the private sector or the government discovering successful export opportunities ("the successful product-destination category") the question is how would they go about doing so? We believe that a greater use of big data, which traditionally was not available in such a way as to assist decision-making and export opportunity recognition, can play an important – even essential role. This is clear when one considers the fact, pointed out by Armenter and Koren (2014, p. 2127) in their "balls and bins" model, that "The

[21] See https://ec.europa.eu/information_society/newsroom/image/document/2018-20/pt-desi_2018-country_profile_eng_B440E073-A50F-CF68-82F6A8FB53D31DE5_52232.pdf.

recent availability of finely disaggregated trade data has spurred a fast-growing research that documents the extensive margin in trade" and moreover that this finely disaggregated data shows that trade data (export-destination combinations) are "sparse." For instance, analogously to Easterly et al. (2009) they point out (Armenter and Koren, 2014, p. 2128) that "There were about 22 million export shipments originating in the United States in 2005 – and thus the same number of observations. At the same time, there are 229 countries and 8,867 product codes with active trade, so a shipment can have more than 2 million possible country-product classifications. More than 40 percent of the traded country-product pairs had only one or two shipments during the year, a clear sign that the data are sparse". The sparseness of the actual export data, as compared to the potential data if more "balls" fall into more "bins" is suggestive of unutilized export opportunities.

The question is, how can the existing "sparse" data be used to identify possible new product-country combinations of export opportunities for a country, such as Portugal, in the present case? The answer is that although the data may be "sparse' from a particular country's point of view, the data is not that sparse from all countries' points of view. Thus, while Portugal may export product s to country d, and not product q, it may be the case that Spain, or some other country, does indeed export product q to country d. This provides spillover knowledge that may, or may not be, useful to Portugal. This property or feature of global trade data, as captured in the UN-COMTRADE database, and refined in the CEPII BACI data set is what we exploit in a trade decision-support model (which we label TRADE-DSM) used in the rest of the section.

4.2. Model description

The basic aim of the TRADE-DSM approach is to bridge the information gap described above and contribute to the identification of realistic export opportunities based on a process of 'filtering' data. The challenge of big data and large number of potential combinations discussed in the preceding sections is addressed by reducing the potential set of options (balls and bins) that need to be selected from based on well researched filters. The approach takes into consideration all possible worldwide product (HS 6-digit) and market (country) combinations, using four major filter categories containing various sub-filters applied consecutively. The approach systematically eliminates less-promising markets until those with the greatest prospects of success are revealed.

A brief description of these filters follows. A full description is to be found in Pearson et al. (2010) and Cuyvers et al (2012). The first filter (Filter 1) considers broad general market potential as reflected in economic size, growth, and political and commercial risk. Key variables considered in this filter include GDP and GDP per capita values as well as annual growth rates of these variables, as well as country risk ratings[22]. The main filter consists of two sub filters. The primary aim of the first (sub-filter 1.1) is to eliminate markets that pose too high a relative political and/or commercial risk. The second (sub-filter filter 1.2)

[22] Originally from the Belgian public credit insurance agency, Office National du Ducroire (ONDD), now the Credendo Group as the ONDD rebranded in 2013.

considers relative macro-economic size or growth. The overall rationale for Filter 1 is to reduce the set of countries that need to form part of the export potential investigation in the subsequent filters.

The second filter (Filter 2) classifies all potential product-market combinations' import demand characteristics (determined through relative size and growth trends). Three key descriptive quantitative characteristics of import demand patterns are calculated for each product x country combination in this filter, namely short-term import growth (last 2 years), long-term import growth (over the last 5 years) and relative import market size.

The third set of filters (Filter 3) considers product-country market access conditions. Cuyvers et al. (2012, p. 80) recognise that simply being selected on the basis of size and growth does imply that a market can easily be penetrated. There are 2 main categories of trade barriers identified in this filter. The first (filter 3.1) is that of the degree of import procurement supplier (import markets) concentration[23] while the second that of trade restrictions (filter 3.2) (Cuyvers et al., 1995:180; Cuyvers, 1997, p. 7; 2004, p. 261). Hoekman and Nicita (2008, p. 17) found that the logistics performance index (LPI) score as published in the World Bank Doing Business (WBDB) Surveys (World Bank, 2016), the Doing Business cost to import measures and ad valorem equivalent[24] tariffs per product[25] are important measures of market access. Filter 3.2 therefore considers transport and logistics costs elements through explicit assumptions regarding transport and logistics dimensions such as international shipping time and cost per country, domestic time and cost to import and the LPI. The above-mentioned components are brought together in the form of a market accessibility index that provides a score for each unique product-country combination relative to all other product-country combinations included in the analysis.

In the final step (Filter 4) each individual product-market combination is categorised based on the home market's current exports and the target market's size, growth patterns and accessibility as well as the home market's current revealed comparative advantage (RCA) and revealed trade advantage (RTA) (Cuyvers, 1997 and Cuyvers et al. 2012). The potential export markets are also further categorised according to the 'home market's current export performance in these markets compared to the performance of the top six competitors in each market (See Figure 8).

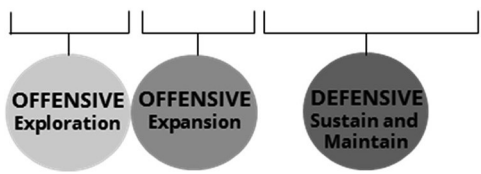
[23] By making use of an adjusted Herfindahl-Hirschmann Index of Hirschmann (1964).

[24] An *ad valorem* equivalent tariff is defined as a tariff presented as a percentage of the value of goods cleared through customs and is calculated as the rate comparable with a tariff derived from unit quantities such as weight, number or volume (ITC, 2020).

[25] Obtained from the ITC's Market Access Map (*MacMap*).

Figure 8: The TRADE-DSM realistic export opportunities map

Target market characteristics (Detailed product x market)	Realistic Export Opportunities (REOs)	Home market relative market share of target market			
		Small	Intermediately		Large
			Small	Large	
	Large	REO1,1	REO2,1	REO3,1	REO4,1
	Growing (*short & long term*)	REO1,2	REO2,2	REO3,2	REO4,2
	Large and growing (*short term*)	REO1,3	REO2,3	REO3,3	REO4,3
	Large and growing (*long-term*)	REO1,4	REO2,4	REO3,4	REO4,4
	Large and growing (*short & long-term*)	REO1,5	REO2,5	REO3,5	REO4,5



Source: Cameron and Viviers (2015), adapted from Cuyvers et al. (2012).

Finally, a monetary value indicator is then calculated to distinguish the relative size of 'unconstrained' and 'untapped' potential export value with a view to prioritising the shortlisted export opportunities. This 'untapped' potential export value is considered as the average market import value of the top six competitors in each market, excluding imports from the 'home market' if such market happens to be one of the top six sources of imports for the target market for a given product. The 'unconstrained' qualifier refers to the fact that the potential is not constrained by production or supply constraints from the perspective of the home (exporting) market.

Since policies aimed at increasing diversity of exports in terms of products versus diversifying destination markets are obviously very different, policymakers need to be correctly informed to use the right tool for the right policy question (Cadot et al. Carrère, 2013). To

this effect Brenton and Newfarmer (2007) defines expansion of existing products in existing markets as growth at the intensive margin, while introduction of "new" products and new geographic markets as growth at the extensive margins and indicate that policies need to be sensitive to these objectives.

In line with informing such objectives, a key aspect of the TRADE-DSM methodology therefore is its ability to address both the intensive and extensive margin dimension of the export promotion and development challenge. The method e.g., offers alternatives to current exporters that are facing saturation and/or declining growth in their traditional markets, while also being able to identify possible new products that could be used to inform investment and industrial policy decision making. Next the stepwise filtering outcomes are shown followed by a brief focus on the outcomes arranged by extensive and intensive margins dimension.

4.3. Model results

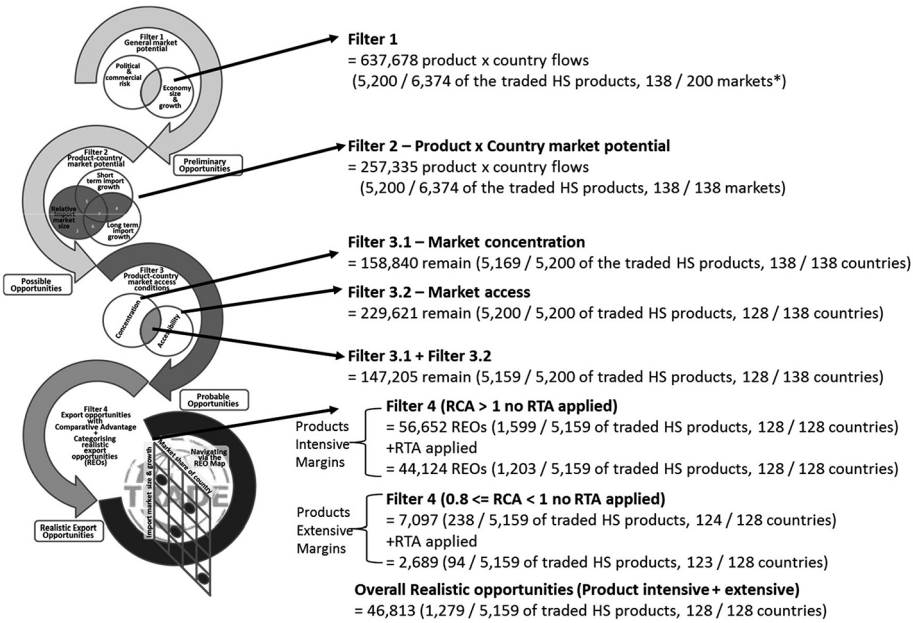
While international trade data for nearly 200 countries[26] or areas are reported via the UN-COMTRADE data set, there are only 181 countries with all the required data available to be modelled through the TRADE-DSM methodology. Based on a combination of countries with available data for all aspects of the modelling and the evaluation of these countries relative to the methodology requirements for Filter 1, only 138 countries and 5,200 HS6-digit product lines remains at the end of the first filter iteration.

Considering all individual product and market import demand flow characteristics in terms of relative size and growth patterns, filter 2 yields 257,335 product x country combinations. When combining outcomes for market concentration and relative market access in terms of tariffs and logistics, the combinations reduces to 147,205 (only 128 countries and 5,159 products remain). The outcomes as obtained in terms of combination of number of products and countries are shown in Figure 9.

To further inform policy makers regarding opportunities related to the extensive and intensive margins with relation to products, the outcomes can be further distinguished based on the relative RCA and RTA outcomes for each product. To this effect the methodology identifies 44,124 product x country combinations for intensive margin product opportunities (i.e., opportunities that Portugal can consider for which products exported from Portugal exhibits a revealed comparative advantage relative to the world norm) and 2,689 product x country combinations in the extensive margin (so possible products that have RCAs >0.8 but less than 1, so being exported, but not so mature yet as proxied by the RCA measure).

[26] https://comtrade.un.org/db/help/uReadMeFirst.aspx

Figure 9: Step-by-step outcomes from the TRADE-DSM filtering process



Source: Authors' calculations and representation, filter diagram from Cameron and Viviers, 2015.

The challenge however is that these numerous opportunities cannot all be pursued at the same time given resource constraints. To assist with this challenge around the international market selection (IMS) process, the outcomes are then arranged in Table 1 according to the REO map (as depicted in Figure 9).

Table 1: Outcomes of opportunities identified for Portugal arranged according to the REO Map

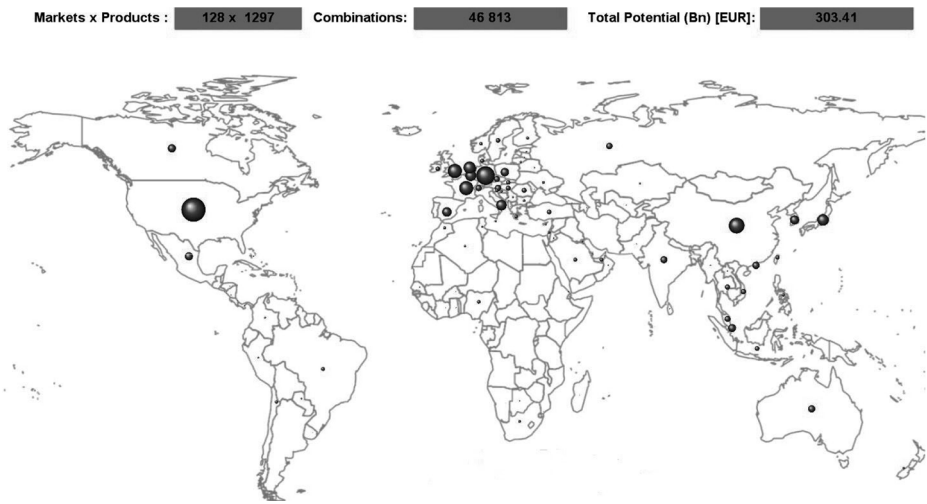
Map of Realistic Export Opportunities (REOs) number [% of total] Untapped potential value Billions (Bn) Euro(€) [% of total value]		Relative market share of Portugal into target market(s)				
		Small (1)	Intermediate small (2)	Intermediate large (3)	Large (4)	Total
Product x target market (country) - size and growth	Large (1)	2,965 [6.3%] 75.10 Bn [24.8%]	321 [0.7%] 4.66 Bn [1.5%]	74 [0.2%] 0.37 Bn [0.1%]	60 [0.1%] 0.19 Bn [0.1%]	3,420 [7.3%] 80.32 Bn [26.5%]
	Growing (2) (Short & long term)	32,485 [69.4%] 51.52 Bn [17.0%]	1,588 [3.4%] 2.92 Bn [1.0%]	391 [0.8%] 0.37 Bn [0.1%]	698 [1.5%] 0.15 Bn [0.0%]	35,162 [75.1%] 54.96 Bn [18.1%]
	Large and growing (3) (Short term)	540 [1.2%] 19.27 Bn [6.4%]	64 [0.1%] 0.98 Bn [0.3%]	12 [0.0%] 0.04 Bn [0.0%]	12 [0.0%] 0.01 Bn [0.0%]	628 [1.3%] 20.30 Bn [6.7%]
	Large and growing (4) (Long term)	1,232 [2.6%] 26.05 Bn [8.6%]	116 [0.2%] 1.41 Bn [0.5%]	26 [0.1%] 0.36 Bn [0.1%]	23 [0.0%] 0.04 Bn [0.0%]	1,397 [3.0%] 27.87 Bn [9.2%]
	Large and growing (5) (Short & long term)	5,342 [11.4%] 109.11 Bn [36.0%]	597 [1.3%] 9.24 Bn [3.0%]	112 [0.2%] 1.10 Bn [0.4%]	155 [0.3%] 0.51 Bn [0.2%]	6,206 [13.3%] 119.96 Bn [39.5%]
	Total	42,564 [90.9%] 281.06 Bn [92.6%]	2,686 [5.7%] 19.20 Bn [6.3%]	615 [1.3%] 2.26 Bn [0.7%]	948 [2.0%] 0.90 Bn [0.3%]	46,813 [100.0%] 303.41 Bn [100.0%]

Source: Authors' calculations.

In total there are 46,813 opportunities identified in Table 1, with the associated estimated untapped potential value of €303.41 billion. Of these outcomes, 90.9% of the number of opportunities (and 92.6% of the estimated untapped potential value) is associated with markets for which Portugal supplies none to very little of the target market(s) existing imports such as United States, Germany, United Kingdom and further away South Korea, Mexico and Canada. Markets where Portugal supplies an intermediately small share of target market(s) imports is associated with 5.7% (and 6.3% in value terms) of these opportunities such as Austria, China, Tunisia and Morocco. Portugal supplies an intermediately large share of target market(s) imports for around 1.3% (0.7%of the value) of these opportunities such as Spain, France, Germany and Netherlands. The market(s) where Portugal supplies a large share imports account for 2.0% and 0.3% of value such as the previous four countries as well as United Kingdom, Italy, Israel and Brazil.

Figure 10 shows the major destinations where the opportunities for these products are to be found. The size of the bubbles indicates the size of the opportunity in €. Details on the products are provided in Appendix G.

Figure 10: Geographic spread of opportunities identified for Portugal



Source: Authors' calculations and representation.

Evident is that there are still a lot of 'untapped' opportunities within the closer proximity of Europe, while some further away opportunities are also present in North America, East and South-East Asia and less so in South America, the Middle East and Africa.

Separating the outcomes into extensive and intensive margins for both products and potential markets (countries), in summary Table 2 presents the aggregate results based on these distinctions.

Table 2: Opportunities identified for Portugal arranged according to margins

Map of Realistic Export Opportunities (REOs) Number / [% of total] Untapped potential value Millions (Mn) Euro(€) / [% of total value]	Extensive margin markets	Intensive margin markets	Totals
Intensive margin products	[Q2 – Green fields] 42,593 [91.0%] 286,630 Mn [94.5%]	[Q1 – Brown fields] 1,531 [3.3%] 3,160 Mn [1.0%]	44,124 [94.3%] 289,790 Mn [95.5%]
Extensive margin products	[Q3 – Blue sky] 2,657 [5.7%] 13,627 Mn [4.5%]	[Q4 – Grey fields] 32 [0.1%] 2.09 Mn [0.0%]	2,689 [5.7%] 13,629 Mn [4.5%]
Totals	45,250 [96.7%] 300,257 Mn [99.0%]	1,531 [3.3%] 3,162 Mn [1.0%]	46,813 [100.0%] 303,419 Mn [100.0%]

Source: Authors' calculations.

Evident is that there is (as expected) more opportunities for Portugal in the extensive margin markets (at 96.7% of number of opportunities), while the intensive markets only represent around 3.3% of total opportunities identified.

In line with the context provided in the preceding sections, this outcome points to the fact that Portugal should pursue export diversification from a market perspective with vigour to assist with contributing to improving the resilience of the Portuguese economy and as mentioned, provide insurance against future shocks (including future pandemics). To this purpose shorter term export promotion focused initiatives can be informed by the intensive margin products combined with extensive margin countries (so quadrant 2 "Green Fields" opportunities as indicated in Table 2 – see Appendix C for more details). This group of products (with RCAs > 1 and new potential markets) represents 91% of the number of opportunities and 94.5% of the associated untapped' value. Opportunities qualified as 'Green fields' therefore potentially provide insights into export promotion activities that could be leveraged to expand exports in the shorter-term. These opportunities include for example opportunities to export motor vehicles, parts and accessories, coke and refined petroleum products, wearing apparel, and machinery and equipment, amongst others. A list of these product opportunities aggregated by sector and key markets, are contained in Appendix F. What the Appendix F indicates is that if Portugal could exploit these export opportunities, it would diversify its exports along the extensive margin in terms of products, as well as in terms of trade partners. At present the country's main three trade partners are Spain, France and Germany. As Appendix F shows, much of the new opportunities are to export

to countries such as the USA, Netherlands, Singapore, China, Ireland, South Africa and Vietnam.

For longer term planning the opportunities that may require potentially more investment from a product export development perspective, the extensive margin products (indicated in quadrant 3 "Blue Sky" quadrant in the representation in Table 2 – see Appendix D for more details) combined with extensive margin (new) markets, represent around 5.7% of the number of opportunities and 4.5% of the 'untapped' value of around €13.63 billion. Depending on the nature of exactly what investment is required to 'mature' and realise opportunities classified as 'Blue sky' results may take longer to materialise and may be more focused to industrial policy questions.

Opportunities identified as "Brown Fields" (extensive margin in terms of markets and intensive margin for products in quadrant 1, see Appendix B for more details) and "Grey Fields" (extensive margin in terms of products and intensive margin for markets in quadrant 4 – see Appendix E for more details) are of less interest from a market diversification strategy perspective and also holds relative small potential in terms of number of opportunities (3.3% and 0.001% respectively) as well as 'untapped' value (1.0% and 0.001% respectively).

5. Concluding remarks

Portugal is a small economy with an ageing population, and high levels of government debt. As such, domestic demand growth is constrained. Indeed, as the country's experience over the past decade has shown, this has left exports as the essential engine of growth. The COVID-19 pandemic, and its economic shock following from the global lockdown on economic activity so as to curb the spread of the virus and reduce pressure on health facilities, has therefore come as a particularly pernicious shock to the country. As with many other small, open economies, Portugal's recovery options depend on being able to export, and moreover, to expand export on both the extensive and intensive margins. The question is, can exports continue to be a driver of growth in Portugal, and in particular, can exports contribute to recovery from the COVID-19 crisis?

We answered this question in this paper in the affirmative. First, we provided an analysis of COVID-19 impact on Portugal's exports, finding that the COVID-19 pandemic has been extremely detrimental to Portuguese exports, with a worse impact than that of the global financial crisis. The pandemic broke out just as Portugal was starting to enjoy the fruits from an upward trajectory in exports and export-led growth; and moreover, that it may take at least a year or two to recover exports to its trend level, of course depending on the duration of the pandemic and the nature of the global economic recovery. Since almost a quarter of traditional Portuguese export revenue is from tourism and given that the tourism and travel industries have been amongst the worst affected by the COVID-19 pandemic, the decline in total exports will be much higher than only the decline in merchandise exports. However, the good news was that global trade has recovered faster than during the global financial crisis, and that a survey from the literature would suggest that, during and after a global crisis such as the COVID-19 crisis, that expanding its exports on the extensive margin could be an appropriate recovery strategy to follow.

The literature survey focused on three strands of relevant literature. First, we provided a short overview of the arguments for the importance of exports, and export diversification, for growth and development in a country such as Portugal. Secondly, we discussed the strand of literature that has tried to answer the question: what determines the exports of a country? And thirdly, we summarized the strand of literature that has dealt with the promotion of exports, particularly trade facilitation – so as to be able to suggest the use of information rich models to identify export opportunities. These three strands of literature are relevant as it provides the theoretical underpinnings of such a data-rich approach that we apply to the case of Portugal to identify new export opportunities.

Our model, applied to Portugal, showed that there is indeed significant potential scope for the country to expand its exports, on both extensive and intensive side. To be specific, we identified 42,593 new export opportunities at the extensive margins for markets and the intensive margin for products (of the overall 46,813 product-country opportunities identified), what we called "Green Fields" opportunities. The associated estimated value of this subset of opportunities was estimated at €286,6 billion in 'untapped' revenue potential (of the overall €303,41 billion identified). Of these 91.0% of the number of opportunities (and 94.5% of the potential value) is associated with markets for which Portugal supplies none, to very little, of the target market(s) existing imports currently – for products that Portugal is already good at exporting, such as machinery and equipment, motor vehicles and parts and wearing apparel. Moreover, we found that there is (as expected) overall more opportunities for Portugal in the extensive margin markets (at 96.7% of number of opportunities). These include countries such as United States, Germany, China, United Kingdom, France and Japan.

In line with the literature review in this paper, our empirical findings support the arguments made that Portugal should pursue export diversification from a market perspective with vigour to assist recovery and improving the resilience of the Portuguese economy, also against future shocks and future pandemics. Over the short-term trade facilitation initiatives can be informed by the intensive margin products combined with extensive margin countries – the "Green Fields" opportunities identified in this study. Clearly whilst COVID-19 has caused damage to health and economy in Portugal, there are still plenty of opportunities globally for its entrepreneurs to utilize. Two requirements for these opportunities to be realised are that the government nurture and support local export-oriented entrepreneurship, including through industrial policies and trade facilitation, and that the global multilateral trade system remains relatively free and open, without recent trends towards de-globalization being furthered by the pandemic.

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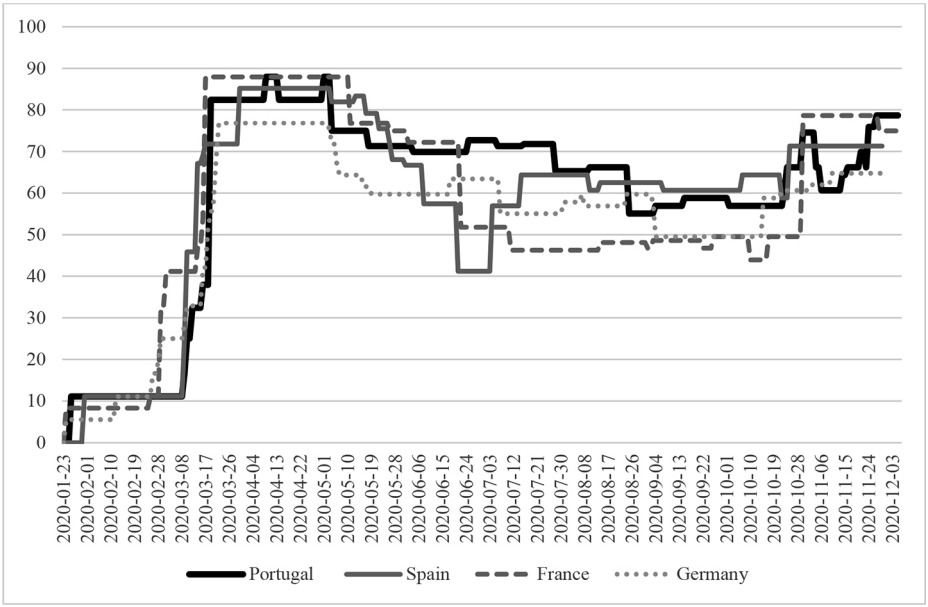
APPENDIX A

Figure 11: Lockdown Stringency: Portugal compared to Spain, France and Germany, 23 January 2019 to 6 December 2020



Source: Authors' compilation based on data from Our World in Data, available on Github.

APPENDIX B

Table 3: Intensive products and intensive markets – outcomes for Portugal

Map of Realistic Export Opportunities (REOs) number [% of total] 'Untapped' potential value Billions (Bn) Euro(€) [% of total value]		Relative market share of Portugal into target market(s)				
		Small (1)	Intermediate small (2)	Intermediate large (3)	Large (4)	Total
Product x target market (country) – size and growth	Large (1)	–	–	74 [4.8%] 0.37 Bn [11.9%]	60 [3.9%] 0.19 Bn [6.1%]	134 [8.8%] 0.57 Bn [17.9%]
	Growing (2) (Short & long term)	–	–	382 [25.0%] 0.37 Bn [11.8%]	675 [44.1%] 0.15 Bn [4.7%]	1,057 [69.0%] 0.52 Bn [16.5%]
	Large and growing (3) (Short term)	–	–	12 [0.8%] 0.04 Bn [1.4%]	12 [0.8%] 0.01 Bn [0.3%]	24 [1.6%] 0.05 Bn [1.6%]
	Large and growing (4) (Long term)	–	–	26 [1.7%] 0.36 Bn [11.5%]	23 [1.5%] 0.04 Bn [1.3%]	49 [3.2%] 0.41 Bn [12.9%]
	Large and growing (5) (Short & long term)	–	–	112 [7.3%] 1.10 Bn [34.9%]	155 [10.1%] 0.51 Bn [16.1%]	267 [17.4%] 1.61 Bn [51.1%]
	Total	–	–	606 [39.6%] 2.26 Bn [71.5%]	925 [60.4%] 0.90 Bn [28.5%]	1,531 [100.0%] 3.16 Bn [100.0%]

Source: Authors' calculations.

This table shows that in total there are 1,531 opportunities, with an associated estimated untapped potential value of € 3.16 billion. Portugal supplies an intermediately large share of target market(s) imports for around 39.6% (71.5% of the value) of these opportunities. The market (s) where Portugal supplies a large share imports account for 60.4% and 28.5% of value.

APPENDIX C

Table 4: Intensive products and extensive markets - outcomes for Portugal

Map of Realistic Export Opportunities (REOs) number [% of total] 'Untapped' potential value Billions (Bn) Euro(€) [% of total value]		Relative market share of Portugal into target market(s)				
		Small (1)	Intermediate small (2)	Intermediate large (3)	Large (4)	Total
Product x target market (country) – size and growth	Large (1)	2 734 [6.4%] 70.28 Bn [24.5%]	319 [0.7%] 4.65 Bn [1.6%]	_	_	3 053 [7.2%] 74.93 Bn [26.1%]
	Growing (2) (Short & long term)	30 518 [71.7%] 49.40 Bn [17.2%]	1 555 [3.7%] 2.88 Bn [1.0%]	_	_	32 073 [75.3%] 52.28 Bn [18.2%]
	Large and growing (3) (Short term)	505 [1.2%] 18.23 Bn [6.4%]	62 [0.1%] 0.97 Bn [0.3%]	_	_	567 [1.3%] 19.20 Bn [6.7%]
	Large and growing (4) (Long term)	1 130 [2.7%] 25.08 Bn [8.8%]	115 [0.3%] 1.40 Bn [0.5%]	_	_	1 245 [2.9%] 26.48 Bn [9.2%]
	Large and growing (5) (Short & long term)	5 064 [11.9%] 104.55 Bn [36.5%]	591 [1.4%] 9.19 Bn [3.2%]	_	_	5 655 [13.3%] 113.74 Bn [39.7%]
	Total	39 951 [93.8%] 267.53 Bn [93.3%]	2 642 [6.2%] 19.09 Bn [6.7%]	_	_	42 593 [100.0%] 286.63 Bn [100.0%]

Source: Authors' calculations.

This table shows that in total there are 42,593 opportunities, with an associated estimated untapped potential value of € 286.63 billion. 93.8% of the number of opportunities (and 93.3% of the estimated untapped potential value) is associated with markets for which Portugal supplies none to very little of the target market(s) imports. Markets where Portugal supplies an intermediately small share of target market(s) imports is associated with 6.2% (and 6.7% in value terms) of these opportunities.

APPENDIX D

Table 5: Extensive products and extensive markets - outcomes for Portugal

Map of Realistic Export Opportunities (REOs) number [% of total] 'Untapped' potential value Millions (Mn) Euro(€) [% of total value]		Relative market share of Portugal into target market(s)				
		Small (1)	Intermediate small (2)	Intermediate large (3)	Large (4)	Total
Product x target market (country) – size and growth	Large (1)	231 [8.7%] 4,827.47,Mn [35.4%]	2 [0.1%] 2.12,Mn [0.0%]	–	–	233 [8.8%] 4,829.59,Mn [35.4%]
	Growing (2) (Short & long term)	1,967 [74.0%] 2,115.98,Mn [15.5%]	33 [1.2%] 38.52,Mn [0.3%]	–	–	2,000 [75.3%] 2,154.50,Mn [15.8%]
	Large and growing (3) (Short term)	35 [1.3%] 1,047.15,Mn [7.7%]	2 [0.1%] 8.24,Mn [0.1%]	–	–	37 [1.4%] 1,055.39,Mn [7.7%]
	Large and growing (4) (Long term)	102 [3.8%] 970.19,Mn [7.1%]	1 [0.0%] 14.62,Mn [0.1%]	–	–	103 [3.9%] 984.81,Mn [7.2%]
	Large and growing (5) (Short & long term)	278 [10.5%] 4,559.68,Mn [33.5%]	6 [0.2%] 43.25,Mn [0.3%]	–	–	284 [10.7%] 4,602.93,Mn [33.8%]
	Total	2,613 [98.3%] 13,520.47,Mn [99.2%]	44 [1.7%] 106.75,Mn [0.8%]	–	–	2,657 [100.0%] 13,627.22,Mn [100.0%]

Source: Authors' calculations.

This table shows that in total there are 2,657 opportunities, with an associated estimated untapped potential value of € 13.63 billion. 98.3% of the number of opportunities (and 99.2% of the estimated untapped potential value) is associated with markets for which Portugal supplies none to very little of the target market(s) imports. Markets where Portugal supplies an intermediately small share of target market(s) imports is associated with 1.7% (and 0.8% in value terms) of these opportunities.

APPENDIX E

Table 6: Extensive products and intensive markets - outcomes for Portugal

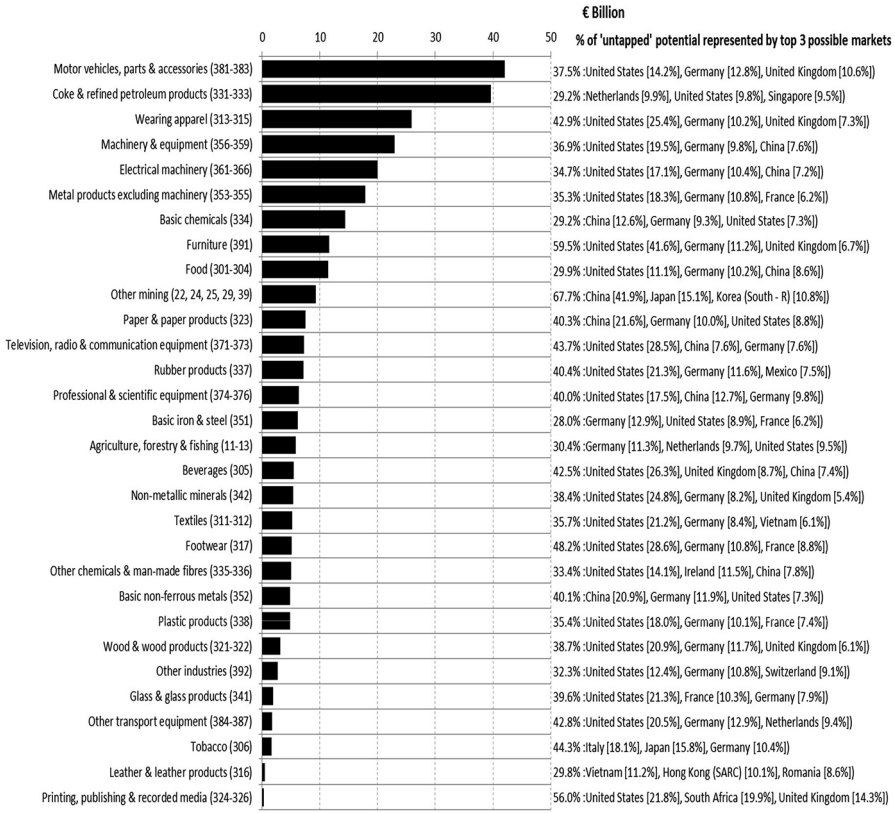
Map of Realistic Export Opportunities (REOs) number [% of total] 'Untapped' potential value Millions (Mn) Euro(€) [% of total value]		Relative market share of Portugal into target market(s)				
		Small (1)	Intermediate small (2)	Intermediate large (3)	Large (4)	Total
Product x target market (country) – size and growth	Large (1)	–	–	–	–	–
	Growing (2) (Short & long term)	–	–	9 [28.1%] 1.71 Mn [81.6%]	23 [71.9%] 0.38 Mn [18.4%]	32 [100.0%] 2.09 Mn [100.0%]
	Large and growing (3) (Short term)	–	–	–	–	–
	Large and growing (4) (Long term)	–	–	–	–	–
	Large and growing (5) (Short & long term)	–	–	–	–	–
	Total	–	–	9 [28.1%] 1.71 Mn [81.6%]	23 [71.9%] 0.38 Mn [18.4%]	32 [100.0%] 2.09 Mn [100.0%]

Source: Authors' calculations.

This table shows that in total there are 32 opportunities identified, with an associated estimated untapped potential value of € 2.09 million. Portugal supplies an intermediately large share of target market(s) imports for around 28.1% (81.6%of the value) of these opportunities. The market(s) where Portugal supplies a large share imports account for 71.9% and 18.4% of value.

APPENDIX F

Table 7: Outcomes for Portugal aggregated according to major economic sector and country



Source: Authors' calculations.

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Intra-Industry Trade: Economies of Scale Revisited

Comércio Intra-Indústria: Economias de Escala Revisitadas

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Carlos Pinto
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ABSTRACT
The Krugman model shows that international trade can trigger mutual gains for the participating countries even when they are similar in technology and endowments. The emerging intra-industry trade between countries is based on economies of scale, the exchange of different types of products produced under monopolistic competition, and heterogenous preferences. We extend the baseline model by considering two dynamic settings, with special focus on the producer. The former reveals that gains in the long run are concomitant with short term losses for workers in the smaller country due to the competitiveness gap. Until the competitiveness gap is narrowed, lower nominal wages or the decline in the exchange rate are required for the country to keep its production capacity and a balanced international trade position. Furthermore, we consider that the cost structure of an industry also depends on factors that cannot depreciate via exchange rate. Here, the employees of companies that are at a competitive disadvantage, due to a low efficiency starting point, may feel a negative impact during the transition as they lose purchasing power. While the country as a whole gains, some country agents might lose, at least in the short term. Results are illustrated numerically, using MATLAB, calibrated against the example in Krugman and Obtsfeld (2006).
Keywords: Krugman; intra-industry trade; economies of scale; monopolistic competition.

JEL Classification: D31; H23; I38.

RESUMO
O modelo do Krugman mostra que o comércio internacional pode surgir e conduzir a ganhos mútuos para os países participantes, mesmo quando são semelhantes em tecnologia e dotações. O comércio intra-indústria emergente entre países baseia-se em economias de escala, no intercâmbio de variedades diferenciadas dos produtos produzidos sob a concorrência monopolista e nas preferências heterogéneas. Alargamos o modelo de base, considerando duas configurações dinâmicas, com especial enfoque no lado do produtor. A primeira extensão

revela que os ganhos a longo prazo são concomitantes com perdas a curto prazo para os trabalhadores do país mais pequeno devido à diferença de competitividade. Até que o fosso de competitividade seja preenchido, é necessária uma diminuição dos salários nominais ou uma diminuição da taxa de câmbio para que o país mantenha a sua capacidade de produção e uma posição comercial internacional equilibrada. Depois, consideramos que a estrutura de custos de uma indústria também depende de fatores que não podem desvalorizar através da taxa de câmbio. Neste contexto, os trabalhadores de empresas que têm uma desvantagem competitiva, devido a um ponto de partida de baixa eficiência, podem sentir um impacto negativo durante um período de transição, perdendo o poder de compra. Enquanto o país como um todo ganha, alguns agentes dentro do país podem perder, pelo menos a curto prazo. Os resultados são ilustrados numericamente, utilizando o MATLAB, calibrado tendo por base o exemplo em Krugman e Obtsfeld (2006).

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1. Introduction

According to traditional international trade theory, Classic and Neoclassic, trade could only arise, and lead to mutual gains for countries, measured by the increase in the utility or level of welfare, if they differed in technologies (Classic, David Ricardo) or in their endowments (Neoclassic, Hecksher-Ohlin); moreover, international trade would consist only of exchanges of products in different product categories (inter-industry trade) – e.g., Appleyard et al. (2008) and Caves et al. (2007).

However, international trade is manly intra-industry and also generates gains for the involved countries as shown for instance by Balassa (1967) and Kravis (1971). It was necessary to wait until the year 1979 for the seminal Krugman's paper "Increasing Return, Monopolistic competition and International Trade", to get into the new wave of the international-trade theory. In line with Krugman (1979) model, this paper also showed an alternative explanation to the international trade, based on the fundamental concepts of economies of scale and the so-called "love for variety" preferences.

Hence, following the point of view proposed by Krugman (1979), we extend the Krugman and Obstfeld (2006) to introduce trade based on internal economies of scale in production.[1] Such trade in similar productions is denominated intra-industry trade. In this case, international trade can occur even when there are no technological nor endowment differences between countries. Internal economies of scale give rise to imperfectly competitive markets and Krugman and Obstfeld (2006) consider monopolistic competition. In this case, there are a number of firms in an industry, each of which produces a differentiated product. Demand for its good depends on the number of other similar products available and their prices. This type of model is useful for illustrating that trade improves the trade-off between scale and variety available to a country. In an industry described by monopolistic competition, a larger market, such as that which arises through international trade, lowers average price by increasing production and lowering average costs and makes available for consumption a greater range of goods. While an integrated market also supports the existence of a larger number of firms in an industry, the model presented in this paper does not make predictions about where these industries will be located.

In order to illustrate the results, the extended models are implemented using MATLAB, calibrated against the example in Krugman and Obtsfeld (2006), and solved numerically.

After this short introduction, Section 2 summarizes the setup of the model, and presents two new dynamic extensions, with and without labor costs. Section 3 illustrates the numerical resolution of the baseline model and the two dynamic extensions. Section 4 concludes.

2. The model

The model uses economies of scale, differentiated products and heterogeneous preferences to explain intra-industry trade. The essence of the model is as follows: (i) preferences

[1] Economies of scale can by external economies whereby the cost per unit relies on the size of the industry, but not necessarily on the size of the firm, or can be internal economies whereby the production cost per unit of output depends on the size of the individual firm, but not necessarily on the size of the industry.

are heterogeneous between and within countries; (ii) production experiences economies of scale; (iii) goods are differentiated Industries within a country will produce goods, which are targeted for the majority of their home consumers, thereby, exploiting economies of scale. However, not all consumers have the same preferences. Some will have preferences for the goods produced elsewhere. These consumers then wind up buying imported goods. The converse is also true: some portion of foreign consumers will have a greater preference for home country goods and home country winds up exporting to this market. With economies of scale there are only a feasible small number of firms to satisfy world demand.

2.1. Baseline model

Firstly, it is characterized the autarkic equilibrium in a monopolistic competitive industry. Then, it is analyzed the effect of international trade on that equilibrium. In the standard model of monopolistic competition, all firms are assumed to be symmetric; that is, "the demand function and cost function are identical for all firms" (even though they are producing and selling somewhat differentiated products) (Krugman and Obtsfeld, 2006). Economies of scale can be modeled by the following total cost linear equation:

$$C = F + c.Q, \tag{1}$$

where F is a fixed cost, Q is the production level, and c the constant firm's marginal cost. Indeed, this linear cost function implies economies of scale since the larger the firm's production the less is the fixed cost per unit. Specifically, the firm's average cost, AC, is:

$$AC = \frac{C}{Q} = \frac{F}{Q} + C = \frac{n.F}{S} + C, \tag{2}$$

where S is the size of the industry's market, which is fixed and does not depend on price, and n is the number of firms. Equation (2) implies that the average cost declines as Q increases since the fixed cost is spread over a larger output. One implication of this cost function is that, given the size of the industry's market, S, the more firms there are in the industry the higher the AC of each firm. Indeed, if the number of firms, n, increases, each firm will sell and produce less since $Q = \frac{S}{n}$ and, therefore, will have an higher average cost. This upward sloping relationship between n and AC is represented in Figure 1 by the blue, red, and green lines.

In turn, in a monopolistic competitive industry, the demand biased towards the product of the typical firm, Q, decreases with its own price, P, and the number of firms in the industry, n, and increases with the size of the total demand for the industry's product, S, and the average price charged by the firm's rivals, P^*. With these assumptions, all it is needed to understand the equilibrium of the industry is the number of firms, the quantity produced by each firm, and the market price, which is also the price charged by each individual firm and their average cost. In a model "in which consumers have different preferences and firms

produce varieties tailored to particular segments of the market" (Krugman and Obstfeld 2006, p. 117), the following specification for the demand is proposed:

$$Q = S.\left[\frac{1}{n} - b.(P - P^*)\right], \tag{3}$$

where b is a constant term representing the responsiveness of a firm's sales to its own price, P, and the average price charged by its competitors, P^*. This equation can be given the following intuitive explanation: "if all firms charge the same price, each will have a market share $\frac{1}{n}$. A firm charging more than the average of the other firms, $P > P^*$, will have a smaller market share, while a firm charging less, $P < P^*$, will have a larger share" (Krugman and Obstfeld, 2006, p. 117). A simplifying assumption is that total industry sales S are unaffected by the average price charged by the firms in the industry. That is firms can gain customers only at each other's expense. This is an unrealistic assumption but simplifies the analysis and helps focus on the competition among firms (Krugman and Obstfeld 2006, p. 118). A crucial implication of equation (3) is that, given the size of the industry's market, S, the more firms there are, the lower the (profit-maximizing) price each firm will charge since "the more firms there are, the more intense will be the competition among them and hence the lower the price. This turns out to be true in this model, but proving it takes a moment" (Krugman and Obstfeld 2006).

To solve the model, the marginal revenue, MR, function from the demand curve facing the typical firm (3), which is given by $MR = P - \frac{Q}{S.b}$. Afterwards, equalizes the to the marginal cost and finally solves the resulting equation to obtain a relationship between (the profit-maximizing price) and (the number of firms), resulting:

$$P = c + 1\ \frac{1}{b.n}. \tag{4}$$

Equation (4) informs us that the more firms there are in the industry, n, the greater the competition and, thus, the lower the price, P, charged by each firm and this downward sloping relationship between P and n is represented by the black downward sloping curve in Figure 1.

Concerning the industry equilibrium, given free entry and exit, it is given by the zero--profit condition; i.e., by equations (2) and (4) the price must equal the coverage cost:

$$P = AC. \tag{5}$$

This equilibrium is defined by the number of firms and the average price they charge. It corresponds to the point of intersection between the black curve and each of the other curves in Figure 1, where there are n firms in the industry and where the profit maximizing price, P is defined; the equilibrium point (n, P) is a stable equilibrium: If the number of firms is

$n_1 < n$, the profit maximizing price P_1 is higher than the average cost AC_1. Thus, established firms are making above-normal profits and, as a result, new firms enter the market. This drives the price down and the average cost up until they are equal at the equilibrium point. In turn, if the number of firms is $n_2 > n$, the opposite happens.

The key contribution of this model is to show that international trade, by creating a combined market larger than any of the national markets that comprise it, allows more varieties of each product to be produced, at lower average costs, than in any national market alone. Krugman's (1979) demonstration is based on the following, bearing in mind Figure 1 from the Krugman and Obstfeld (2006) example: in autarky, the industry equilibrium in each country is at point (6, 10.000) for country A and (8, 8.750) for country B; when international trade starts, the market size of the industry increases, S, and, given the number of firms, n, the sales of each firm rise, $Q = \frac{S}{n}$. As a result, the AC of each firm falls for any given n. In turn, international trade and the ensuing increase in the size of the market do not have any effect on the curve $P = 1 + \frac{1}{b.n}$, which relates the profit-maximizing price with the number of firms since the size of the market does not enter into the equation that defines P.

Conclusion: in Figure 1 the industry equilibrium shifts toward the equilibrium point (10, 8.000), which means that the number of firms increases, while the price falls. As stated in Krugman and Obstfeld (2006), consumers prefer to be part of a large market than a small one since a greater variety of products is available at a lower price. An increase in S due to international trade shifts the average cost curve downwards thus lowering the price of the product, while increasing the number of viable firms. The greater the number of firms the more the number of differentiated products, thus international trade provides consumers with greater variety and lower prices. The $P = 1 + \frac{1}{b.n}$ curve is independent of S and, therefore, does not shift.

Note though that with a non-horizontal $P = 1 + \frac{1}{b.n}$ curve, the number of firms that exist in the long run with international trade is less than the sum of the numbers across countries in autarky. It is also useful to note the impact of the different parameter and variables in the two equations: (i) c, the marginal cost, has a positive impact on both average cost and price. The impact is 1-to-1, which can be seen in the derivatives of equations (2) and (4) with respect to c; (ii) F, the fixed cost, impacts directly the average cost (2) such that the higher the fixed costs, the higher the average cost; (iii) b, the consumer price sensitivity, affects directly the market price (4) and the higher b the lower the price will be; (iv) S, the size of the market, the larger the more firms can produce and, thus, the lower average cost (2) will be; (v) n, the number of firms, implies that, all other things being equal, the larger the number of firms, the higher the average cost (2) in the market. This is because, a higher number of firms for the same quantity demanded will let each firm produce less. Since the model has economies of scale, lower scale at the firm level results in higher average costs. On the other hand, the number of firms has the opposite effect on price (4). Everything else constant, the more firms there are, the lower the market price will be.

It is clear from Figure 1 that the larger the market of the firms, the more savings they can obtain from economies of scale and the more varieties of the product a customer have access to. We also know the implications for the openness to consumers.

2.2. Dynamic model with labor costs

We intend to explain how firms of an non-homogeneous good and countries adjust after international trade openness. The cost structure has a fixed and a variable component and is initially equal in both countries in local currency. The demand remains inelastic, the size of the market is again fixed and does not respond to variations in price, the level consumption and production is the same in every period, there is no price differentiation, external trade balance is always equal to zero and countries can not have trade deficits.

To understand the dynamic implications of the model, we now consider that firms are unable to adjust immediately to the new optimal scale due to, for example, lack of information on the true size of the market, capital adjustment costs, labor market rigidity, regulatory constraints. To consider these rigidities, we assume that, each period, firms only cover part of the gap between their current production capacity and the optimal production capacity:

$$Q_t = (1 - \alpha)Q_{t-1} + \alpha Q^*, \quad (6)$$

where Q^* represents the optimal firm's production after international trade and Q_{t-1} is the production in the previous time period since t represent the present time period. We consider that labor is the productive factor. The fixed cost is now the number of working hours that are needed regardless of the quantity produced in addition to the additional number of working hours required for each unit produced. Moreover, after international trade is allowed, the price of the product is the same worldwide and equal to the price in the most competitive country. This is a result of the zero profit condition – average cost is equal to price – and less competitive firms can adjust their wage costs to ensure zero profit condition. This adjustment can be performed through nominal adjustments in wages or through the exchange rates. For the purpose of the model, it is irrelevant what is the method used to adjust wage costs. For simplicity, we assume that is done via exchange rates. Hence, this assumption means that there is no other tradable good, and we can assume that this product is the only tradable good in the economy. This will also allow us to understand the exchange rate implications of efficiency convergence and international trade.

We start by considering that countries are in autarky, $t = 1$. Then, in the following period, the countries start trading with each other and the price of the product equalizes for both countries. However, the firms in each country have different sizes, with the larger country having larger firms, closer to the optimal scale. Firms in both countries adjust at a rate α towards the optimal scale. Hence, replacing n by $\frac{S}{Q}$ in equations (2) and (4) results:

$$AC = \frac{F}{Q^*} + c, \quad (7)$$

$$P = c + \frac{Q^*}{b.S}. \quad (8)$$

We keep the zero profit assumption, so average cost will be equal to price. Equalizing (7) and (8) and solving with respect to Q^*, we get the optimal value for the quantity produced by the firms, $Q^* = (S.b.w_t.l)^{0.5}$. However, now firms do not immediately start producing that

quantity since, from (6), firms in each country $i = A,B$ follow an autoregressive process with α representing the flexibility of the economy. Hence, Q^i, $i = A,B$, evolves according to the rule:

$$Q_t^i = (1 - \alpha^i)Q_{t-1}^i + \alpha^i Q^*. \tag{9}$$

Hence, Q^i can be different from Q^* for some periods of time, depending on the adjustment term α^i. However, since zero profit assumption remains for all firms, the most competitive firms (with the larger scale) will still have price equal to the average cost. Additionally, since countries are now a single market for the product, there are a worldwide single price. Thus, to compete in the market, the other firms need to adjust factor costs.

Fixed costs represent now the number of working hours required for a firm to function regardless of quantity produced, multiplied by the wage per hour: $F_t = w_t l$, where F is the fixed cost per firm, w is the wage per hour, and l is the fixed number of working hours required for the firm to function in each period, regardless of produced units. In turn, the variable cost depends on the number of hours required to build one unit of the product multiplied by the wage rate: $c_t = w_t h$, where c is the variable cost and h represents the working hours required to produced one additional unit of product. Replacing these expressions in equation (2), the new average cost is

$$AC = \frac{W_t l}{Q_t} + W_t h. \tag{10}$$

Given that $P^A = P^B$, and $P = AC$ then $\frac{W_t^A l}{Q_t^A} + W_t^A h = \frac{W_t^B l}{Q_t^B} + W_t^B h$. For these equality to hold, $Q_t^B < Q_t^B, W_t^B < W_t^B$. In summary, the economy is ruled by the following dynamic system in each period of time:

$$Q^* = \left(S.b.w_t.l\right)^{0.5} \tag{11}$$

$$Q_t^A = \left(1 - \alpha^A\right)Q_{t-1}^A + \alpha^A Q^* \tag{12}$$

$$Q_t^B = \left(1 - \alpha^B\right)Q_{t-1}^B + \alpha^B Q^* \tag{13}$$

$$P_t = \min\left(w_t^A h + \frac{Q^A}{b.S},\ w_t^B h + \frac{Q^B}{b.S}\right) \tag{14}$$

$$P_t = P_t^A = P_t^B = AC_t^A = AC_t^B \tag{15}$$

$$AC_t^A = \frac{w_t^A l}{Q_t^A} + w_t^A h = AC_t^B = \frac{w_t^B l}{Q_t^B} + w_t^B h. \tag{16}$$

2.3. Dynamic model without labor costs

In the previous Subsection, we have considered that the only costs faced by the firms were labor costs. Both fixed and variable costs were assumed to be labor related. Now, we change this assumption to account for the fact that firms might have some costs that are not possible to devalue via exchange rate. We can think of several examples such as internationally traded raw materials, oil, or other intermediate products where the price does not depend on the internal dynamics of the economy. For that purpose, we will now make the variable cost a constant, c, just as in the baseline case in Section 2. This parameter c represents the cost of the additional raw materials required to produce one more unit of the product. Since for the purposes of this Subsection, it is irrelevant whether labor costs are only partially or fully excluded from the variable component, we exclude labor costs since it is more intuitive and algebraically easier to illustrate. Hence, in relation to the previous case, we have this main change: the variable costs are $c_t = c$ to produce an additional unit of the product (not possible to deflate via exchange rate). The new average cost is thus:

$$AC = \frac{W_t l}{Q_t} + c. \tag{17}$$

Given that $P^A = P^B$ and $P = AC$ then $\frac{W_t^A l}{Q_t^A} + c = \frac{W_t^B l}{Q_t^B} + c$. The economy is now ruled, at each period of time, by the following dynamic system:

$$Q^* = (S.b.c)^{0.5} \tag{18}$$

$$Q_t^A = (1 - \alpha^A) Q_{t-1}^A + \alpha^A Q^* \tag{19}$$

$$Q_t^B = (1 - \alpha^B) Q_{t-1}^B + \alpha^B Q^* \tag{20}$$

$$P_t = \min\left(c + \frac{Q^A}{b.S},\ c + \frac{Q^B}{b.S}\right) = c + \min\left(\frac{Q^A}{b.S}, \frac{Q^B}{b.S}\right) \tag{21}$$

$$P_t = P_t^A = P_t^B = AC_t^A = AC_t^B \tag{22}$$

$$AC_t^A = \frac{w_t^A l}{Q_t^A} + c = AC_t^B = \frac{w_t^B l}{Q_t^B} + c. \tag{23}$$

3. Numerical resolution

3.1. Baseline model

In the baseline case we consider the following values for parameters and exogenous variables in line with Krugman and Obstfeld (2006): the market price sensitivity, b, is $\frac{1}{30.000}$, the home market size, S^A, is 900.000, the foreign market size, S^B, is 1.600.000, the fixed cost, F, is 750.000.000, and the marginal cost, c, is 5.000. Results are shown is Figure 1.

Figure 1: Baszeline case. The upward sloping curves represent the relationships between n and AC. The downward sloping curve represent the relationship between n and P

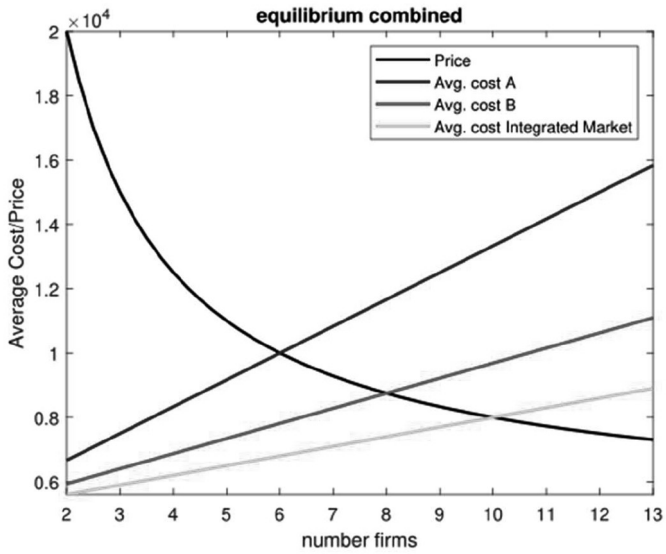


Table 1: Baseline case. Main results in autarky and under international trade: results for countries A and B, integrated markets, and the comparison between both countries and the integrated markets

	country A	country B	integrated markets (IM)	comparison IM & A	comparison IM & B
total sales (× 1000)	900	1600	2500	1600	900
price	10000	8750	8000	-2000	-750
average cost	10000	8750	8000	-2000	-750
sales/firm (× 1000)	150	200	250	100	50
number of firms	6	8	10	4	2

3.2. Dynamic model with labor costs

Now, we adapt the baseline case to our dynamic extensions. The fixed number of hours required per firm, l, is 15.000.000, the number of working hours required per additional unit of product, h, is 100, the wage per hour, w, is 50, the flexibility parameter, α, is 0.1. Thus, the variable cost is hw. The wage is in international units of currency (IUC), which coincides with the value in local currency in period $t = 1$ for both countries. We assume that nominal wages have downwards rigidity in local currency, so downwards adjustments in wages are done via exchange rate.

In period $t = 1$, we assume the autarky equilibrium calculated in the previous Subsection – see Table 1: $Q^A = 150.000$; $Q^B = 200.000$; $n^A = 6$; $n^B = 8$; $P^A = 10.000$; $P^B = 8.750$; Q^* is the quantity that resulted from the integrated markets equilibrium – see Table 1: $Q^* = 250.000$; $n^* = 10$; $P^* = 8.000$.

In this case we also need to observe what happens in terms of number of working hours in the economy to produce, e, the price level of the product in each country divided by the price of the product in the cheapest country in autarky, P, the real wage that is the wage rate divided by the price level, w^r, and the exchange rate corresponding to the price of the product in local currency in country B divided by the price of the product in local currency in country A (it is easy to prove that, in this case, it is equal to the ratio of nominal wages in IUCs). The exchange rate is assumed to be 1 in the $t = 1$, although the value has no special meaning in autarky.

Figure 2: Dynamic model with labor costs – main results

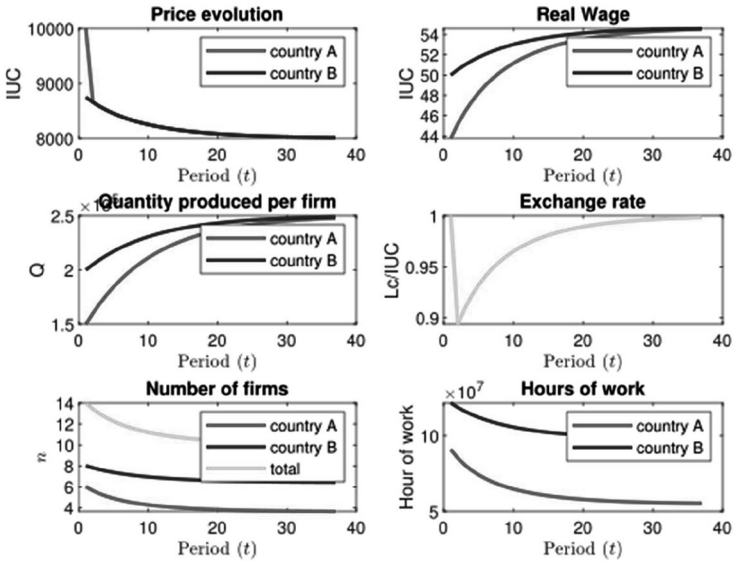


Figure 2 summarizes the main results. In the first period, both economies are in autarky. Under international trade the product price is the same in both countries, representing a larger gain for the consumers initially in the smaller country who had to pay a larger price for the product. It is also worth noting that the price does not move immediately towards the equilibrium price defined in the previous assignment. This is because firms do not reach the optimal scale immediately after international trade becomes possible. The optimal quantity produced per firm (the scale of production) is 250.000. With a flexibility parameter of $\alpha = 0.1$, the economies take about 37 periods to reach the optimal scale; however, most of the gains are obtained in the first 15 periods. In the first periods there is a significant difference in scale between firms in the originally smaller *A* and the originally larger market *B*. That difference starts to vanish over time. Towards the end, firms in both countries achieve similar scale, operating at the same level of efficiency. Given that, by assumption, market size is fixed, this additional scale by individual firms will result in less firms as the ones incapable of scaling-up are eliminated or merged.

Although consumers will not get immediately the full benefit of the price reduction (specially consumers in *B*), they still benefit from additional choices as soon as the countries open to international trade. Assuming that the varieties originally available in the smaller country are not a sub-group of the ones available in the large country, even the consumers in the large country benefit from additional varieties of the product. In the extreme case where the product varieties originally available in the two countries are mutually exclusive,

the consumers benefit more from in terms of product varieties in the transition period than in the final equilibrium.

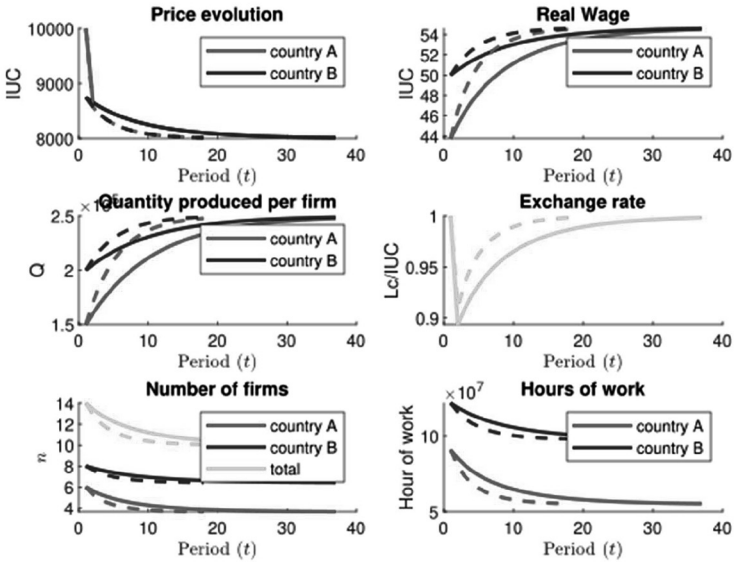
In summary, from the consumer perspective, there are some big immediate gains for consumers in the smaller country *A* who can see a large price drop after international trade, benefiting from the production efficiency of the trade partner. Consumers in the larger country *B* also benefit from a lower price, but are restricted by the capacity of its firms to optimize. Both can benefit significantly by additional varieties, but that benefit decreases during the transition period as the industry consolidates.

The number of hours of work required to produce the fixed quantity (remember we have inelastic demand and no trade deficits/surpluses) goes down over time as firms optimize, meaning that firms need less and less workers or the workers can work less and less hours to produce the same. As a consequence, the real wage per hour goes up over time. In the larger country *B*, the real wage per hour in the first period corresponds to the nominal wage as per the normalization defined in the previous chapter. In the smaller country *A* the nominal wage is adjusted by the price of the product, starting at a lower point. With international trade the real wages converge over time.

The exchange rate is calculated assuming that nominal wages in local currency have full downwards rigidity. They will not be lower than 50 units in local currency as per the initial equilibrium. If we assume a parity starting point, the smaller country will have to do a sharp devaluation once the economy opens up to international trade. However the exchange rate value in autarky has little meaning since, without trade and international flows, there is no real exchange rate setting mechanism. The main take away here is that, as productivity in the smaller country converges with that of the larger country, the currency of the small country will gain in value over time.

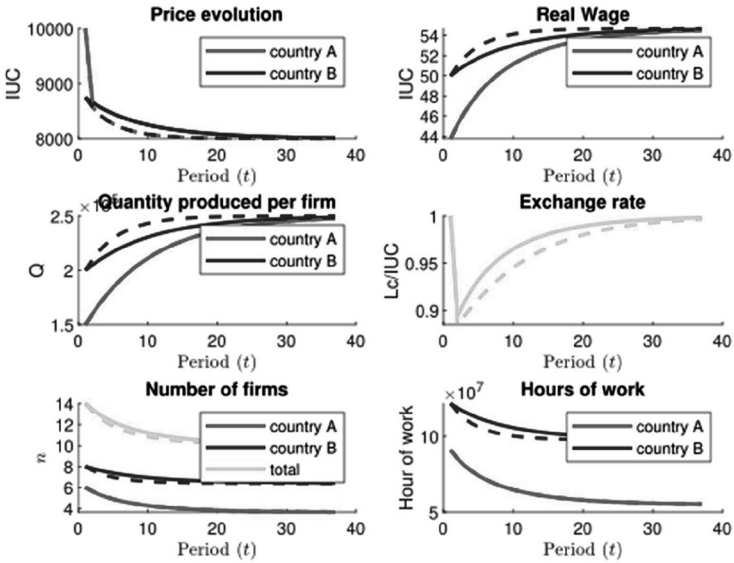
In terms of sensitivity analysis, we start by looking at the speed of adjustment, α. We first observe what would be the impact of doubling the adjustment rate in both countries (a proxy for increasing the flexibility of the economy). The outcomes can be seen in Figure 3. The old scenarios remain there for comparison and the new scenarios are represented with dotted lines. As expected, a higher adjustment rate leads to a faster movement towards the final equilibrium. It is interesting to notice that double the rate of adjustment will make the adjustment period last for roughly one third of the original time. Both countries benefit, but it is obvious by observing the chart that the smaller country *A* gets in absolute and relative terms bigger gains in terms of scale and real wage. The devaluation requirement in the period after opening up to international trade is also lower and parity is achieved faster.

Figure 3: Dynamic model with labor costs,



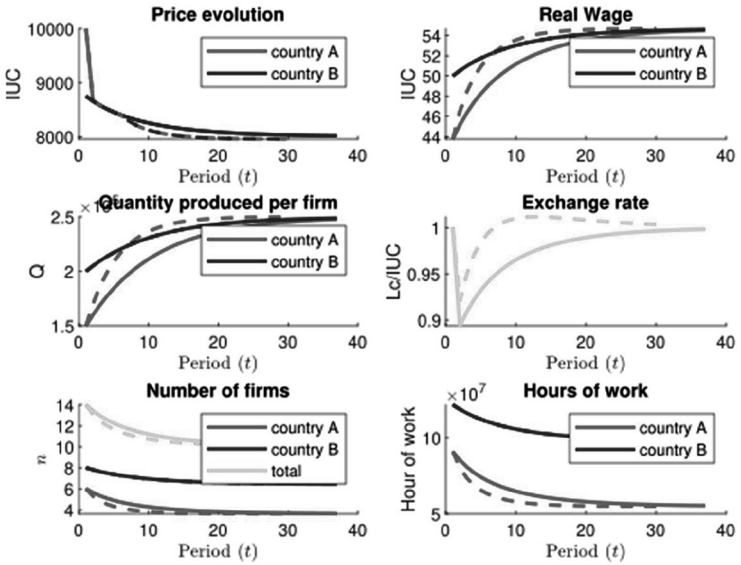
We are assuming so far that the economies' flexibility factor moves in parallel in both countries. We now check the cases in which the flexibility factor is larger only in one of the countries. First, we will assume that $\alpha^B = 0.2$, while α^A remains at 0.1 – see Figure 4. The additional flexibility allows the large economy to increase real wages, firms scale faster, as expected. Overall market price also lowers, which benefits consumers in both countries. So, increasing economic flexibility in one country actually benefits its trade partners indirectly. In order to compensate for the additional gap in competitiveness, the currency in the small country is forced to decline further when opening up to trade and remain below for all periods until equilibrium is reached.

Figure 4: Dynamic model with labor costs, $\alpha^A = 0.1$ and $\alpha^B = 0.2$



Now we check the case in which the flexibility factor is larger in the smaller economy, which, by considering $\alpha^A = 0.2$, becomes more flexible. The outputs are summarized in Figure 5. With additional flexibility, firms can adjust quicker to the new equilibrium. They can adjust so quick that the initial competitiveness advantage coming of the large economy resulting from more scale disappears after five periods. After five periods firms in country *A* become more efficient and closer to the optimal scale. As such, the real wage in the small economy also becomes higher. The exchange rate even remains slightly above parity until the large country achieves equilibrium. The roles in price determination also change: it is now the turn for consumers in the large country to benefit from lower prices due to the additional competitiveness of the smaller economy.

Figure 5: Dynamic model with labor costs, $\alpha^A = 0.2$ and $\alpha^B = 0.1$

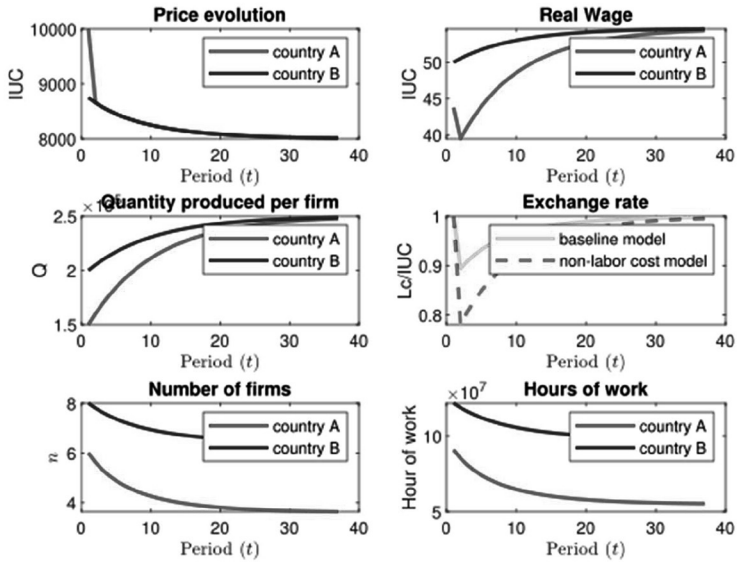


In summary, the economy flexibility factor is crucial to understand the length of the adjustment period, and the currency devaluation requirements. Inflexibility in the economy drives large devaluations and real wage losses for long periods of time.

3.3 Dynamic model with non-labor costs

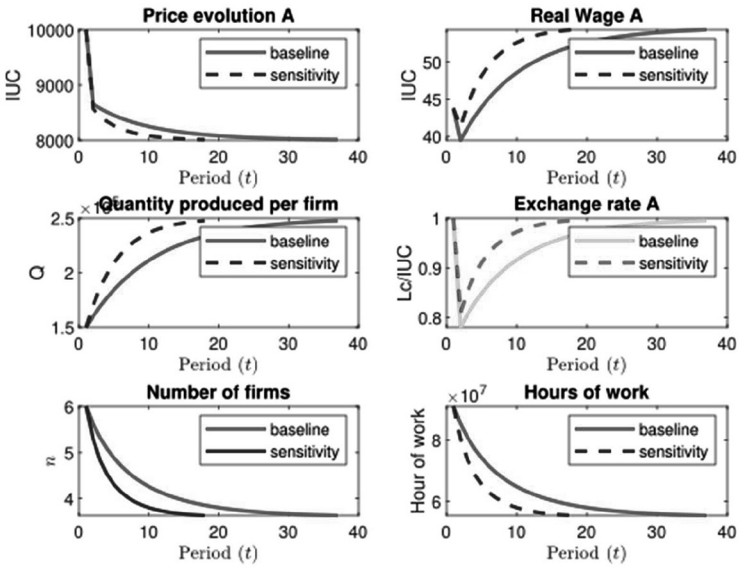
This model drops the parameter h and regains the parameter c, considering that $c = 5000$ matches the initial value for the variable cost both in the baseline model and in the dynamic model with labor costs. Figure 6 summarizes the main results. If we compare it with Figure 2, it is easy to conclude that nothing has changed. Both the final equilibrium and the path towards that equilibrium remain unchanged. This happens because the price level of the firms' optimization path are determined by the economy's flexibility and the path of the most efficient economy, which are unaltered by a shift in how the variable costs are calculated. For the same values of α, same final equilibrium and same initial equilibrium, these curves remain unchanged. The price declines as much as in the previous model. However, the less competitive economy is unable to devalue all the production costs to match the price decline. There is a portion of the costs that are not possible to devalue via exchange rate. The implication of this is that the costs that can be devalued, need to be devalued more than before. Hence, the exchange rate will have to decrease further in order to ensure that firms' average costs in IUC decline as much as before to regain competitiveness.

Figure 6: Dynamic model with non-labor costs – main results



Now, the exchange rate declines further in the initial moment when international trade starts, followed by a quicker recovery than before, reaching equilibrium at the same time. However, the exchange rate in this model remains always below the exchange rate in the previous model, only meeting in the end where both exchange rates meet parity. The exchange rate differences are significant in the initial periods of the adjustment when the scale differences are higher and fixed wage costs represent a higher proportion of the cost structure. As the firms scale up, gain economies of scale and fixed wage costs represent a lower proportion of total costs, the exchange rate in this model becomes more similar to the previous model. It is now important to observe the impact of this exchange rate evolution in the real wage. In the previous model, the exchange rate decline in the small economy was of the exactly same magnitude as the price decline. One (the exchange rate) was a direct response to the other. The impact of this was that the real wage never declined after international trade. The real wage started at the same point as in autarky, increasing from there as a result of firms scaling up and gaining efficiency.

Figure 7: Dynamic model with non-labor costs, $\alpha^A = \alpha^B = 0.2$

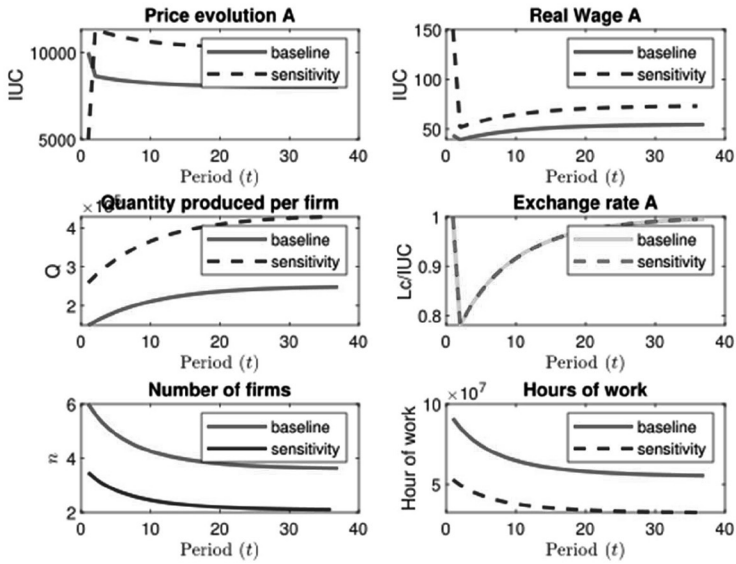


Nothing changed in the real wage of the large country *B*. The significant change occurs in the real wage of country *A*. The real wage benefits from a decrease in the product's price just as in the previous model, but it is affected negatively by the decline in exchange rate. This time, the decline in exchange rate is larger than the decline in price, so, unless the economy's flexibility is very large, the real wage will decline in the period after international trade starts. Hence, workers of the most inefficient country producing the tradable product can actually have a short-term decline in their purchasing power after international trade. Thus, while consumers (that in this example can be seen as the people working in the non-tradable sector) benefit from the international trade, workers can see their purchasing power decline.

In terms of the sensitivity analysis, we start by looking at variations in the economy's flexibility factor α. If the factor is double the original value, as expected, exchange rate decreases less and returns to parity faster than in the main model – Figure 7. The real wage also returns faster to the value before international trade, rising faster above it afterwards. Unsurprisingly, we have the opposite situation when we take a flexibility factor half of the original value.

In conclusion, the more flexible the economy is, the shorter is the period workers spend with a net loss in real salary after international trade. As firms are allowed to grow, consolidate and scale-up, they increase efficiency, produce more at a lower cost leading to an increase in exchange rate, which raises workers' real wage.

Figure 8: Dynamic model with non-labor costs, c = 15.000



The second sensitivity worth analyzing is the weight of the non-labor costs in firms' cost structure. To do that, we have tripled the non-labor variable cost, increasing it from 5.000 to 15.000 – Figure 8. The starting point of the real wage is higher because (as mentioned in the beginning) it is indexed against the larger economy. But the interesting insights are twofold: the exchange rate stays exactly the same as the original model. This occurs because the relative differences in productivity (although lower in absolute value) remain unchanged. Second, and most importantly, the drop in real wage is more steep and it also takes longer to regain the same level of real wage as before international trade. Higher variable costs impossible to devaluate do not erase relative productivity differences, but decrease the potential gains of efficiency that make real wages increase over time. The higher the non-labor component of the cost structure, the more the workers will see their real wages falling and the longer it will take until they start gaining from international trade deals.

4. Concluding remarks

A larger market from international trade allows firms to produce more and benefit from additional economies of scale. This, in turn, is reflected in lower consumer prices. As shown, the increased market size permits the activity of more firms, increasing the number of varieties of the same product. Hence, consumers in a small closed economy will tend to pay more and have less variety of a product than consumers in a large closed economy.

Therefore, once the economies open up to international trade, the market size increases and both economies have access to the same number of varieties at the same price. It is noteworthy that, although being mutually beneficial, consumers in small economies benefit even more than consumers in large economies from opening up to trade.

As is standard in international trade theory everyone stands to gain from opening up to international trade. While that is true in equilibrium, the transition periods can tell a different story. Despite the fact that consumers in the small country are the ones who have more to gain from international trade, it is also the workers of the small country that have the most short-run loses. When we assume, as in the first model, that the whole cost structure is dependent on wages, then the efficiency downwards adjustment in wages (we have done it via exchange rate, but it could equally be done by nominal wage decreasing) is compensated by the decrease in prices, leaving real wages unaltered, just with the upside from the additional productivity coming from economies of scale. We observe that, even in a dynamic setting, worker's real wage could only increase by opening to international trade. But that is only true when there are only labor costs in the cost function.

When we consider that the cost structure of an industry also depends on factors that can not devalue via exchange rate, workers in firms that have a competitive disadvantage because of a low efficiency starting point (the smaller country in our model) might feel a negative impact during a transition period, losing purchasing power. While the country as a whole gains (specially those in non-tradable sectors that benefit from lower prices of tradable products), some agents within the country might have something to lose, at least in the short-run.

A flexible economy, allowing firms to adjust fast to the new reality, might significantly shorten in length this short-run loss. However, if the economy is too rigid and/or the initial efficiency differential is too large, the workers might lose purchasing power for a long period of time. International trade is a major driver of global growth and most nations, specially the smaller ones, have taken big jumps in productivity and welfare after getting more involved in international trade. However, political leaders need to ensure that economies are enough flexible to reduce transition times and that there are mechanisms in place to soften the short-run losses of those that pay the price of the international trade deals.

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Global Knowledge and Wealth with National Human Capital and Free Trade

Conhecimento Global e Riqueza com Capital Humano Nacional e Comércio Livre

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ABSTRACT
This paper deals with issues of global economic growth with endogenous private wealth, national human capital, and global knowledge. We build a multi-country growth model with interactions between wealth accumulation, human capital change, and knowledge growth by integrating the basic economic mechanisms in a few theories. The model is framed within neoclassical growth theory. Human capital accumulation is based on the Uzawa-Lucas two-sector model. Trade pattern is determined as in the Oniki-Uzawa trade model. Knowledge growth is influenced by new growth theory. Household behavior is modelled using Zhang's concept of disposable income and utility function. The dynamics of the J-country world economy is described by 2J+1 differential equations for wealth, human capital, and knowledge. We simulate the movement of the global economy based on three economies. We also conduct comparative dynamic analysis to show how changes in national characteristics, such as propensity to save, propensity to receive education, efficiency of applying human capital and creativity, shift dynamic paths of the global and domestic economic development.
Keywords: Growth; international trade; human capital; wealth; creativity; research policy.

JEL Classification: O41; F11; F21; J24.

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1. Introduction

Modern economies are characterized of global connections in business, shared rational knowledge, and widely spread education. Human capital is globally enhanced due to spread education. In the last hundred years knowledge has experienced fast growth due to research by different countries. Factor distributions between domestic sectors and national economies are shifted overtime. Living standards are increased globally, but in association with enlarged gaps. Some economies appear even relatively poorer in recent decades. All these changes are interrelated in a globalizing world. It is thus important to build a genuine dynamic general equilibrium framework to analyze these complicated interactions. The purpose of this paper is to build a multi-country growth model of interactions between wealth accumulation, human capital change, and knowledge growth with free trade. We examine how national differences in propensities to save and to receive education, national characteristics in creation and utilization in human capital and knowledge affect global wealth and knowledge, national differences in income and wealth propensities to save, propensities to receive education, productivity of human capital accumulation, human capital application efficiency, creativity, and knowledge utilization efficiencies. The model is constructed by synthesizing neoclassical growth theory, the Uzawa-Lucas two-sector growth model, the Oniki-Uzawa trade model, and some ideas in new growth theory with Zhang's concept of disposable income and utility.

This study treats knowledge a global public good in the sense that every country is freely access the global knowledge stock. Although this is a strict assumption as much knowledge, such as knowledge for producing nuclear powers, is protected for free access in different ways. With regard to knowledge accumulation this study assumes research as a sole channel of knowledge growth. Research is financially supported by national governments. There are many studies on endogenous knowledge and economic growth (e.g., Romer, 1986, 2019; Grossman and Helpman, 1991; Aghion and Howitt, 1992, 1998; Funke and Sttrulik, 2000; Klette and Kortum, 2004; and Kuwahara, 2019). We introduce research sectors which are concentrated on creating new knowledge. Knowledge is nonrival as the utilization of knowledge by any agent does not prevent it from being used by others. This study is similar with Romer's approach, but different in that research is publicly supported in this study, rather than by profit-maximizing firms as in Romer's model. It should be noted that the Romer model does not include endogenous human capital. A R&D-based growth model with endogenous human capital is proposed by Arnold (1998). The Arnold approach is an integration of new growth theory and Uzawa-Lucas model. As mentioned late, this paper takes a different approach from Arnold's.

There are close interactions between knowledge and human capital. Knowledge growth is an important source of education and human capital growth. Enlarged knowledge stock makes education more effectively. On the other hand, knowledge growth can be effectively conducted only with people with high human capital (e.g., Zeng, 1997; Kumar, 2003; Galor, 2005; Tamura, 2006; Reis and Sequeira, 2007; Baldanzi et al., 2019, and Fonseca et al, 2019). This study considers human capital accumulation is endogenous. Like in the Uzawa-Lucas model, we consider formal education a sole channel of accumulating human capital. Education sectors of different countries are perfectly competitive and provide education

services with market prices. Households pay their own education. Investment in education has recently become a high priority in almost all developed and developing economies. Higher education has been fast developed and spread in many countries (Bergh and Fink, 2009). There are many empirical studies on relations between education and income. Mincer (1974) finds that for white males not working on farms, an extra year of education raises the earnings by about 7%. Psacharopoulos (1994) compares the rates of return to education among 78 countries and identifies great differences among countries. O'Neill (1995) shows that among the developed economies, convergence in education levels reduce income dispersion; while for the world as a whole incomes diverge despite substantial convergence in education levels. O'Neill argues that this occurs because the rise in the return to education favors the developed countries at the expense of the less developed countries. Krueger and Kumar (2004) analyze the differences of education and economic development between US and Europe in the 1980s and 1990s. Bergh and Fink (2009) observe that there does not seem to be a systematic relation between the structure of higher education and the overall degree income inequality. Kottaridi and Stengos (2010) examine impact of human capital on economic growth. Other issues related to the role of human capital on economy are examined (e.g., Liao et al., 2019; Osiobe, 2019). There are also theoretical models on connections between education (Uzawa, 1965; Lucas, 1988, 2015). The Uzawa-Lucas two-sector model is a key model in the literature of formal modeling growth and human capital. The model explains a competitive economy composed of education and production sectors. The Uzawa-Lucas model is generalized in numerous studies (e.g., Jones et al. 1993; Stokey and Rebelo, 1995; De Hek, 2005; Chakraborty and Gupta, 2009; and Sano and Tomoda, 2010). This study follows this tradition in modelling human capital in a multi-country framework with endogenous knowledge.

Households' preference for education and for saving are important for sustainable economic growth. The basic purpose of this study is to propose a dynamic general equilibrium model with interactions between wealth accumulation, human capital accumulation, knowledge growth, preference for receiving education and saving, and economic structural change. Physical capital is a determinant of human capital accumulation and knowledge growth. On the other hand, physical accumulation is determined separately from knowledge growth and human capital accumulation. As far as decisions on saving, consumption and education are concerned, this study applies Zhang's approach to household behavior (Zhang, 2005). The economic structure and economic production are based on neoclassical growth theory (Solow, 1956; Swan, 1956; and Burmeister and Dobell, 1970). As far as capital mobility and trade are concerned, our model is based on neoclassical growth trade models. We specially refer to Oniki and Uzawa (1965) which examine global economic growth with capital accumulation and trade patterns between the two economies in a Heckscher-Ohlin model with fixed saving rates. It should be noted that there is a large number of academic articles about issues related to this paper (e.g., Storper and Scott, 2009). For instance, Fleisher et al. (2019) empirically examine regional development and inequality in a growth model with endogenous human capital. They found that human capital positively affects output and productivity growth and investment in education help to reduce regional disparities in national economic development.

The model in this study is a synthesis of the two models by Zhang. Zhang (1993) introduces a research sector and endogenous knowledge to neoclassical growth theory. Zhang (2015)

introduces an education sector and endogenous human capital into the Oniki and Uzawa (1965) trade model in neoclassical trade theory. It should be remarked that basic issues addressed in this model are similar with the open-economy endogenous growth model by Arnold (2007). The paper differs mainly in that the Arnold model examines behavior of household with the Dixit-Stiglitz approach, while this study bases on Zhang's approach; the Arnold model considers creativity and productivity improvement by individual firms' profit-maximization as in new growth theory, while this study considers human capital and government-supported research as the main contributors of technological improvements; the Arnold model considers an open economy, while this study considers a world economy consisting of multiple open economies. A further integration of the two models should provide more insights into the complexity of global growth with trade. The paper is organized as follows. Section 2 introduces the multi-country model with wealth accumulation, human capital accumulation, and knowledge growth. Section 3 proves some properties of the model and shows the movement of the global economy with three national economies. Section 4 carries out comparative dynamic analysis to demonstrate how the global economy shifts its development paths when exogenous changes such as propensities to save, creativity, and propensities to receive education take place. Section 5 concludes the study.

2. The global growth model with research and education

Funke and Strulik (2000) build an analytical formal framework to integrate the two separate lines of research on growth with knowledge – the Uzawa model with education and the endogenous growth models. This paper deals with similar issues but with alternative approaches to household's behavior and knowledge growth. The model is a synthesis of the two models by Zhang. Zhang (1993) proposes a neoclassical growth model of capital and knowledge accumulation with research sector. Knowledge is treated as a global public good. Zhang (2015) develops a multi-country growth model with endogenous human capital on the basis of the Uzawa-Lucas model. This study considers a global economy which is composed of multiple national economies, indexed by $j = 1, ..., J$. Each country has a fixed population, denoted by $\bar{N}_j$, $j = 1, ..., J$. Each national economy is composed one production/industrial sector, one education sector, and one research sector. We use subscript index i, e, and r, respectively, to represent production, education and research sector. Let $K_{jm}(t)$ and $N_{jm}(t)$ stand for, respectively, the capital stock and labor input employed by country j's sector m, $m = i,e,r$. We use $r(t)$ and $w_j(t)$ to denote globally equal rate of interest and wage rate per unit work hour in country j. The production sector follows the neoclassical growth theory, especially the Solow one-sector growth model. All national economies produce a homogenous commodity which can be either invested or consumed. There is only one homogenous durable commodity in the global economy. Assets are owned by households. Households distribute their incomes to consume and to save. Production sectors produce goods with capital and labor inputs. All markets are perfectly competitive. All available input factors are fully utilized. Saving is undertaken only by households. All prices are measured in terms of the commodity and the price of the commodity is unity. The production sectors use three factor inputs, physical capital, labor, and knowledge. Capital and labor are paid at

their marginal rates. Knowledge is free. Education sector provides educational service with physical capital, labor, and knowledge as inputs.

2.1. The total labor supply

We use $T_j(t)$ and $T_{je}(t)$ to stand for, respectively, the work time and study time of the representative household, in country j. Country j's total labor supply is the total labor time of the population by effective human capital:

$$N_j(t) = H_j^{m_j}(t)T_j(t)\bar{N}_j \tag{1}$$

where $H_j(t)$ is the level of human capital in country j and m_j is the representative household j's efficiency of applying human capital.

2.2. Production functions and marginal conditions of production sectors

In this study, we assume that knowledge stock $Z(t)$ is a pure public good in the sense that everyone is freely access to it and no one is excluded to fully use it when someone uses it. The production functions $F_j(t)$ of production sectors are taken on the following form:

$$F_j(t) = A_j Z^{m_{ji}}(t) K_{ji}^{\alpha_{ji}}(t) N_{ji}^{\beta_{ji}}(t), \quad A_{ji}, \alpha_{ji}, \beta_{ji} > 0, \quad \alpha_{ji} + \beta_{ji} = 1, \tag{2}$$

in which A_{ji}, α_{ji} and β_{ji} are positive parameters. Here, the parameter m_{ji} is called the production sector j's knowledge utilization efficiency parameter. For any individual firm rate of interest, wage rate, and prices are exogenously given. Production sector j chooses $K_{ji}(t)$ and $N_{ji}(t)$ to maximize its profit. The marginal conditions imply:

$$r(t) + \beta_{jk} = \frac{\alpha_{ji}\bar{t}_j F_{ji}(t)}{K_{ji}(t)}, \quad w_j(t) = \frac{\beta_{ji}\bar{t}_j F_{ji}(t)}{N_{ji}(t)}, \quad j = 1,2, \tag{3}$$

where τ_j is the fixed tax rate on production sector j and $\bar{t}_j \equiv 1 - \tau_j$.

2.3. The current income and disposable income

We use τ_{jw} and τ_{jk} to represent, respectively, the fixed tax rate on wage income and the fixed tax rate on consumption, and $\bar{t}_{jw} \equiv 1 - \tau_{jw}$ and $\bar{t}_{jw} \equiv 1 - \tau_{jw}$ in country j. The representative household's current income $y_j(t)$ from the interest payment $\bar{t}_{jk} r(t)\bar{k}_j(t)$ and the wage payment $\bar{t}_{jw} H^{mj}(t)T_j(t)w_j(t)$ is:

$$y_j(t) = \bar{t}_{jk} r(t)\bar{k}_j(t) + \bar{t}_{jw} H_j^{mj}(t)T_j(t)w_j(t). \tag{4}$$

The total value of wealth is $\bar{k}_j(t)$. Suppose that the household can use this amount to purchase goods and to save. The representative household's disposable income $\hat{y}_j(t)$ is the sum of the current income and the value of wealth:

$$\hat{y}_j(t) = \bar{y}_j(t) + \bar{k}_j(t). \tag{5}$$

The disposable income is distributed between expenditures on saving, consuming, and receiving education.

2.4. The budget and utility function

We use $p_j(t)$ to stand for per unit price of education service in country j. Following the approach to household behavior by Zhang (2005), we use a utility function to describe how the representative household rationally chooses how much to save $s_j(t)$ how many hours to receive education $T_{je}(t)$, and how much to consume $c_j(t)$. Let τ_{jc} stand for the fixed tax rate on consumption and $\tilde{\tau}_{jc} \equiv 1 + \tau_{jc}$ in country We have the following budget constraint:

$$\tilde{\tau}_{jc}c_j(t) + s_j(t) + p_j(t)T_{je}(t) = \hat{y}_j(t). \tag{6}$$

Each one is faced with the time constraint:

$$T_j(t) + T_{je}(t) = T_0, \tag{7}$$

where T_0 is the available time for work and study for any people. For simplicity of analysis, this study does not take account of leisure time. As shown in Zhang (2005), it is straightforward to include leisure time in the model. Inserting (7) in the definition of $\hat{y}_j(t)$ implies:

$$\hat{y}_j(t) \equiv \bar{y}_j(t) - \tilde{t}_{jw}H^{mj}(t)T_{je}(t)w_j(t), \tag{8}$$

where

$$\bar{y}_j(t) \equiv (1 + \tilde{t}_{jk}r(t))\bar{k}_j(t) + \tilde{t}_{jw}H^{mj}(t)T_0w_j(t).$$

Substituting (8) into (6) produces:

$$\tau_{jc}c_j(t) + s_j(t) + \bar{p}_j(t)T_{je}(t) = \bar{y}_j(t), \tag{9}$$

where

$$\bar{p}_j(t) \equiv p_j(t) + \tilde{t}_{jw}H^{mj}(t)w_j(t).$$

The right-hand side of (9) means the "potential" income that the household gets when the household spends all the available time on work. The left-hand side is the sum of the total cost of consumption, saving and opportunity cost of education. Following Zhang (2015), we specify the representative household's utility function as follows:

$$U_j(t) = c_j^{\xi_{0j}(t)} s_j^{\lambda_{0j}(t)} T_e^{\eta_{0j}(t)}, \tag{10}$$

where ξ_{0j} is called the propensity to consume, λ_{0j} the propensity to own wealth, and η_{0j} the propensity to receive education. The household takes account of future by his preference. It is possible to make the propensities (which are assumed to be constant in this study to be endogenous in my framework (Zhang, 2005, 2020).

2.5. Optimal decision

The household maximizes $U_j(t)$ subject to (9). The first-order conditions imply:

$$c_j(t) = \xi_j \bar{y}_j(t), \;\; s_j(t) = \lambda_j \bar{y}_j(t), \;\; \bar{p}_j(t) T_{je}(t) = \eta_j \bar{y}_j(t), \tag{11}$$

where

$$\xi_j \equiv \frac{\rho_j \xi_{j0}}{\tilde{\tau}_{jc}}, \;\; \lambda_j \equiv \rho_j \lambda_{j0}, \;\; \eta_j \equiv \rho_j \eta_{j0}, \;\; \rho_j = \frac{1}{\xi_{j0} + \lambda_{j0} + \eta_{j0}}.$$

2.6. Wealth accumulation

The change in wealth is saving minus dissaving. The definitions of $\bar{k}_j(t)$ and $s_j(t)$ imply:

$$\bar{k}_j(t) = s_j(t) - \bar{k}_j(t). \tag{12}$$

2.7 The education sector

As in Zhang (2015), we assume that education is perfectly competitive. The student in country j pays the education fee $p_j(t)$ per unit of time. The education sector use capital input, labor input and knowledge to supply education service. The production functions $F_{je}(t)$ of the education sectors are taken on the following form:

$$F_{je}(t) = A_{je} Z^{m_{je}}(t) K_{je}^{\alpha_{je}}(t) N_{je}^{\beta_{je}}(t), \;\; m_{je} \geq 0, \;\; \alpha_{je}, \beta_{je} > 0, \;\; \alpha_{je} + \beta_{je} = 1, \tag{13}$$

where A_{je}, α_{je} and β_{je} are positive parameters. There are some studies on production functions of human capital (e.g., Attanasio et al., 2009). The parameter m_{je} is the efficiency of knowledge utilization by country j's education sector. The education sector pays teachers and

capital with market rates. The total cost of the education sector is $w_j(t)N_{je}(t) + (r(t) + \delta_{jk})K_{je}(t)$. The marginal conditions imply:

$$r_j(t) + \delta_{jk} = \frac{\alpha_{je} p_j(t) F_{je}(t)}{F_{je}(t)}, \quad w_j(t) = \frac{\beta_{je} p_j(t) F_{je}(t)}{N_{je}(t)}. \tag{14}$$

2.8. Accumulation of human capital

We follow Uzawa (1965) in modelling human capital accumulation. We apply a generalized Uzawa's human capital accumulation as follows

$$\dot{H}_j(t) = \frac{\upsilon_{je} Z^{m_{jh}}(t)(F_{je}(t)/T_{je}(t)\bar{N}_j)^{a_{je}} (H^{m_j}(t)T_{je}(t))^{b_{je}}}{H^{\pi_{je}}(t)} - \delta_{jh} H_j(t), \tag{15}$$

where $\delta_{jh} (> 0)$ is the depreciation rate of human capital in country j, υ_{je}, m_{jh}, a_{je}, and b_{je} are non-negative parameters. The sign of π_{je} may be negative or positive. The equation implies that human capital rises in education service per unit time, $F_{je}(t)/T_{je}(t)\bar{N}_j$, and in the (qualified) total study time, $(H^{m_j}(t)T_{je}(t))^{b_{je}}$. The term $1/H^{\pi_{je}}$ implies that learning through education may exhibit increasing returns to scale in the case of $\pi_{je} < 0$ or decreasing returns to scale in the case of $\pi_{je} > 0$. The household decides the investment in education which is dependent on wages, and wages are related to human capital. Hence, investment in education is determined by the current human capital and (exogenous) preference for receiving education. Equation (15) moves human capital and thus affects wage rate.

2.9. Knowledge creation

This study assumes that knowledge growth is through research. We assume that knowledge stock rises in the past knowledge stock, labor input and capital input. As in Zhang (1992), knowledge changes according to the following equation:

$$\dot{Z}(t) = \sum_{j=1}^{J} \upsilon_{jr} Z^{m_{jr}}(t) K_{jr}^{\alpha_{0jr}}(t) N_{jr}^{\beta_{0jr}}(t) - \delta_z Z(t), \tag{16}$$

in which δ_z (≥ 0) is the depreciation rate of knowledge, and α_{0jr} and β_{0jr} are positive parameters. Diebolt and Hippe (2019) make an empirical study on long-run interdependence between regional human capital, innovation, and regional economic development. Using the data from the 19th and 20th century, they show that past regional human capital is an important determinant for regional disparities in innovation and economic development. It should be noted that Capolupo (2009) provide some empirical evidence on new growth theory.

2.10. The optimal research with the government budget

The governments are sole financial supporters of the research sectors. The governments collect taxes to support their own research sectors. Country *j's* government receives the following tax income $Y_{jp}(t)$:

$$Y_{jp}(t) = \tau_j F_j(t) + \tau_{jc} c_j(t)\bar{N}_j + \tau_{jk} r(t)\bar{k}_j(t)\bar{N}_j + \tau_{jw} H_j^{m_j}(t) T_0 \bar{N}_j w_j(t). \tag{17}$$

The budget constraint for the research sector is:

$$(r(t) + \delta_{jk})K_{jr}(t) + w_j(t)N_{jr}(t) = Y_{jp}(t). \tag{18}$$

The total capital cost for the research sector is $(r(t) + \delta_{jk})K_{jr}(t)$ and the total labor cost is $w_j(t)N_{jr}(t)$. The government spends the total budget on supporting research in such a way that the total research output $v_{jr} Z^{m_{jr}}(t) K_{jr}^{\alpha_{0jr}}(t) N_{jr}^{\beta_{0jr}}(t)$ be maximized. The research sector is effective in the sense that it maximizes research output subject to its budget. The problem is as follows:

$$Max \;\; v_{jr} Z^{m_{jr}}(t) K_{jr}^{\alpha_{0jr}}(t) N_{jr}^{\beta_{0jr}}(t),$$

subject to (18). The marginal conditions imply:

$$(r(t) + \delta_{jk})K_{jr}(t) = \alpha_{jr} Y_{jp}(t), \;\; w_j(t)N_{jr}(t) = \beta_{jr} Y_{jp}(t), \tag{19}$$

where

$$\alpha_{jr} \equiv \frac{\alpha_{0jr}}{\alpha_{0jr} + \beta_{0jr}}, \; \beta_{jr} \equiv \frac{\alpha_{0jr}}{\alpha_{0jr} + \beta_{0jr}}.$$

2.11. Demand and supply in national education market

The total demand for education service in country j is $T_{je}(t)\bar{N}$. The demand and supply for education balances at any point in time:

$$T_{je}(t)\bar{N} = F_{je}(t). \tag{20}$$

2.12. Full employment of national labor and capital

The national physical capital $K_j(t)$ and national labor force $N_j(t)$ are fully employed by the three sectors:

$$K_j(t) + K_{je}(t) + K_{jr}(t) = K_j(t), \;\; N_{ji}(t) + N_{je}(t) + N_{jr}(t) = N_j(t). \tag{21}$$

2.13. Global physical capital being fully employed

The global physical capital $K(t)$ is the sum of capital stocks employed by all the national economies. We thus have:

$$\sum_{j=1}^{J} K_j(t) = K(t). \tag{22}$$

2.14. Wealth is owned by households

Nation j's value of wealth $\bar{K}_j(t)$ is the sum of its people's value of wealth:

$$\bar{K}_j(t) = \bar{k}_j(t)\bar{N}_j \tag{23}$$

2.15. Global wealth equals the sum of national wealth

$$\sum_{j=1}^{J} \bar{K}_j(t) = K(t). \tag{24}$$

We constructed a dynamic general equilibrium model with endogenous wealth, human capital and knowledge for a global economy which is composed of any number of national economies. Markets are perfectly competitive. The model is built on the basis of some main ideas in economic growth theory. Structurally it includes some models as special cases. For instance, if we fix human capital and knowledge and national economies are identical, our model is structurally similar to the neoclassical growth models by Solow (1956), Uzawa (1961). Our model is similar to the Uzawa-Lucas model if we fix knowledge and assume identical national economies (Uzawa, 1965; Lucas, 1988). If human capital is fixed, it is by the Zhang's model of knowledge growth with research (Zhang, 1993). If human capital and knowledge are fixed, our model is similar to the Oniki-Uzawa model.

3. Global economic dynamics

We first show that in general case the dynamics of the world economy can be expressed by a $2J + 1$ dimensional differential equations system. We introduce a new variable $z_1(t)$:

$$z_1(t) \equiv \frac{r(t) + \delta_{1k}}{w_1(t)}, \quad (H_j(t)) \equiv (H_1(t), \ldots, H_J(t)), \quad \{\bar{k}_j(t)\} \equiv (\bar{k}_1(t), \ldots, \bar{k}_J(t)).$$

3.1. Lemma

The dynamics of the world economy is governed by the following $2J + 1$ differential equations with $z_1(t)$, $Z(t)$, $(H_j(t))$ and $\{\bar{k}_j(t)\}$ as the variables:

$$\begin{aligned}
&\dot{z}_1(t) = \Omega_z(z_1(t), Z(t), (H_j(t)), \{\bar{k}_j(t)\}) \\
&\dot{\bar{k}}_j(t) = \Omega_{jk}(z_1(t), Z(t), (H_j(t)), \{\bar{k}_j(t)\}), \ j = 2,,J, \\
&\dot{H}_j(t) = \Omega_{jH}(z_1(t), Z(t), (H_j(t)), \{\bar{k}_j(t)\}), \ j = 1,,J, \\
&\dot{Z}(t) = \Omega_z(z_1(t), Z(t), (H_j(t)), \{\bar{k}_j(t)\}),
\end{aligned} \tag{25}$$

in which functions $\Omega_{jx}(t)$ are uniquely determined by variables $z_1(t)$, $Z(t)$, $\{\bar{k}_j(t)\}$ and $(H_j(t))$, as shown in the Appendix. For any given solution $z_1(t)$, $Z(t)$, $\{\bar{k}_j(t)\}$ all the other variables are uniquely determined by the following procedure: $r(t)$ by (A2) $\rightarrow z_j(t)$ by (A7) $\rightarrow w_j(t)$ by (A4) $\rightarrow p_j(t)$ by (A5) $\rightarrow \bar{k}_1(t)$ by (A19) $\rightarrow k_j(t)$ by (A16) $\rightarrow N_j(t)$ by (A15) $\rightarrow N_{je}(t)$ by (A13) $\rightarrow N_{ji}(t)$ by (A12) $\rightarrow N_{jr}(t)$ by (A11) $\rightarrow K_{jm}(t)$, $m = i, s, r$, by (A1) $F_{je}(t)$ by (13) $\rightarrow \tilde{y}_j(t)$ by (8) $\rightarrow c_j(t)$, $s_j(t)$, $T_{je}(t)$ by (11) $\rightarrow T_j(t) = T_0 - T_{je}(t) \rightarrow F_j(t)$ by (A13).

We found the dynamic equations for following movement of the global economy. The system is nonlinear and contains many equations. It is difficult to provide general analytical solutions. Nevertheless, we can follow the movement with proper initial conditions. We simulate the model to illustrate the properties of the dynamic system. We choose $T_0 = 1$ and $\delta z = 0.02$. We specify the other parameters as follows:

$$\begin{pmatrix}\bar{N}_1\\ \bar{N}_2\\ \bar{N}_3\end{pmatrix}=\begin{pmatrix}5\\ 30\\ 50\end{pmatrix},\ \begin{pmatrix}A_{1i}\\ A_{2i}\\ A_{3i}\end{pmatrix}=\begin{pmatrix}1\\ 0.9\\ 0.8\end{pmatrix},\ \begin{pmatrix}A_{1e}\\ A_{2e}\\ A_{3e}\end{pmatrix}=\begin{pmatrix}1.1\\ 1\\ 0.9\end{pmatrix},\ \begin{pmatrix}m_1\\ m_2\\ m_3\end{pmatrix}=\begin{pmatrix}0.45\\ 0.4\\ 0.35\end{pmatrix},$$

$$\begin{pmatrix}m_{1i}\\ m_{2i}\\ m_{3i}\end{pmatrix}=\begin{pmatrix}0.45\\ 0.35\\ 0.3\end{pmatrix},\ \begin{pmatrix}\alpha_{1i}\\ \alpha_{2i}\\ \alpha_{3i}\end{pmatrix}=\begin{pmatrix}0.3\\ 0.29\\ 0.28\end{pmatrix},\ \begin{pmatrix}\alpha_{1e}\\ \alpha_{2e}\\ \alpha_{3e}\end{pmatrix}=\begin{pmatrix}0.33\\ 0.35\\ 0.33\end{pmatrix},\ \begin{pmatrix}\alpha_{1r}\\ \alpha_{2r}\\ \alpha_{3r}\end{pmatrix}=\begin{pmatrix}0.3\\ 0.2\\ 0.16\end{pmatrix},$$

$$\begin{pmatrix}\beta_{1r}\\ \beta_{2r}\\ \beta_{3r}\end{pmatrix}=\begin{pmatrix}0.4\\ 0.3\\ 0.26\end{pmatrix},\ \begin{pmatrix}\xi_{10}\\ \xi_{20}\\ \xi_{30}\end{pmatrix}=\begin{pmatrix}0.1\\ 0.1\\ 0.1\end{pmatrix},\ \begin{pmatrix}\lambda_{10}\\ \lambda_{20}\\ \lambda_{30}\end{pmatrix}=\begin{pmatrix}0.5\\ 0.5\\ 0.5\end{pmatrix},\ \begin{pmatrix}\eta_{10}\\ \eta_{20}\\ \eta_{30}\end{pmatrix}=\begin{pmatrix}0.015\\ 0.01\\ 0.007\end{pmatrix},$$

$$\begin{pmatrix}\tau_1\\ \tau_2\\ \tau_3\end{pmatrix}=\begin{pmatrix}0.03\\ 0.02\\ 0.02\end{pmatrix},\ \begin{pmatrix}\tau_{1k}\\ \tau_{2k}\\ \tau_{3k}\end{pmatrix}=\begin{pmatrix}0.02\\ 0.01\\ 0.01\end{pmatrix},\ \begin{pmatrix}\tau_{1w}\\ \tau_{2w}\\ \tau_{3w}\end{pmatrix}=\begin{pmatrix}0.02\\ 0.01\\ 0.01\end{pmatrix},\ \begin{pmatrix}\tau_{1c}\\ \tau_{2c}\\ \tau_{3c}\end{pmatrix}=\begin{pmatrix}0.03\\ 0.03\\ 0.03\end{pmatrix},$$

$$\begin{pmatrix}m_{1r}\\ m_{2r}\\ m_{3r}\end{pmatrix}=\begin{pmatrix}0.15\\ 0.1\\ 0.08\end{pmatrix},\ \begin{pmatrix}v_{1r}\\ v_{2r}\\ v_{3r}\end{pmatrix}=\begin{pmatrix}0.55\\ 0.5\\ 0.45\end{pmatrix},\ \begin{pmatrix}m_{1e}\\ m_{2e}\\ m_{3e}\end{pmatrix}=\begin{pmatrix}0.25\\ 0.2\\ 0.15\end{pmatrix},\ \begin{pmatrix}v_{1e}\\ v_{2e}\\ v_{3e}\end{pmatrix}=\begin{pmatrix}0.45\\ 0.4\\ 0.35\end{pmatrix},$$

$$\begin{pmatrix}a_{1e}\\ a_{2e}\\ a_{3e}\end{pmatrix}=\begin{pmatrix}0.25\\ 0.2\\ 0.15\end{pmatrix},\ \begin{pmatrix}b_{1e}\\ b_{2e}\\ b_{3e}\end{pmatrix}=\begin{pmatrix}0.45\\ 0.4\\ 0.35\end{pmatrix},\ \begin{pmatrix}\pi_{1e}\\ \pi_{2e}\\ \pi_{3e}\end{pmatrix}=\begin{pmatrix}0.35\\ 0.4\\ 0.35\end{pmatrix},\ \begin{pmatrix}\delta_{1k}\\ \delta_{2k}\\ \delta_{3k}\end{pmatrix}=\begin{pmatrix}0.04\\ 0.05\\ 0.055\end{pmatrix},$$

$$\begin{pmatrix}\delta_{1h}\\ \delta_{2h}\\ \delta_{3h}\end{pmatrix}=\begin{pmatrix}0.06\\ 0.06\\ 0.07\end{pmatrix}. \tag{26}$$

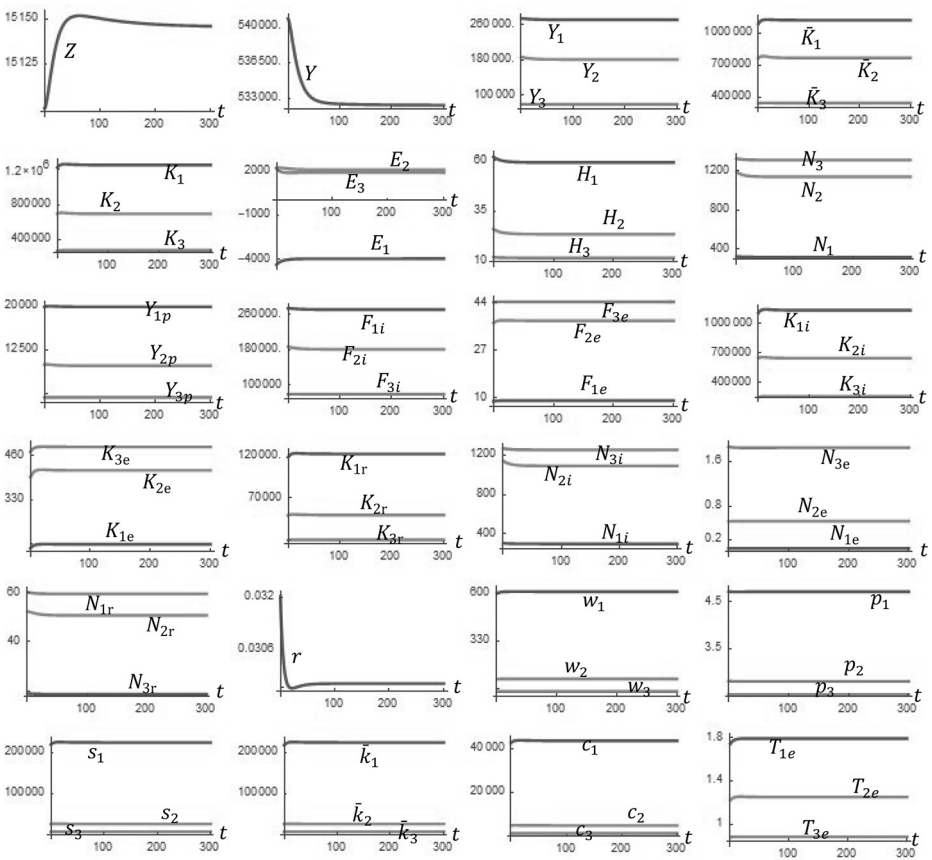
Country 1, 2 and 3's populations are respectively 5, 30, and 50. Country 1 has the smallest. Country 1, 2 and 3's total factor productivities of the production and education sectors rank from high to low. Country 1, 2 and 3's efficiencies of applying human capital m_j are respectively 0.45, 0.4 and 0.45. Country 1 applies human capital mostly effectively; country 2 next and country 3 lest effectively. We specify the values of the parameters a_{ji} in the Cobb-Douglas productions approximately equal to 0.3. The tax rates are fixed lowly from 1 percent to 3 percent. Depreciation rates of physical capital and human capital vary between countries and between 4 percent and 7 percent. The returns to scale parameters in research are all positive, which implies that knowledge accumulation exhibits decreasing returns to scale. We plot the motion of the system with the following initial conditions:

$z_1(0) = 0.0001,\ H_1(0) = 62,\ H_2(0) = 26,\ H_2(0) = 12,\ \bar{k}_2(0) = 25500,\ \bar{k}_3(0) = 15100,$
$Z(0) = 15100.$

It should be noted that the choice can be at any point. The choice has no impact on the stability of the equilibrium. The system starts not far from its long-term equilibrium and approaches to its equilibrium in the long term. Before the system approaches its

equilibrium point, the global wealth and knowledge stock rises and then falls. The global income falls over time. As the system starts not far from the equilibrium point, most the variables change slightly over time.

Figure 1: The motion of the global economy



In Figure 1, the national output of country j is given by $Y_j(t) = F_j(t) + p_j(t)F_{je}(t)$. Our results provide some insights into issues related to convergence. As economic theory lacks a proper analytical framework to discuss global economic growth, discussions about income convergence are often based on results from analyzing growth models developed for closed economies. A well-mentioned insight from the well-known Solow model is that convergence in income levels between closed countries is achieved by faster accumulation of physical capital in poorer countries. As shown in Figure 1, different countries will not experience convergence in per capita income, consumption and wealth in the long term as they are

different in preferences and total productivities. In another well-accepted approach is by Tamura (1991, pp. 522-523) who concludes that: "Income convergence arises from human capital convergence … Individuals with below-average human capital agents gain disproportionately by the external effect compared with above-average human capital agents. … Convergence arises because below–average human capital agents gain the most from learning". Tamura's approach neglects depreciation of human capital. Accordingly, it is possible for a below-average human capital agent catches up in the long term as the above-average human capital agents will slow down human capital accumulation. It is straightforward to confirm that the dynamic system has an equilibrium point as follows:

$$\begin{pmatrix} Z \\ K \\ r \end{pmatrix} = \begin{pmatrix} 15146 \\ 2.23 \\ 0.0397 \end{pmatrix}, \quad \begin{pmatrix} Y_1 \\ Y_2 \\ Y_3 \end{pmatrix} = \begin{pmatrix} 270838 \\ 181366 \\ 80034 \end{pmatrix}, \quad \begin{pmatrix} E_1 \\ E_2 \\ E_3 \end{pmatrix} = \begin{pmatrix} -3968 \\ 2077 \\ 1891 \end{pmatrix}, \quad \begin{pmatrix} H_1 \\ H_2 \\ H_3 \end{pmatrix} = \begin{pmatrix} 59.2 \\ 23.5 \\ 11.6 \end{pmatrix},$$

$$\begin{pmatrix} N_1 \\ N_2 \\ N_3 \end{pmatrix} = \begin{pmatrix} 320.3 \\ 1139 \\ 12111 \end{pmatrix}, \quad \begin{pmatrix} Y_{1p} \\ Y_{2p} \\ Y_{3p} \end{pmatrix} = \begin{pmatrix} 19908 \\ 9789 \\ 4334 \end{pmatrix}, \quad \begin{pmatrix} K_1 \\ K_2 \\ K_3 \end{pmatrix} = \begin{pmatrix} 1.25x10^6 \\ 695915 \\ 278852 \end{pmatrix}, \quad \begin{pmatrix} \overline{K}_1 \\ \overline{K}_2 \\ \overline{K}_3 \end{pmatrix} = \begin{pmatrix} 1.12x10^6 \\ 765837 \\ 342534 \end{pmatrix},$$

$$\begin{pmatrix} F_{1i} \\ F_{2i} \\ F_{3i} \end{pmatrix} = \begin{pmatrix} 270896 \\ 181271 \\ 79910 \end{pmatrix}, \quad \begin{pmatrix} F_{1e} \\ F_{2e} \\ F_{3e} \end{pmatrix} = \begin{pmatrix} 8.05 \\ 37.5 \\ 44.3 \end{pmatrix}, \quad \begin{pmatrix} N_{1i} \\ N_{2i} \\ N_{3i} \end{pmatrix} = \begin{pmatrix} 302 \\ 1088 \\ 1250 \end{pmatrix}, \quad \begin{pmatrix} N_{1e} \\ N_{2e} \\ N_{3e} \end{pmatrix} = \begin{pmatrix} 0.05 \\ 0.54 \\ 1.85 \end{pmatrix},$$

$$\begin{pmatrix} N_{1r} \\ N_{2r} \\ N_{3r} \end{pmatrix} = \begin{pmatrix} 18.7 \\ 50.7 \\ 59.5 \end{pmatrix}, \quad \begin{pmatrix} K_{1i} \\ K_{2i} \\ K_{3i} \end{pmatrix} = \begin{pmatrix} 1.13x10^6 \\ 646373 \\ 258874 \end{pmatrix}, \quad \begin{pmatrix} K_{1e} \\ K_{2e} \\ K_{3e} \end{pmatrix} = \begin{pmatrix} 199.7 \\ 416.4 \\ 485.2 \end{pmatrix}, \quad \begin{pmatrix} K_{1r} \\ K_{2r} \\ K_{3r} \end{pmatrix} = \begin{pmatrix} 122406 \\ 49125 \\ 19492 \end{pmatrix},$$

$$\begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} = \begin{pmatrix} 609.8 \\ 116 \\ 45 \end{pmatrix}, \quad \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix} = \begin{pmatrix} 4.71 \\ 2{,}53 \\ 2.81 \end{pmatrix}, \quad \begin{pmatrix} \bar{k}_1 \\ \bar{k}_2 \\ \bar{k}_3 \end{pmatrix} = \begin{pmatrix} 223994 \\ 25528 \\ 6851 \end{pmatrix}, \quad \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix} = \begin{pmatrix} 43494 \\ 4957 \\ 1330 \end{pmatrix},$$

$$\begin{pmatrix} T_{1e} \\ T_{2e} \\ T_{3e} \end{pmatrix} = \begin{pmatrix} 1.79 \\ 1.25 \\ 0.89 \end{pmatrix}. \tag{27}$$

It is straightforward to calculate the seven eigenvalues at the equilibrium point as follows

$-0.173, -0.169 \pm 0.001, -0.079, -0.07, -0.065, -0.012.$

We see that the equilibrium is locally stable. This implies that if we start with different initial states not far away from the equilibrium point, the system approaches to the equilibrium point in the long term.

4. Comparative dynamic analysis

The previous sector plotted the movement of the global economy. It is important to ask questions such as how changes in one country's conditions will affect the global economy and different countries. This section conducts comparative dynamic analysis.

4.1. A rise in country 1's creativity

First, we study how the global economy is affected if country 1's creativity rises in the following way: v_i: 0.55 to 0.58. The rise of creativity augments the knowledge stock which is freely available to all the economies. The global wealth and income are enhanced. The national incomes of, national wealth of, capital stocks employed by the three national economies are all enhanced. Country 1's trade balance is deteriorated and the other two national economies' trade balances are improved. The human capital levels, labor forces and government's tax incomes are all increased. The three sectors expand in the long term. The rate of interest and wage rates rise. The households spend on consumption and have more wealth. We conclude that the global economy and the national economies benefit from the rise of creativity.

4.2. A rise in country 1's efficiency of applying human capital

We now examine how the global economy is affected if country 1's efficiency of applying human capital is enhanced in the following way: m_1: 0.45 to 0.47. The rise of creativity augments the knowledge stock which is freely available to all the economies. The global wealth and income are enhanced. The national incomes of, national wealth of, capital stocks employed by the three national economies are all enhanced. Country 1's trade balance deteriorates, and the other two national economies' trade balances are improved. The human capital levels, labor forces and government's tax incomes are all increased. The three sectors expand in the long term. The rate of interest and wage rates rise. The households spend on consumption and have more wealth. We conclude that the global economy and the national economies benefit from the rise of creativity. We see that the change directions of the variables due to the rise in efficiency of applying human capital are the same as those due to the rise in creativity. The main difference is that the change in the creativity enlarge

the gaps of income and wealth between country 1 and the other two countries more than the rise in the efficiency of applying human capital.

4.3. A rise in country 1's tax rate on its production sector

We now study how the global economy is affected if country 1's tax rate on the production sector's output is increased as follows: τ_i: 0.03 to 0.035. The rise of the tax rate increases the research sector's expenditure. The knowledge stock rises due to more research carried out by country 1. The other two economies also spend mote tax income on research. The global wealth and income are enhanced. The national incomes of, national wealth of, capital stocks employed by the three national economies are all enhanced. Country 1's trade balance is improved initially and deteriorated in the long term. The other two national economies' trade balances are deteriorated initially and improved in the long term. The human capital levels, labor forces and government's tax incomes are all increased in the long term. The three sectors expand in the long term. The rate of interest falls initially and rises in the long term. Wage rates rise in the long term. The households spend on consumption and have more wealth in the long term.

4.4. A rise in country 1's propensity to receive education

Different countries and cultures exhibit different propensities to receive education. For instance, China might sustain economic development mainly due to Chinese culture's emphasis on education and due to huge modern knowledge stock mainly created in Western cultural environment. It is reasonable to argue that China's fast growth in the last three decades is due to its high propensity to save, high propensity to receive education and easy access to global markets. We now provide some general insights into possible impact of the propensity to receive education on national as well as global economic growth. We now study what happen to the global economy if country 1's household increases the propensity to receive education as follows: η_{01}: 0.015 to 0.016. Country 1's representative household spends more hours on education, while the education time are slightly affected. Country 1's human capital is enhanced, while the other two economies' human capital are slightly affected. The knowledge stock, global wealth and global output fall initially and rise in the long term. Country 1's trade balance is deteriorated and the other two national economies' trade balances are improved. The households in all the economies spend more and have more wealth in the long term. It should be noted that the rise in country 1's propensity to receive education bring benefits to all economies mainly because the country has high creativity in knowledge. A high propensity to receive education brings about higher human capital which will leads to higher tax income in the long term. Higher tax income expands the research sector, which results in increases in knowledge. The increase in knowledge stock enables every economy to benefit.

4.5. A rise in country 1's propensity to save

We now study what happen to the global economy if country 1's household increases the propensity to save as follows: λ_{01}: 0.5 to 0.51. The global wealth and income are augmented. The national incomes of, national wealth of, capital stocks employed by the three national economies are all enhanced. Country 1's trade balance is improved and the other two national economies' trade balances are deteriorated. Country 1's human capital is enhanced and the other two countries' human capital levels are lowered. The labor forces and government's tax incomes are all increased in the long term. The economic structural changes are illustrated in the figure. The rate of interest falls. The wage rates rise. The households spend on consumption and have more wealth in the long term.

4.6. A rise in country 3's population

There are different opinions about relations between population and economic growth. In the literature of theoretical economic growth with endogenous human capital there are situation-dependent interactions between population and economic growth. We now examine effects of population growth on the world and national economies. We increase country 3's population as follows: $\tilde{N}_3$: 50 to 52. In this knowledge-based economy the rise in the population augment countries 1's and 2's per household wealth and consumption. Although countries 3's per household wealth and consumption fall, the variables rise in the long term. The personal education hours of the three economies fall. The global wealth, global income and knowledge are all increased. Country 3's trade balance is improved. The other two economies' trade balances are deteriorated. Country 3's macroeconomic variables are increased.

5. Conclusions

This paper built a global growth model with endogenous saving, human capital and knowledge. It deals with the effects of national differences in the propensities to save and to receive education, and creativities and knowledge utilization efficiencies in human capital and knowledge on the global economic growth and national income and wealth distributions. It synthesized the Solow growth model, the Uzawa-Lucas two-sector growth model, the Oniki-Uzawa trade model, and Zhang's trade model with research. Knowledge, human capital, and wealth are endogenously determined according to different economic mechanisms. After building the multi-country model, we showed that the dynamics of the world economy is described differential equations. We simulated the movement of the global economy with three economies. We also conducted comparative dynamic analysis to show how changes in national characteristics as propensities to save wealth, propensities to receive education, efficiency of applying human capital, and creativities shift dynamic paths of the global and national economic development.

APPENDIX: PROVING THE LEMMA

By (3), (14) and (19) we obtain:

$$z_j \equiv \frac{r + \delta_{jk}}{w_j} = \frac{N_{jm}}{\beta_{jm} K_{jm}}, \ j = 1, J, \ m = i, s, e, \tag{A1}$$

where

$$\beta_{jm} \equiv \frac{\beta_{jm}}{\alpha_{jm}}, \ m = i, e, r.$$

From (A1) and (4), we obtain:

$$r(Z, z_j) = \alpha_j Z^{m_{ji}} z_j^{\beta_{ji}} - \delta_{jk}, \ j = 1, \ldots, J, \tag{A2}$$

where $\alpha_j \equiv \alpha_{ji} \tau_j A_{ji}^{\beta_{ji}}$. From (A2) we have:

$$z_j(Z, z_1) = \left(\frac{\alpha_1 Z^{m_{1i}} z_1^{\beta_{1i}} - \delta_{1k} + \delta_{jk}}{\alpha_j Z^{m_{ji}}} \right)^{1/\beta_{ji}}, \ j = 2, \ldots, J. \tag{A3}$$

Equations (A1) imply

$$w_j(Z, z_1) = \frac{r + \delta_{jk}}{z_j}, \tag{A4}$$

From (6) we have:

$$p_j = \frac{\beta_{je}^{\alpha_{je}} w_j z_j^{\alpha_{je}}}{\beta_{je} A_{je} Z^{m_{je}}}.$$

From (A1) and (2), we have:

$$\frac{N_{ji}}{\beta_{ji}} + \frac{N_{je}}{\beta_{je}} + \frac{N_{jr}}{\beta_{jr}} = z_j K_j, \ N_{ji} + N_{je} + N_{jr} = N_j. \tag{A6}$$

From (14), we have:

$$F_{je} = \frac{w_j N_{je}}{\beta_{je} p_j}. \tag{A7}$$

Insert (11) and (A7) in (20)

$$N_{je} = n_{j0} - n_{j1} N_j, \tag{A8}$$

where we use (1), (7), and

$$n_{j0}(H_j, z_j, Z) \equiv \frac{\beta_{je} p_j T_0 \bar{N}_j}{w_j}, \quad n_{j1}(H_j, z_j, Z) \equiv \frac{\beta_{je} p_j}{w_j H^{m_j}}.$$

From (2) and (A1) we have:

$$F_j = \frac{A_{ji} N_{ji} Z^{m_{ji}}}{\beta_{je}^{\alpha_{ji}} z_j^{\alpha_{ji}}}. \tag{A9}$$

From (8) and (11) we have:

$$c_j = (1 + \bar{t}_{jk} r)\xi_j \bar{k}_j + \bar{t}_{jw} \xi_j H_j^{m_j} T_0 w_j. \tag{A10}$$

From (17) and (19), we have:

$$N_{jr} = w_{j0} + w_{j1} \bar{k}_j + w_{j2} N_{ji}, \tag{A11}$$

where we apply (A9) and (A10) and

$$w_{j0} \equiv (\bar{t}_{jw} \tau_{jc} \xi_j + \tau_{jw}) \bar{N}_j \beta_{jr} H_j^{m_j} T_0, \quad w_{j1} \equiv \left((1 + \bar{t}_{jk} r)\tau_{jc} \xi_j + \tau_{jk} r\right) \frac{\beta_{jr} \bar{N}_j}{w_j}$$

$$w_{j2} \equiv \frac{\beta_{jr}}{w_j} \frac{\tau_j A_{ji} Z^{m_{ji}}}{\beta_{ji}^{\alpha_{ji}} z_j^{\alpha_{ji}}}.$$

Insert (A11) in (A5)

$$N_{ji} + \frac{N_{je}}{w_{j3} \beta_{je}} + \frac{w_{j0} + w_{j1} \bar{k}_j}{w_{j3} \beta_{jr}} + \frac{z_j K_j}{w_{j3}}, \quad (1 + w_{j2}) N_{ji} + N_{je} + w_{j0} + w_{j1} \bar{k}_j = N_j, \tag{A12}$$

where

$$w_{j3} \equiv \frac{N_{ji}}{\beta_{ji}} + \frac{w_{j2}}{\beta_{jr}}.$$

From (A12)

$$\tilde{\omega}_{j0}K_j - \frac{(1 + w_{j2})w_{j0} + (1 + w_{j2})w_{j1}\bar{k}_j}{w_{j3}\beta_{jr}} + \tilde{\omega}_j N_{je} + w_{j0} + w_{j1}\bar{k}_j = N_j, \tag{A13}$$

where

$$\tilde{\omega}_{j0} \equiv \frac{(1 + w_{j2})z_j}{w_{j3}}, \quad \tilde{\omega}_j \equiv 1 - \frac{(1 + w_{j2})}{w_{j3}\beta_{je}}$$

Insert (A8) in (A13)

$$\tilde{\omega}_{j0}K_j - \frac{(1 + w_{j2})w_{j0} + (1 + w_{j2})w_{j1}\bar{k}_j}{w_{j3}\beta_{jr}} + \tilde{\omega}_j n_{j0} + w_{j0} + w_{j1}\bar{k}_j = (1 + \tilde{\omega}_j n_{j1})N_j. \tag{A14}$$

From (8) and (11) we have:

$$N_j = \bar{n}_{j0} - \bar{n}_{j1}\bar{k}_j, \tag{A15}$$

where we use (7) and

$$\bar{n}_{j0} \equiv \left(1 - \frac{\tau_{jw}\eta_j H_j^{m_j} w_j}{\bar{p}_j}\right) T_0 \bar{N}_j H_j^{mj}, \quad \bar{n}_{j1} \equiv \frac{(1 + \tau_{jk}r)\eta_j \bar{N}_j H_j^{m_j}}{\bar{p}_j}.$$

Insert (A15) in (A14):

$$K_j = m_{j0} + m_{j1}\bar{k}_j, \tag{A16}$$

where

$$m_{j0} \equiv \left[(1 + w_j n_{j1})n_{j0} + \frac{(1 + w_{j2})w_{j0}}{w_{j3}\beta_{jr}} - w_j n_{j0} - w_{j0}\right]\frac{1}{w_{j0}},$$

$$m_{j1} \equiv \left[\frac{(1 + w_{j2})w_{j1}}{w_{j3}\beta_{jr}} - (1 + w_j n_{j1})n_{j1} - w_{j1}\right]\frac{1}{w_{j0}}.$$

Adding equations (16) yields

$$\sum_{j=1}^{J} K_j = m_0 + \sum_{j=1}^{J} m_{j1}\bar{k}_j, \tag{A17}$$

where

$$m_0 = \sum_{j=1}^{J} m_{j0}.$$

From (22)-(24) and (A17), we have

$$\sum_{j=1}^{J} \bar{k}_j \bar{N}_j = m_0 + \sum_{j=1}^{J} m_{j1}\bar{k}_j, \tag{A18}$$

Solve (A18):

$$\bar{k}_1(z_1, Z, (H_j), \{\bar{k}_j\}) = \left(m_0 - \sum_{j=2}^{J} (\bar{N}_j - m_{j1})\bar{k}_j \right)(\bar{N}_j - m_{j1})^{-1}. \tag{A19}$$

We determine all the variables as functions of z_1, Z, (H_j) and $\{\bar{k}_j\}$: r by (A2) $\rightarrow$ z_j by (A7) $\rightarrow$ w by (A4) $\rightarrow$ p by (A5) $\rightarrow$ $\bar{k}_1$ by (A19) $\rightarrow$ K_j by (A16) $\rightarrow$ N_j by (A15) $\rightarrow$ N_{je} by (A13) $\rightarrow$ N_{ji} by (A12) $\rightarrow$ N_{jr} by (A11) $\rightarrow$ K_{jm}, $m = i, s, r$, by (A1) $\rightarrow$ F_{je} by (13) $\rightarrow$ $\bar{y}_j$ by (8) $\rightarrow$ c_j, s_j, T_{je} by (11) $\rightarrow$ $T_j = T_0 - T_{je} \rightarrow F_j$ by (A13). From the procedure, (12), (15) and (16) we have

$$\bar{k}_1 = \Omega_0(z_1, Z, (H_j), \{\bar{k}_j\}), \tag{A20}$$

$$\bar{k}_j = \Omega_{jk}(z_1, Z, (H_j), \{\bar{k}_j\}),\ j = 2,,J,$$

$$\dot{H}_j = \Omega_{jH}(z_1, Z, (H_j), \{\bar{k}_j\}),\ j = 1,,J,$$

$$\dot{Z} = \Omega_z(z_1, Z, (H_j), \{\bar{k}_j\}). \tag{A21}$$

Taking derivatives of (A19) with respect to time yields:

$$\dot{\bar{k}}_1 = \frac{\partial \bar{k}_1}{\partial z_1}\dot{z}_1 + \sum_{j=1}^{J} \Omega_{jH} \frac{\partial \bar{k}_1}{\partial H_j} + \sum_{j=2}^{J} \Omega_{jk} \frac{\partial \bar{k}_1}{\partial \bar{k}_j} + \Omega_z \frac{\partial \bar{k}_1}{\partial Z}, \tag{A22}$$

where we use (A21). From (A20) and (A22) we solve:

$$\dot{z}_1 = \Omega_{1k}(z_1, Z, (H_j), \{\bar{k}_j\})$$

$$\equiv \left(\Omega_0 - \sum_{j=1}^{J} \Omega_{jH} \frac{\partial \bar{k}_1}{\partial H_j} - \sum_{j=2}^{J} \Omega_{jk} \frac{\partial \bar{k}_1}{\partial \bar{k}_j} + \Omega_z \frac{\partial \bar{k}_1}{\partial Z} \right) \left(\frac{\partial \bar{k}_1}{\partial z_1} \right)^{-1}. \tag{A23}$$

We thus checked the Lemma.

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How Quantitatively Important are the Shocks to the Time Endowment for Business Cycle Fluctuations? Lessons Learnt From Bulgaria (1999-2018)

Qual a Importância Quantitativa dos Choques na Dotação de Tempo para as Flutuações nos Ciclos Económicos? Lições da Bulgária no Período 1999-2018

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ABSTRACT
Shocks to time endowment are introduced into a real-business-cycle setup augmented with a detailed government sector. The model is calibrated to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). The quantitative importance of the presence of shocks to total time available to households is investigated for the magnitude of cyclical fluctuations in Bulgaria. Although hours worked became more volatile, and wages a bit smoother, the quantitative effect of such a shock is found to be small, and thus not very important for the propagation of business cycle fluctuations.
Keywords: Business cycles; time endowment shocks; Bulgaria.

JEL Classification*:* E24; E32.

1. Introduction and motivation

It is a well-known fact, e.g. Prescott (1986), that the aggregate fluctuations produced by the standard real-business-cycle (RBC) model are entirely driven by highly-persistent innovations to the total factor productivity part of the aggregate production functions (and labeled as "technological shocks"). One way to improve the standard RBC model is to add additional shocks. In this paper we will focus on a disturbance that affects the total time available to the representative household. Such a stochastic process will affect labor supply, which in interaction with the other major variables in the model, could produce interesting additional effects. This example is considered graphically only in Gillman (2010) as a shift of a stochastic labor supply curve. In this paper, we add value to the graphical analysis by performing a careful quantitative analysis using a micro-founded general-equilibrium model.

In the model setup in this paper, the shock to the time endowment could be interpreted in a similar fashion to a preference shock a la Bencivenga (1992). The process is also akin to a home-production technology shock (Benhabib et al. 1991), or some time-saving technology, which decreases cleaning time, or the time needed to prepare and cook food. Yet another interpretation is a cut to non-work hours, such as transportation or commuting costs incurred to reach the workplace. Alternatively, higher time endowment could be a result of a healthier lifestyle, which cuts out the time lost from taking smoking breaks, and potentially more sick days being taken. Finally, it might be a result of the new normal, and in particular "working from home" practice, where everything is available at one's fingertips, and there is no need to travel (and even to groom) to perform certain office tasks. We can go even further and speculate about demographic changes in the labor supply, like allowing individuals between 16-18 to work freely, or increasing the retirement age.

We do not aim to provide a detailed literature review here, as we will be staying agnostic regarding the true cause of the change in the time endowment; i.e, we are not going to explicitly model those in this paper, beyond the exogenous shock to time. Still, the major idea is taken seriously, and this paper incorporates shocks to the household's time endowment in an otherwise standard real-business-cycle (RBC) model with a detailed government sector. The model is calibrated for Bulgaria in the period 1999-2018, as Bulgaria provides an interesting testing case for the theory. The paper then proceeds to quantitatively evaluate the effect of such an additional stochastic process as a tool for business cycle transmission. This is the first study on the issue using modern macroeconomic modelling techniques, and thus an important contribution to the field. Unfortunately, despite making hours worked more volatile, and wages a bit smoother, he quantitative effect of such a shock is found to be small, and thus not very important cause behind the propagation of business cycle fluctuations in Bulgaria over the period 1999-2018.

The rest of the paper is organized as follows: Section 2 describes the model framework and describes the decentralized competitive equilibrium system, Section 3 discusses the calibration procedure, and Section 4 presents the steady-state model solution. Sections 5 proceeds with the out-of-steady-state dynamics of model variables, and compared the simulated second moments of theoretical variables against their empirical counterparts. Section 6 concludes the paper.

2. Model description

There is a representative household, which derives utility out of consumption and leisure. The time available to households can be spent in productive use or as leisure. The time endowment is subject to a stochastic shock. The government taxes consumption spending, levies a common proportional ("flat") tax on labor and capital income in order to finance wasteful purchases of government consumption goods, and government transfers. On the production side, there is a representative firm, which hires labor and capital to produce a homogeneous final good, which could be used for consumption, investment, or government purchases.

2.1. Households

There is a representative household, which maximizes its expected utility function

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \{ln c_t + \gamma \ln (n_t - h_t)\}, \quad (2.1)$$

where E_0 denotes household's expectations as of period 0, c_t denotes household's private consumption in period t, h_t are hours worked in period t, $0 < \beta < 1$ is the discount factor, $0 < \gamma < 1$ is the relative weight that the household attaches to leisure. The endowment, n_t will be assumed to be time-varying, and will take an average value of unity.

The household starts with an initial stock of physical capital $k_0 > 0$, and has to decide how much to add to it in the form of new investment. The law of motion for physical capital is

$$k_{t+1} = i_t + (1 - \delta)k_t \quad (2.2)$$

and $0 < \delta < 1$ is the depreciation rate. Next, the real interest rate is r_t, hence the before-tax capital income of the household in period t equals $r_t k_t$. In addition to capital income, the household can generate labor income. Hours supplied to the representative firm are rewarded at the hourly wage rate of w_t, so pre-tax labor income equals $w_t h_t$. Lastly, the household owns the firm in the economy and has a legal claim on all the firm's profit, π_t.

Next, the household's problem can be now simplified to

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \{ln c_t + \gamma \ln (n_t - h_t)\}, \quad (2.3)$$

s.t

$$(1 + \tau^c)c_t + k_{t+1} - (1 - \delta)k_t = (1 - \tau^y)[w_t h_t + r_t k_t + \pi_t] + g_t^t, \quad (2.4)$$

where $\{\tau^c, \tau^y\}$ are the ta rates on consumption and income, respectively, and g_t^t denotes government transfers. The household takes fiscal policy instruments as given, as well as the prices, and chooses consumption, capital and hours sequences that maximize its utility s.t the period budget constraint.

The first-order optimality conditions are as follows:

$$c_t: \frac{1}{c_t} = \lambda_t(1 + \tau^c) \tag{2.5}$$

$$h_t: \frac{y}{n_t - n_t} = \lambda_t(1 + \tau^y)w_t \tag{2.6}$$

$$k_{t+1}: \lambda_t = E_t\lambda_{t+1}[1 + (1 - \tau^y)r_{t+1} - \delta] \tag{2.7}$$

$$TVC: \lim_{t\to\infty} \beta^t y_t k_{t+1} = 0 \tag{2.8}$$

where λ_t is the Lagrangean multiplier attached to households budget constraint in period t. The interpretation of the fir st-order conditions above is as follows: the first one states that for each household, the marginal utility of consumption equals the marginal utility of wealth, corrected for the consumption tax rate. The second equation states that when choosing labor supply optimally, at the margin, each hour spent by the household working for the firm should balance the benefit from doing so in terms of additional income generates, and the cost measured in terms of lower utility of leisure. Note that this equation also captures the varying nature of the time endowment. The third equation is "the so-called "Euler condition," which describes how the household chooses to allocate physical capital over time. The last condition is called the "transversality condition" (TVC): it states that at the end of the horizon, the value of physical capital should be zero.

2.2. Firm problem

There is a representative firm in the economy, which produces a homogeneous final product, y_t. The price of output is normalized to unity. The production technology is Cobb-Douglas and uses both physical capital, k_t, and labor hours, h_t, to maximize static profit

$$\pi_t = A_t k_t^{\alpha} h_t^{1-\alpha} - r_t k_t - w_t h_t, \tag{2.9}$$

where A_t denotes the level of technology in period t. Since the firm rents the capital from households, the problem of the firm is a sequence of static profit maximizing problems. In equilibrium, there are no profits, and each input is priced according to its marginal product, i.e.:

$$k_t: \alpha \frac{y_t}{k_t} = r_t \tag{2.10}$$

$$h_t: (1 - \alpha) \frac{y_t}{h_t} = w_t \tag{2.11}$$

In equilibrium, given that the inputs of production are paid their marginal products,

$\pi t = 0, \forall t.$

2.3. Government

In the model setup, the government is levying taxes on labor and capital income, as well as consumption, in order to finance spending on wasteful government purchases, and government transfers. The government budget constraint is as follows:

$$g_t^c + g_t^t = \tau^c c_t + \tau^y [r_t k_t + w_t h_t + \pi_t] \quad (2.12)$$

In the model, consumption tax rate, income tax rate and government consumption-to-output ratio would be chosen to match the average share in data, while government transfers would be determined residually in each period so that the government budget is always balanced.

2.4. Dynamic competitive equilibrium (DCE)

For a given process followed by technology and time endowment $\{A_t, n_t\}_0^\infty$, tax schedules $\{\tau^c, \tau^y\}_0^\infty$ and initial capital stock $\{k_0\}$ the decentralized dynamic competitive equilibrium is a list of sequences $\{c_t, h_t, k_{t+1}\}_0^\infty$ for the household, a sequence of government purchases and transfers $\{g_t^c, g_t^t\}_0^\infty$, and input prices $\{w_t, r_t\}_0^\infty$ such that (i) the household maximizes its utility function subject to its budget constraint; (ii) the representative firm maximizes profit; (iii) government budget is balanced in each period; (iv) all markets clear.

3. Data and model calibration

To characterize business cycle fluctuations in Bulgaria, we will focus on the period following the introduction of the currency board (1999-2018). Quarterly data on output, consumption and investment was collected from National Statistical Institute (2020), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2020). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics: first, as in Vasilev (2016), the discount factor, $\beta = 0.982$, is set to match the steady-state capital-to-output ratio in Bulgaria, k/y = 13.964, in the steady-state Euler equation. The labor share parameter, $1 - \alpha = 0.571$, is obtained as in Vasilev (2017d), and equals the average value of labor income in aggregate output over the period 1999-2018. This value is slightly higher as compared to other studies on developed economies, due to the overaccumulation of physical capital, which was part of the ideology of the totalitarian regime, which was in place until 1989. Next, the average labor and capital income tax rate was set to $\tau^y = 0.1$. Similarly, the average tax rate on consumption is set to its value over the period, $\tau^c = 0.2$.

Next, the relative weight attached to the utility out of leisure in the household's utility function, γ, is calibrated to match that in steady-state consumers would supply one-third of their time endowment to working. This is in line with the estimates for Bulgaria (Vasilev 2017a) as well over the period studied. Next, the depreciation rate of physical capital in

Bulgaria, $\delta = 0.013$, was taken from Vasilev (2016). It was estimated as the average quarterly depreciation rate over the period 1999-2014. Finally, the process followed by the TFP process is estimated from the detrended series by running an AR(1) regression and saving the residuals. Due to the lack of data, the moments of the time shock process will be set the same. Table 1 below summarizes the values of all model parameters used in the paper.

Table 1: Model Parameters

Parameter	Value	Description	Method
β	0.982	Discount factor	Calibrated
α	0.429	Capital Share	Data average
$1-\alpha$	0.571	Labor Share	Calibrated
γ	0.873	Relative weight attached to leisure	Calibrated
δ	0.013	Depreciation rate on physical capital	Data average
τ^y	0.100	Average tax rate on income	Data average
τ^c	0.200	VAT/consumption tax rate	Data average
ρ_a	0.701	AR(1) persistence coefficient, TFP process	Estimated
ρ_t	0.701	AR(1) persistence coefficient, time shock process	Set
σ_a	0.044	st. error, TFP process	Estimated
σ_t	0.044	st. error, time shock process	Set

4. Steady-state

Once the values of model parameters were obtained, the steady-state equilibrium system solved, the "big ratios" can be compared to their averages in Bulgarian data. The results are reported in Table 2 below. The steady-state level of output was normalized to unity (hence the level of technology A differs from one, which is usually the normalization done in other studies), which greatly simplified the computations. Next, the model matches consumption-to-output and government purchases ratios by construction; The investment ratios are also closely approximated, despite the closed-economy assumption and the absence of foreign trade sector. The shares of income are also identical to those in data, which is an artifact of the assumptions imposed on functional form of the aggregate production function. The after-tax return, where $r^- = (1-\tau^y)r-\delta$ is also relatively well-captured by the model. Lastly, given the absence of debt, and the fact that transfers were chosen residually to balance the government budget constraint, the result along this dimension is understandably not so close to the average ratio in data.

Table 2: Data Averages and Long-run Solution

Variable	Description	Data	Model
y	Steady-state output	N/A	1.000
c/y	Consumption-to-output ratio	0.648	0.674
i/y	Investment-to-output ratio	0.201	0.175
k/y	Capital-to-output ratio	13.96	13.96
gc/y	Government consumption-to-output ratio	0.151	0.151
wh/y	Labor income-to-output ratio	0.571	0.571
rk/y	Capital income-to-output ratio	0.429	0.429
h	Share of time spent working	0.333	0.333
r^-	After-tax net return on capital	0.014	0.016

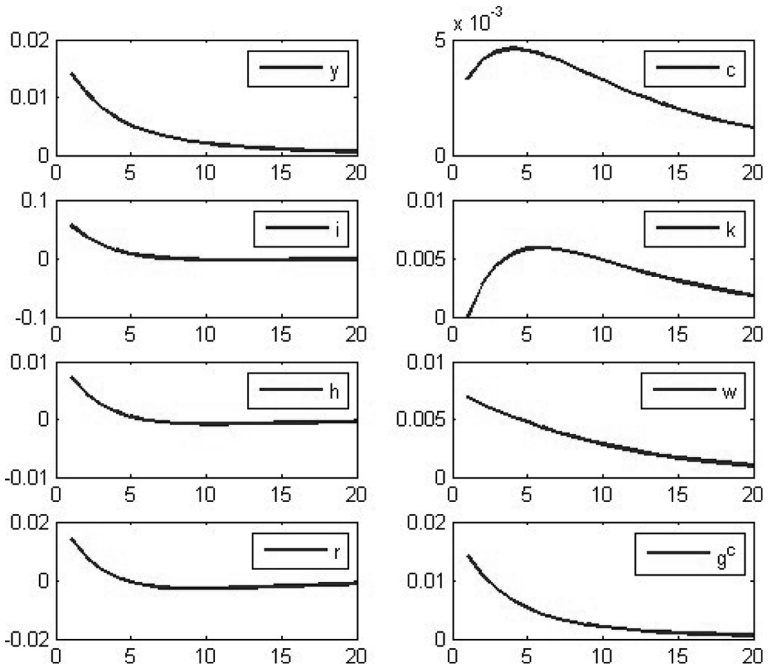
5. Out of steady-state model dynamics

Since the model does not have an analytical solution for the equilibrium behavior of variables outside their steady-state values, we need to solve the model numerically. This is done by log-linearizing the original equilibrium (non-linear) system of equations around the steady- state. This transformation produces a first-order system of stochastic difference equations. First, we study the dynamic behavior of model variables to an isolated shock to the total factor productivity process, and then we fully simulate the model to compare how the second moments of the model perform when compared against their empirical counterparts.

This subsection documents the impulse responses of model variables to a 1% surprise innovation to technology and time. The impulse response functions (IRFs) are presented in Fig. 1 and Fig. 2, respectively. As a result of the one-time unexpected positive shock to total factor productivity, output increases upon impact. This expands the availability of resources in the economy, so uses of output - consumption, investment, and government consumption also increase contemporaneously.

At the same time, the increase in productivity increases the after-tax return on the two factors of production, labor and capital. The representative households then respond to the incentives contained in prices and start accumulating capital, and supplies more hours worked. In turn, the increase in capital input feeds back in output through the production function and that further adds to the positive effect of the technology shock. In the labor market, the wage rate increases, and the household increases its hours worked. In turn, the increase in total hours further increases output, again indirectly.

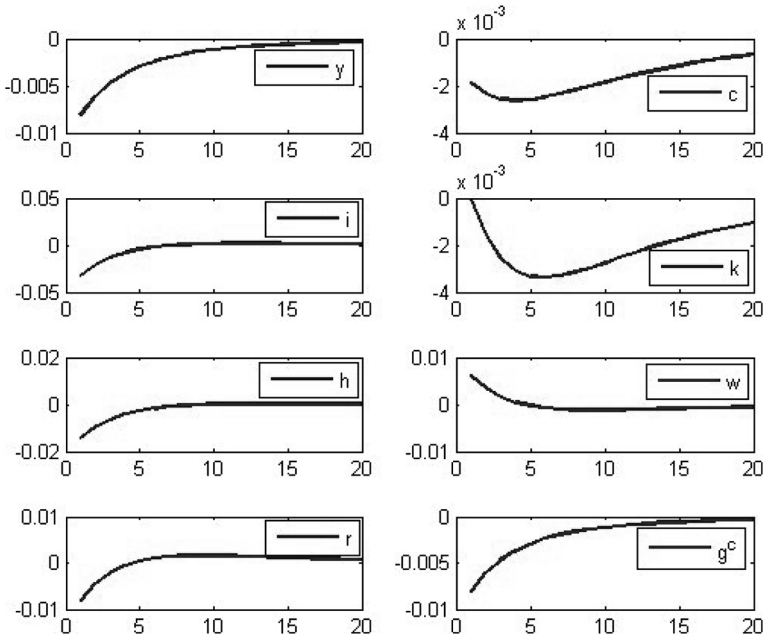
Figure 1: Impulse Responses to a 1% surprise innovation in technology



Over time, as capital is being accumulated, its after-tax marginal product starts to decrease, which lowers the households' incentives to save. As a result, physical capital stock eventually returns to its steady-state, and exhibits a hump-shaped dynamics over its transition path. The rest of the model variables return to their old steady-states in a monotone fashion as the effect of the one-time surprise innovation in technology dies out.

In the case of the shock to time endowment, despite being significant, the effect is quite short-lived. A positive and unexpected increase in time endowment relaxes the time constraint, and makes hours less valuable at the margin. That is why, upon impact of the shock, hours worked fall, which directly affects output. As a result of the reduction in labor supply, marginal productivity of labor increases, and wages go up. Next, due to the fact that capital and labor are complements in the production function, investment also falls, and interest rates as well. This decrease in capital over the transition path negatively impacts output in an indirect manner. As the shock dies out, the variables return to their old steady-states in a monotone fashion, with the exception of consumption and capital, which follow hump-shaped dynamics.

Figure 2: Impulse Responses to a 1% surprise innovation in time endowment



5.1. Simulation and moment-matching

As in Vasilev (2017b), we will now simulate the model 10,000 times for the length of the data horizon. Both empirical and model simulated data is detrended using the Hodrick-Prescott (1980) filter. Table 3 on the next page summarizes the second moments of data (relative volatilities to output, and contemporaneous correlations with output) versus the same moments computed from the model-simulated data at quarterly frequency. The "Model" is the case with both shocks at work, as well as the scenario when one process is turned off. In addition, to minimize the sample error, the simulated moments are averaged out over the computer-generated draws. As in Vasilev (2016, 2017b, 2017c), all models match quite well the absolute volatility of output. By construction, government consumption in the model varies as much as output. In addition, the predicted consumption and investment volatilies are too high. Still, the model is qualitatively consistent with the stylized fact that consumption generally varies less than output, while investment is more volatile than output. The model with time hocks produces smoother wage series (but the effect is quite small), and more volatile hours worked series, where the latter effect is quite substantial, and perfectly matches the volatility in data.

Table 3: Business Cycle Moments

	Data	Model (both shocks)	Model (TFP (shocks only)	Model (time (shocks only)
σy	0.05	0.05	0.05	0.05
$\sigma c/\sigma y$	0.55	0.81	0.82	0.82
$\sigma i/\sigma y$	1.77	2.37	2.35	2.35
$\sigma g/\sigma y$	1.21	1.00	1.00	1.00
$\sigma h/\sigma y$	0.63	0.63	0.28	1.16
$\sigma w/\sigma y$	0.83	0.78	0.86	0.44
$\sigma y/h/\sigma y$	0.86	0.78	0.86	0.44
corr(c, y)	0.85	0.89	0.90	0.90
corr(i, y)	0.61	0.83	0.83	0.83
corr(g, y)	0.31	1.00	1.00	1.00
corr(h, y)	0.49	0.58	0.59	0.92
corr(w, y)	-0.01	0.71	0.96	-0.17

With respect to the labor market variables, with only TFP at play, the variability of employment predicted by the model is lower than that in data, but the variability of wages in the model is very close to that in data. This is yet another confirmation that the perfectly-competitive assumption, e.g. Vasilev (2009), as well as the benchmark calibration here, does not describe very well the dynamics of labor market variables. Next, in terms of contemporaneous correlations, the model systematically over-predicts the pro-cyclicality of the main aggregate variables – consumption, investment, and government consumption. This, however, is a common limitation of this class of models, and the presence of time shocks does not help much. Along the labor market dimension, the contemporaneous correlation of employment with output is too high. With respect to wages, the model predicts strong cyclicality, while wages in data are acyclical. This shortcoming is well-known in the literature and an artifact of the wage being equal to the labor productivity in the model.

In the next subsection, as in Vasilev (2016), we investigate the dynamic correlation between labor market variables at different leads and lags, thus evaluating how well the model matches the phase dynamics among variables. In addition, the autocorrelation functions (ACFs) of empirical data, obtained from an unrestricted VAR(1) are put under scrutiny and compared and contrasted to the simulated counterparts generated from the model.

5.2. Auto-and cross-correlation

This subsection discusses the auto-(ACFs) and cross-correlation functions (CCFs) of the major model variables. The coefficients empirical ACFs and CCFs at different leads and lags are presented in Table 4 below against the averaged simulated AFCs and CCFs. For the sake of brevity, only the results for the setup with both shocks at play is reported.

As seen from Table 4 on the previous page, the model compares relatively well vis-a-vis data. Empirical ACFs for output and investment are slightly outside the confidence band predicted by the model, while the ACFs for total factor productivity and household consumption are well-approximated by the model. The persistence of labor market variables are also relatively well-described by the model dynamics. Overall, the model with time shocks generates too much persistence in output and employment, and is subject to the criticism in Nelson and Plosser (1982), Cogley and Nason (1995) and Rotemberg and Woodford (1996b), who argue that the RBC class of models do not have a strong internal propagation mechanism besides the strong persistence in the TFP process. In those models, e.g. Vasilev (2009), and in the current one, labor market is modelled in the Walrasian market-clearing spirit, and output and unemployment persistence is low.

Next, as seen from Table 5 below, over the business cycle, in data labor productivity leads employment. The model, however, cannot account for this fact. As in the standard RBC model a technology shock can be regarded as a factor shifting the labor demand curve, while holding the labor supply curve constant. The shocks to the labor supply does not help much. Therefore, the overall effect between employment and labor productivity is only a contemporaneous one.

Table 4: Autocorrelations for Bulgarian data and the model economy

		k			
Method	Statistic	0	1	2	3
Data	$corr(n_t, n_{t-k})$	1.000	0.484	0.009	0.352
Model	$corr(n_t, n_{t-k})$	1.000	0.955	0.899	0.834
	(s.e.)	(0.000)	(0.028)	(0.053)	(0.078)
Data	$corr(y_t, y_{t-k})$	1.000	0.810	0.663	0.479
Model	$corr(y_t, y_{t-k})$	1.000	0.956	0.903	0.843
	(s.e.)	(0.000)	(0.027)	(0.053)	(0.076)
Data	$corr(a_t, a_{t-k})$	1.000	0.702	0.449	0.277
Model	$corr(a_t, a_{t-k})$	1.000	0.954	0.900	0.836
	(s.e.)	(0.000)	(0.028)	(0.054)	(0.078)
Data	$corr(c_t, c_{t-k})$	1.000	0.971	0.952	0.913
Model	$corr(c_t, c_{t-k})$	1.000	0.958	0.908	0.851
	(s.e.)	(0.000)	(0.025)	(0.048)	(0.070)
Data	$corr(i_t, i_{t-k})$	1.000	0.810	0.722	0.594
Model	$corr(i_t, i_{t-k})$	1.000	0.953	0.895	0.828
	(s.e.)	(0.000)	(0.029)	(0.056)	(0.081)
Data	$corr(w_t, w_{t-k})$	1.000	0.760	0.783	0.554
Model	$corr(w_t, w_{t-k})$	1.000	0.956	0.905	0.846
	(s.e.)	(0.000)	(0.026)	(0.051)	(0.074)

Table 5: Dynamic correlations for Bulgarian data and the model economy

		k						
Method	Statistic	-3	-2	-1	0	1	2	3
Data	$corr(h_t,(y/h)_{t-k})$	-0.342	-0.363	-0.187	-0.144	0.475	0.470	0.346
Model	$corr(h_t,(y/h)_{t-k})$	0.022	0.019	0.012	-0.011	0.058	-0.076	-0.087
	(s.e.)	(0.337)	(0.297)	(0.252)	(0.506)	(0.271)	(0.291)	(0.320)
Data	$corr(h_t, w_{t-k})$	0.355	0.452	0.447	0.328	-0.040	-0.390	-0.57
Model	$corr(h_t, w_{t-k})$	0.022	0.019	0.012	-0.011	0.058	-0.076	-0.087
	(s.e.)	(0.337)	(0.297)	(0.252)	(0.506)	(0.271)	(0.291)	(0.320)

6. **Conclusions**

Shocks to time endowment are introduced into a real-business-cycle setup augmented with a detailed government sector. The model is calibrated to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). The quantitative importance of the presence of shocks to total time available to households is investigated for the magnitude of cyclical fluctuations in Bulgaria. Despite making hours worked more volatile, and wages a bit smoother, he quantitative effect of such a shock is found to be small, and thus not very important for the propagation of business cycle fluctuations.

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Recursos Turísticos, Especialização em Turismo e Crescimento Económico

Tourism Resources, Tourism Specialization and Economic Growth

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RESUMO
Utilizando como ponto de partida o modelo de crescimento económico de Lanza e Pigliaru (1994), o presente trabalho introduz e analisa o efeito da heterogeneidade das dotações de recursos turísticos na escolha relativa à especialização total em turismo de maior ou de menor qualidade. Dessa suposição resulta de imediato que as economias com dotações de recursos reduzidas não conseguem oferecer produtos turísticos de qualidade elevada, ao passo que aquelas com dotações elevadas dificilmente oferecerão produtos turísticos de baixa qualidade. Conclui-se que os níveis de desenvolvimento económico alcançados no longo prazo serão tanto mais elevados quanto maior for a qualidade dos produtos turísticos oferecidos.
Palavras-chave: Especialização em turismo; qualidade; recursos turísticos; crescimento económico.

ABSTRACT
Using the economic growth model of Lanza and Pigliaru (1994) as a starting point, this paper introduces and analyzes the effect of heterogeneity of the endowments of tourist resources on the choice between total specialization in higher or lower-quality tourism. From this assumption it immediately follows that economies with reduced resource endowments are unable to offer high quality tourism products, while those with high endowments are unlikely to offer low quality tourist products. It is concluded that the levels of economic development achieved in the long run will be all the greater the higher the quality of the tourism products offered.
Keywords: Tourism specialization; quality; tourism resources; economic growth.

JEL Classification: F43; O41; Z32.

1. Introdução

O turismo é encarado por muitas economias, independentemente da sua dimensão ou nível administrativo (regional ou nacional), como uma possível estratégia de crescimento e desenvolvimento económico. Contudo, e por um lado, a teoria do crescimento exógeno (Solow, 1956) atribui ao progresso técnico o papel de condição *sine qua non* do crescimento económico. Por outro lado, as teorias do crescimento endógeno (Lucas, 1988; Romer, 1986, 1987) não só reforçam esta tese como sugerem que o progresso técnico e, concomitantemente, o crescimento económico, resultam da investigação e desenvolvimento e da acumulação de capital físico e humano.

Contudo, a maior parte das atividades económicas que concorrem para a formação de produtos turísticos são intensivas em mão-de-obra e, por isso mesmo, pouco capazes de gerar ou incorporar inovações capazes de aumentar significativamente a produtividade dos fatores. Assim, fica-se com a ideia de que uma economia que afete mais recursos ao turismo do que a outros setores mais intensivos em bens de capital físico ou humano pode vir a comprometer a sua taxa de crescimento económico de longo prazo. Mas tal não é necessariamente verdade. Aliás, existem vários estudos empíricos que demonstram que as economias especializadas em turismo podem registar taxas de crescimento económico mais elevadas do que outros tipos ou conjuntos de economias (Li, Jin e Shi, 2018; Nunkoo et al., 2019).

Lanza e Pigliaru (1994) sugerem que, em determinadas circunstâncias, a especialização de uma economia em turismo (vista como uma atividade caraterizada pela baixa produtividade) pode levar a que essa economia cresça mais do que outra especializada em manufatura (considerada uma atividade de produtividade relativamente superior). De facto, a literatura tem demonstrado que as atividades caraterísticas do turismo, nomeadamente a hotelaria, são caraterizadas por baixos níveis e taxas de crescimento da produtividade do trabalho (Pechlaner e Tschurtschenthaler, 2003; Pham, 2019; Webber et al. 2018). Lanza e Pigliaru (1994) concluem ainda que uma economia especializada em turismo de qualidade elevada auferirá, no longo prazo, receitas mais elevadas (e, portanto, alcançará um nível de desenvolvimento económico mais elevado) do que outra especializada em turismo de qualidade baixa. A dedução deste resultado parte do pressuposto de que todas as economias pequenas especializadas em turismo estão dotadas de uma quantidade exógena e idêntica de recursos naturais suscetíveis de aproveitamento turístico. É uma suposição aceitável, mas, do nosso ponto de vista, suscetível de melhoria.

Se pretendermos uma maior proximidade à realidade, parece-nos plausível admitir, por um lado, que existem outros recursos, para além dos naturais, passíveis de constituir ou transformar em atração turística. Esta constatação sugere que a especialização e o desenvolvimento turísticos não dependem exclusivamente da presença de recursos naturais. Recursos culturais dos mais variados tipos, entre outros, também podem constituir a base da oferta turística de qualquer economia (Breda, 2004; Denicolai et al. 2010; Jensen-Verbeke, 1986, entre outros). Por outro lado, diferentes cidades, regiões ou países, mesmo que de semelhante dimensão geográfica, parecem ser bastante diferenciados em termos de dotação de recursos turísticos, quer do ponto de vista quantitativo (e.g. diferentes praias têm areais de diferentes extensões, diferentes cidades têm mais ou menos monumentos e museus, eventos, centros de congressos, etc.), quer do ponto de vista tipológico (e.g. praias e monumentos

são atrações turística de tipos diferentes associadas, na maior parte das vezes, a diferentes tipos de produtos turísticos).

Para se perceber melhor o que está em causa, tomemos como referência a lista de lugares considerados Património da Humanidade pela Unesco.[1] Países distintos mas comparáveis entre si no que diz respeito à sua dimensão geográfica, avaliada através do respetivo número de habitantes, revelam quantidades tremendamente díspares de lugares presentes nessa lista e, como tal, de recursos naturais e culturais suscetíveis de constituírem atrações de turismo cultural ou de natureza. Por exemplo, a Tailândia (66 milhões de habitantes) e a França (67 milhões de habitantes) contam, respetivamente, com 5 e 45 lugares listados. Quénia (48 milhões de habitantes) e Espanha (47 milhões de habitantes) com 7 e 48. Já Cuba (11 milhões de habitantes) e Portugal (10 milhões de habitantes) contam, respetivamente, com 9 e 17 lugares naquela lista.

Numa outra perspetiva, dentro dos dez principais destinos turísticos em 2018, todos eles com mais de 70 milhões de turistas, vamos encontrar países completamente diferentes quer em termos de área geográfica (e.g. Hong-Kong com 2.700 km^2, contra os mais de 9 milhões de km^2 dos EUA ou da China), de população (e.g. Hong-Kong com 7,5 milhões de habitantes, contra a Ucrânia com 42 milhões, a Turquia com 82 milhões, o México com 126 milhões, os EUA com 329 milhões ou a China com 1.400 milhões) ou dos já referidos lugares considerados Património da Humanidade (e.g. Hong-Kong com zero lugares listados, contra Ucrânia com 7, a Turquia com 18 ou a China com 55)

O objetivo deste trabalho é analisar o efeito da heterogeneidade das dotações de recursos turísticos na escolha relativa à especialização em turismo de maior ou menor qualidade, utilizando como base o modelo de Lanza e Pigliaru (1994). Por uma questão de simplicidade, admitiremos aqui que dita heterogeneidade se resume à quantidade disponível de recursos, suposição esta, como veremos, suficiente para analisar questões de grande relevância prática. De facto, se as várias economias diferem em termos da dimensão das respetivas dotações de recursos turísticos, aquelas com menor quantidade dos mesmos poderão procurar compensar essa escassez através da atração de um maior número de turistas.[2] Ou, muito simplesmente, poderão ver os seus recursos saturados pela presença de elevados níveis de procura turística. Quer a primeira situação (intencional), quer a segunda (acidental), poderão acarretar consequências negativas sobre a qualidade dos seus produtos turísticos e, eventualmente, sobre as suas perspetivas de crescimento económico. Coloca-se então uma questão, concomitante ao objetivo acima definido: será que a dimensão da dotação de recursos turísticos condiciona o desempenho económico das economias especializadas em turismo? É a esta questão que pretendemos dar uma resposta com este trabalho.

Na secção seguinte fazemos uma breve revisão da literatura relacionada, tendo em vista situar o nosso contributo. Na secção 3 apresentamos uma versão simplificada do modelo que

[1] https://whc.unesco.org/en/list/&order=country#alphaP (acedido em 10 de fevereiro de 2020).

[2] Supondo, como se verá adiante, que o objetivo de longo prazo das empresas é a maximização das receitas totais. Esta hipótese é uma simplificação que pode ser justificada pelo facto de os únicos custos envolvidos serem os relativos ao pagamento de salários. Como todas as economias estão dotadas com a mesma quantidade de trabalho, os custos de todas elas são idênticos, permitindo-se a equivalência entre os problemas de maximização do lucro e da receita total. Por outro lado, a suposição pode ser justificada também pela relevância que os preços, e não só as quantidades, desempenham no contexto da atividade turística enquanto fatores de criação de riqueza.

Lanza e Pigliaru (1994) desenvolveram, por sua vez adaptado a partir do modelo de Lucas (1988) com *learning-by-doing*, e destinado a descrever quais as condições que se devem verificar para que a especialização em turismo não seja prejudicial ao crescimento económico. Apesar de a abordagem de Lanza e Pigliaru (1994) se referir à questão da especialização de um país em turismo, aqui iremos supor que dito modelo é igualmente aplicável a outros referenciais geográficos, nomeadamente regiões ou locais. Assumindo a verificação daquelas condições, na secção 4 procuramos avaliar em que circunstâncias é que a aposta na oferta de um produto turístico de qualidade elevada é preferível à aposta na oferta de um produto turístico de qualidade inferior. O modelo aí apresentado difere do proposto por Lanza e Pigliaru (1994) pelo facto de assumir, ao contrário deste, a hipótese de heterogeneidade das dotações de recursos turísticos. Na última secção apresentamos as nossas principais conclusões e avançamos com várias recomendações úteis em matéria de política económica.

2. Breve revisão da literatura

O nosso trabalho insere-se dentro de uma linha de investigação que recorre a modelos teóricos tendo em vista analisar o papel da expansão do turismo no crescimento económico de longo prazo de uma pequena economia aberta. Que seja do nosso conhecimento, esta linha de investigação foi inaugurada pelo trabalho de Lanza e Pigliaru (1994), que tomamos como ponto de partida e desenvolvemos nos moldes descritos na secção anterior. Importa salientar, no entanto, e embora tal não seja explicitamente reconhecido por Lanza e Pigliaru (1994), que a tónica e a abordagem por eles seguida tem proximidades óbvias com o trabalho de Baumol (1967). Este último constitui uma das primeiras referências a respeito do estudo do crescimento económico de uma economia com dois setores cujas taxas de crescimento da produtividade são diferentes.

A variável crucial da nossa análise é a qualidade do produto turístico, que também já foi alvo de atenção em seis estudos anteriores. Gómez et al. (2008) estudam o comportamento de longo prazo de uma pequena economia aberta completamente especializada em turismo. Neste modelo, de inspiração neoclássica, a acumulação de capital na indústria turística é o motor do crescimento económico. O turismo corresponde a um bem compósito que inclui o capital privado, o capital público e o capital natural (isto é, o ambiente). A qualidade, entendida neste trabalho numa perspetiva ampla, aparece refletida numa função preço hedónica. De acordo com esta função, os turistas estão dispostos a pagar tanto mais quanto mais elevados forem os níveis de capital público, privado e natural por turista. Por outro lado, um maior fluxo de turistas contribui para diminuir a qualidade percecionada do produto turístico por via do aumento do grau de congestão turística e de deterioração do capital natural/ambiente. O objetivo dos autores é analisar os efeitos decorrentes da tributação das dormidas turísticas.

Concluem que no longo prazo a tributação turística contribui para melhorar a qualidade ambiental bem como para diminuir a capacidade de alojamento e o número de turistas. Na perspetiva dos residentes, o efeito negativo sobre o bem-estar dos residentes decorrente da redução do número de visitantes é mais do que compensado pelo aumento dos preços do pacote turístico. Este aumento decorre da melhoria do ambiente, da diminuição do grau de

congestão turística e, também, do aumento da qualidade dos serviços de alojamento, pois as receitas tributárias permitem aumentar os investimentos público e privado relacionados com o turismo.

Num trabalho imediatamente posterior, o mesmo coletivo de autores socorre-se do mesmo modelo para analisar uma questão distinta. Nesse trabalho, Lozano et al. (2008) estudam o papel da interação entre a congestão turística e a qualidade dos serviços turísticos privados no desempenho de longo prazo de uma pequena economia aberta especializada em turismo.

Concluem que o destino turístico acabará por atingir um ponto de estagnação decorrente da escassez de recursos ambientais. No entanto, a duração da fase de crescimento económico, bem como o nível de utilidade alcançado pelos residentes, depende da qualidade dos serviços turísticos privados. Em concreto, a qualidade mais elevada do alojamento turístico implica um período mais longo até à estagnação económica, bem como menores fluxos turísticos, maior qualidade ambiental e menor congestão dos bens públicos.

Logo a seguir, Álvarez-Albelo e Hernández-Martin (2009) recorrem a modelos de crescimento exógeno, com funções produção de Cobb-Douglas, para analisar o papel da especialização em turismo de luxo no crescimento económico de longo prazo. Apresentam-nos dois modelos, sendo que em ambos existe uma economia grande e rica que produz um bem de capital transacionável e uma economia pequena e pobre que produz serviços turísticos igualmente transacionáveis. Os modelos diferem, apenas, na natureza do bem turístico, que num caso é de luxo e no outro não. Por sua vez, o bem turístico é caraterizado como sendo ou não de luxo em função das preferências dos consumidores. Como tal, é a existência (ou não) de um nível mínimo de consumo do bem turístico que torna a função utilidade dos consumidores oriundos do país grande não homotética levando, por isso, à caraterização desse bem como sendo (ou não) de luxo.

Concluem que a economia turística pode crescer de forma sustentada ao longo do tempo graças à melhoria contínua dos termos de troca, a qual resulta da existência de um diferencial de produtividade entre os dois tipos de bens analisados. Constatam ainda que o diferencial de crescimento é significativamente maior, a favor da economia turística, quando o turismo é um bem de luxo.

Este tipo de questões volta a ser alvo de análise numa sequência de três trabalhos interligados, desta feita no âmbito das teorias do crescimento endógeno. No modelo proposto por Pina e Martinez-García (2013) e Albaladejo et al. (2014), o turismo é o motor de crescimento económico de longo prazo das economias turísticas, estando esse crescimento assegurado pela manutenção da qualidade dos serviços turísticos. Por sua vez, essa qualidade corresponde à quantidade de capital físico por unidade de serviço turístico produzido, apelidada pelos autores de "taxa intrínseca de atratividade do turismo".

A conclusão geral é a de que a taxa de crescimento económico exógeno do resto do mundo é suscetível de estimular as chegadas e as despesas dos turistas na economia recetora, sem prejuízo de que essa economia possa aumentar a sua taxa de atratividade do turismo através do investimento. Por sua vez, as receitas turísticas permitem a importação de bens de capital destinados à realização do investimento turístico necessário à manutenção da qualidade dos serviços turísticos.

Na sequência dos dois trabalhos anteriores, Albaladejo e Martinez-García (2015) reconhecem que se o turismo seguir o modelo do ciclo de vida sugerido por Butler (1980) a

capacidade de carga do destino turístico acabará por limitar o respetivo crescimento económico, conduzindo-o inevitavelmente a uma situação de estagnação económica. O modelo apresentado agora incorpora a abordagem de Butler (1980) num modelo de crescimento económico baseado em investigação e desenvolvimento. Neste modelo a taxa de crescimento das chegadas de turistas é função quer da taxa intrínseca de atratividade do turismo, quer da capacidade de carga turística. Esta, por sua vez, corresponde a um quociente entre a oferta/produção de serviços turísticos e o nível individual de consumo turístico.

No final, concluem que o investimento em investigação e desenvolvimento permite a sustentabilidade do crescimento económico do destino turístico através do aumento da capacidade de carga turística. De facto, esta última é suscetível de variar – neste caso, aumentar – em função dos investimentos e inovações que se venham a registar no âmbito da melhoria das infraestruturas e das redes de transporte, da capacidade de alojamento, da diversificação das atrações turísticas, etc. Portanto, no longo prazo a taxa de crescimento económico do destino turístico será igual à taxa de crescimento da inovação.

O nosso trabalho distingue-se dos anteriores em vários aspetos. Em primeiro lugar, partimos de um enquadramento teórico bastante simples e bem conhecido, o que é vantajoso do ponto de vista da transparência da análise. Em segundo lugar, introduzimos um conceito de qualidade muito intuitivo e que traduz, em simultâneo, as noções de congestão turística e de capacidade de carga. Esse conceito está intimamente relacionado com a dimensão da dotação de recursos turísticos, fator central da nossa análise. Em terceiro lugar, comparamos diretamente as consequências da especialização em três patamares distintos de qualidade do produto turístico, dependentes da disponibilidade de recursos de economia recetora. Existe uma vasta literatura, em ciências empresariais, subordinada às dimensões e medição da qualidade dos serviços e dos produtos turísticos (Augustyn e Ho, 1998; Bhat, 2012; Fick e Ritchie, 1991; Garrigos-Simon et al., 2019; Mukherjee et al., 2018; Narayan et al.; 2008, Narayan et al. 2009; Park e Jeong, 2019; Soler e Gemar, 2019). Nessa literatura a qualidade é habitualmente avaliada em escalas que vão da baixa à alta qualidade, passando por todo o espectro intermédio de valores. Numa perspetiva mais simplista, embora coerente com a literatura disponível, iremos assumir no nosso trabalho que a qualidade do produto turístico pode ser baixa, média ou alta.

3. Especialização em turismo vs. Especialização em manufatura

3.1. Caraterização do lado da oferta

No espírito do modelo de Lucas (1988), suponhamos que o espaço geográfico relevante (mundo ou país) é composto por várias economias de pequena dimensão (i.e. vários países ou várias regiões) a dois setores, onde o volume de produção (Q) é função do capital humano (h), sob a forma de *learning-by-doing*, e do trabalho (L), ou seja:[3]

[3] A ausência de capital físico apenas pretende simplificar a análise, já que a relevância do modelo assenta no papel do capital humano.

$$Q_i = h_i L_i, \tag{1}$$

correspondendo i a M (manufatura) ou a T (turismo).

O motor do crescimento económico é a acumulação de capital humano, cuja função é dada por:

$$\dot{h}_i = \lambda_i h_i L_i, \tag{2}$$

correspondendo a taxa de crescimento do capital humano a:

$$\frac{\dot{h}_i}{h_i} = \lambda_i L, \tag{3}$$

representando λ_i o potencial para *learning-by-doing* do setor *i*. Por uma questão de simplicidade, assume-se que todas as economias dispõem de uma força de trabalho de idêntica dimensão (por serem pequenas), constante e igual a 1. Quer isto dizer que a taxa de crescimento do stock de capital humano de cada setor é igual ao potencial para *learning-by-doing* do respetivo setor.

Se supusermos que ditas economias se abrem ao exterior, elas serão conduzidas à especialização completa, por força da lei das vantagens comparativas.[4] Nestas circunstâncias, a taxa de crescimento de uma economia completamente especializada no setor i será dada por:

$$\frac{\dot{Q}_i}{Q_i} = \lambda_i. \tag{4}$$

Assim, a taxa de crescimento de uma economia completamente especializada no setor i corresponde ao respetivo potencial para *learning-by-doing*. Daqui decorre que supor que $\lambda_M > \lambda_T$ equivale a supor que a taxa de crescimento das economias especializadas em manufatura é superior à taxa de crescimento das economias especializadas em turismo.

3.2. Caraterização do lado da procura

A nível internacional (ou inter-regional) as preferências dos consumidores por produtos manufaturados e por produtos turísticos são caraterizadas por uma função elasticidade CES[5] e por uma restrição orçamental dadas, respetivamente, por:

[4] Esta é uma suposição habitual, quer em economia internacional, quer na literatura acima revista, que tem as suas raízes fundadas no célebre exemplo ricardiano da especialização produtiva de Portugal em vinho e da Inglaterra em tecido, de acordo com as vantagens comparativas de cada país, apesar da Inglaterra ter vantagem absoluta na produção de ambos os bens. Por outro lado, é possível questionar o realismo desta hipótese, o que nos remeteria para a célebre controvérsia popularizada por Friedman (1953) e resumida por Boland (2008), discussão essa que não pretendemos retomar aqui. A este respeito, limitamo-nos a subscrever a perspetiva de que a hipótese de especialização completa é uma mera simplificação destinada a facilitar a análise e a perceber o que é que acontece à medida que a economia tende para a especialização completa no produto relativamente ao qual ela possui uma vantagem comparativa.

[5] Do inglês, constant elasticity of substitution. A utilização de funções CES no âmbito do estudo do crescimento económico remonta aos trabalhos de Solow (1956), Uzawa (1962) e Dixit e Stiglitz (1977). As funções utilidade CES são úteis para a representação de situações nas quais se supõe que a taxa de substituição entre os fatores ou bens

$$U(Q_M, Q_l) = (\alpha_M Q_M^{-\rho} + \alpha_T Q_T^{-\rho})^{-1/\rho} \quad (5)$$

e por

$$y = (P_M Q_M + P_T Q_T), \quad (6)$$

sendo y o rendimento total, P_M o preço do produto manufaturado e P_T o preço do produto turístico.

Das condições de primeira ordem do problema de maximização da utilidade[6] resulta a função procura relativa dada por:

$$\frac{Q_T}{Q_M} = \left(\frac{\alpha_T}{\alpha_M}\right)^{\sigma} \left(\frac{P_T}{P_M}\right)^{-\sigma}, \quad (7)$$

sendo σ a elasticidade de substituição entre o turismo e a manufatura, correspondente a:

$$\sigma = \frac{1}{1+\rho}. \quad (8)$$

Neste contexto, a elasticidade de substituição pode ser vista como um indicador da facilidade com que os consumidores estão dispostos a substituir o consumo de serviços turísticos pelo consumo de produtos manufaturados, e vice-versa.

3.3. Equilíbrio final

A função procura relativa permite deduzir a taxa de crescimento dos termos de troca, dada por:

$$\frac{\dot{P}}{P} = \left(\frac{\dot{Q}_M}{Q_M} - \frac{\dot{Q}_T}{Q_T}\right)\sigma^{-1}, \quad (9)$$

correspondendo os termos de troca a:

$$P = \frac{P_T}{P_M}. \quad (10)$$

em causa é constante, tal como se pretende no caso das preferências entre o turismo e a manufatura. Constituem o caso geral a partir do qual a conhecida função de Cobb-Douglas pode ser deduzida.

[6] Como o consumidor não enfrenta trade-offs entre capital e consumo (ou de qualquer outro tipo) o problema de maximização da utilidade requer, tão somente, a construção e maximização do respetivo Lagrangiano. A função procura assim encontrada estabelece, como seria de esperar, que a procura de cada bem é tanto maior quanto maior for a preferência dos consumidores por esse bem e quanto menor for o respetivo preço. Note-se que se trata de uma função procura. A determinação das quantidades e preços efetivos teria de levar em conta o lado da oferta da economia.

De acordo com esta definição, o aumento dos termos de troca equivale ao aumento do preço relativo dos produtos turísticos, o que é favorável às economias especializadas em turismo.

Na hipótese de especialização completa de todas as economias em turismo ou em manufatura, a taxa de crescimento dos termos de troca é dada por:

$$\frac{\dot{P}}{P} = (\lambda_M - \lambda_T)\sigma^{-1}. \quad (11)$$

Esta expressão diz-nos que quanto maior for a diferença entre as taxas de crescimento das economias especializadas em manufatura e em turismo, maior será o aumento dos termos de troca (ou seja, do preço relativo do produto turístico). Este resultado pode ser explicado da seguinte forma: se taxa de crescimento da produtividade da manufatura for superior à taxa de crescimento da produtividade do turismo, o escoamento da produção manufatureira só pode ser assegurado à custa de um preço relativo da manufatura mais baixo, o que equivale a um preço relativo do turismo mais alto (o que, por sua vez, beneficia as economias especializadas em turismo). Numa outra perspetiva, paralela, há que recordar que o crescimento da produtividade traz consigo quedas dos custos médios e, por aí, quedas dos preços praticados.

Existe já suficiente evidencia teórica e empírica de que os mercados turísticos são mercados de concorrência imperfeita (Dwyer et al., 2010), pelo que os produtores têm alguma margem para fixação de um *mark-up* sobre os preços concorrenciais. Evidentemente, e tal como o postula a teoria económica no que diz respeito à diferenciação do produto, esse *mark-up* será tanto mais alto quanto mais evidente for a qualidade do produto oferecido. Assim, tudo aquilo que puder acrescentar valor ao produto turístico permitirá justificar a fixação de margens de lucro mais elevadas, daí resultando preços turísticos também mais elevados (Mangion et al., 2005; Espinet et al., 2003, entre outros).

3.4. Comparação entre as taxas de crescimento das economias completamente especializadas em turismo e em manufatura

A especialização em turismo constitui uma opção benéfica (ou não prejudicial) para uma determinada economia se a sua taxa de crescimento for superior (ou pelo menos igual) à taxa de crescimento de uma outra economia especializada em manufatura. Nesse sentido, a taxa de crescimento de uma economia completamente especializada em turismo (Υ_T), em termos do produto manufaturado, é dada por:[7]

$$\Upsilon_T = \lambda_T + (\lambda_M - \lambda_T)\sigma^{-1}, \quad (12)$$

ou seja, é igual à taxa de crescimento do volume de produção turística adicionada dos ganhos ou perdas dos termos de troca. A taxa de crescimento de uma economia especializada em manufatura (Υ_M), também em termos do produto manufaturado, é dada, muito simplesmente, por:

$$\Upsilon_M = \lambda_M. \quad (13)$$

[7] Dedução em apêndice.

Assim, a especialização em turismo constitui uma opção não prejudicial se e só se $Y_T \geq Y_M$, de onde resulta $\sigma \leq 1$. Concluímos assim que se a elasticidade de substituição for igual ou inferior à unidade, as economias especializadas em turismo registarão taxas de crescimento iguais ou superiores às registadas pelas economias especializadas em manufatura.[8]

Lanza et al.(2003) estimaram as elasticidades de substituição entre a manufatura e o turismo relativas a uma amostra de 13 países da OCDE ao longo do período compreendido entre 1975 e 1992. Os valores obtidos oscilaram entre os 0,13 e os 0,97, permitindo-lhes concluir que a elasticidade de substituição parece ser, de facto, igual ou inferior à unidade. Assim, pelo menos no contexto dos países analisados, o maior grau de especialização em turismo não esteve necessariamente associado às piores performances em termos de taxas de crescimento económico.

4. Turismo de qualidade elevada vs. Turismo de qualidades inferiores

4.1. Caraterização do lado da oferta (i): definição de qualidade

Tal como Lanza e Pigliaru (1994), iremos assumir a definição de qualidade proposta por Leibenstein (1950): a qualidade de um bem ou serviço é tanto mais elevada quanto menor for a quantidade de pessoas que o consomem.[9] Formalmente, isso corresponde a definir um índice de qualidade, designado por α, que é função inversa do grau de congestionamento, T, ou seja:

$$\alpha = \delta T^{-\beta}, \tag{14}$$

sendo δ um parâmetro positivo e β a elasticidade da qualidade em relação ao grau de congestionamento turístico.[10] Este último é dado por:

$$T = \frac{Q}{S}, \tag{15}$$

onde Q é um indicador do volume de produção turística[11] e S corresponde à dotação de recursos turísticos. De acordo com as expressões (14) e (15), quanto maior for o volume de produção turística, maior será o grau de congestionamento e, consequentemente, menor

[8] Uma elasticidade de substituição baixa – i.e. inferior à unidade – indica uma maior relutância por parte dos consumidores em substituir o consumo de bens manufaturados por bens turísticos, o que parece plausível no caso destes dois tipos de bens. Assim, o resultado obtido aqui indica que quanto menor for a elasticidade de substituição entre o turismo e a manufatura, mais provável será que a especialização produtiva em turismo se venha a revelar uma opção favorável.

[9] No contexto do turismo, a qualidade de um recurso ou produto turístico (como uma praia ou um museu, por exemplo) é tanto maior quanto menor for o número de pessoas que o consomem/frequentam.

[10] $0 < \delta < 1$ é um mero parâmetro de escala, $\beta > 0$ traduz a ideia de que a qualidade diminui quando o grau de congestão turística aumenta e $\alpha \geq 0$ porque T é um quociente entre valores não negativos.

[11] Por exemplo, a capacidade hoteleira disponível.

será a qualidade do produto turístico[12], e vice-versa. Portanto, as quantidades produzidas e apresentadas aqui correspondem ao volume de produção da economia completamente especializada em turismo, tal como postulado pela equação (1).

Note-se que o inverso do grau de congestionamento é um indicador da quantidade de recurso turístico por unidade produzida de bem turístico[13], ou seja:

$$T^{-1} = \frac{S}{Q}. \tag{15'}$$

4.2. Caraterização do lado da oferta (ii): heterogeneidade das dotações de recursos turísticos

Para capturar e explorar as implicações da hipótese de heterogeneidade das dotações de recursos turísticos, iremos supor adiante que, no longo prazo, o volume de procura turística pode ser alto (Q_A) ou baixo (Q_B) e que a dotação de recursos turísticos pode ser elevada (S_E) ou reduzida (S_R). Daqui resultam diferentes graus de congestionamento turístico, dados por:

$$T_{CON} = \frac{Q_A}{S_R}, \tag{16}$$

$$T_{MED} = \frac{Q_A}{S_E} = \frac{Q_B}{S_R}, \tag{17}$$

$$T_{LUX} = \frac{Q_B}{S_E}. \tag{18}$$

Cada um destes graus de congestionamento turístico implicará um índice de qualidade diferente. Assim, T_{CON}, T_{MED} e T_{LUX} correspondem, respetivamente, aos graus de congestionamento associados aos produtos turísticos congestionado (ou de qualidade baixa), mediano (ou de qualidade média) e de luxo (ou de qualidade elevada). Verifica-se $T_{CON} > T_{MED} > T_{LUX}$.[14]

As quantidades de recursos turísticos por unidade produzida de bem turístico, correspondentes a cada um daqueles graus de congestionamento, são dadas, respetivamente, por:

$$T_{CON}^{-1} = \frac{S_R}{Q_A}. \tag{16'}$$

$$T_{MED}^{-1} = \frac{S_E}{Q_A} = \frac{S_R}{Q_B}. \tag{17'}$$

[12] Lanza e Pigliaru (1994) admitem que no longo prazo existem apenas dois tipos de produtos turísticos: os "congestionados" e os de "luxo". Os primeiros e os segundos estão associados aos índices exógenos de congestionamento T1 e T2, respetivamente. Naturalmente, verifica-se T1 > T2. Para além disso, está-se a assumir que toda a capacidade hoteleira disponível (por exemplo) é ocupada.

[13] Por exemplo, por turista, por visitante ou por dormida.

[14] Na verdade, não é obrigatório que Q_A/S_E seja igual a Q_B/S_R. Não obstante, para simplificar a análise, iremos assumir que os valores de Q_A, Q_B, S_E e S_R são tais que aquela igualdade é respeitada (e.g. se Q_A = 1000, Q_B = 100, S_E = 500 e S_R = 50).

$$T_{LUX}^{-1} = \frac{S_E}{Q_B}. \qquad (18')$$

Verifica-se, como é óbvio, $T_{LUX}^{-1} > T_{MED}^{-1} > T_{CON}^{-1}$. Esta desigualdade diz-nos que, no longo prazo, a quantidade de recursos turísticos disponíveis por unidade de produto turístico é mais elevada no caso dos produtos (ou destinos) turísticos de luxo e mais reduzida no caso dos produtos (ou destinos) turísticos congestionados.

Note-se que $T^{-1} = S/Q$ é uma mera relação técnica de produção, correspondente à caraterização física de cada tipo de produto turístico. Com base nesta relação apenas ficamos a saber que o que distingue cada tipo de produto turístico é a quantidade de recursos turísticos disponíveis por unidade produzida de bem turístico[15]. No entanto, o que é alvo de procura são unidades de cada um daqueles tipos de produtos. Assim, relativamente a cada tipo de produto turístico (i.e. de qualidade baixa, média ou alta) há que fazer uma distinção entre aquela relação técnica de produção e as quantidades de cada um deles que são efetivamente procuradas. Estas últimas designaremos por q_{CON}, q_{MED} e q_{LUX}, correspondentes, respetivamente, às quantidades efetivamente procuradas de produtos turísticos congestionado, mediano e de luxo no longo prazo.

Daqui resulta que as economias com dotações de recursos turísticos relativamente menores nunca podem optar pela produção de produtos turísticos de qualidade elevada, ao passo que as economias com elevadas dotações de recursos turísticos dificilmente produzirão produtos turísticos de baixa qualidade.

4.3. Caraterização do lado da procura

Assume-se que a nível internacional (ou inter-regional) as preferências dos consumidores são caraterizadas por uma função utilidade quasi-homotética de Stone-Geary, dada por:[16]

$$U(q_{CON}, q_{MED}, q_{LUX}) = (q_{CON} - \theta)^{\alpha_{CON}}(q_{MED})^{\alpha_{MED}}(q_{LUX})^{\alpha_{LUX}}. \qquad (19)$$

A restrição orçamental é dada por:

$$r = p_{CON}q_{CON} + p_{MED}q_{MED} + p_{LUX}q_{LUX}. \qquad (20)$$

[15] Por exemplo, a quantidade de recursos turísticos por cama disponível. Assim, se a economia tiver 400 camas disponíveis por dia e se estiver em causa o produto turístico sol e praia relativo a uma localidade cuja atração turística é uma praia com uma extensão de 5 km^2 (ou seja, 5.000 m^2), teremos S = 5.000, Q = 400 e T-1 = 12,5 m^2 por cama disponível.

[16] A função utilidade de Stone-Geary constitui um caso particular da função utilidade de tipo Cobb-Douglas e é adequada à representação de problemas nos quais se assume que existe pelo menos um bem que tem um nível de consumo de subsistência (como é, por exemplo, o caso da água). No caso em apreço, existe um nível mínimo de consumo turístico que é sempre realizado, independentemente do seu preço ou do nível de rendimento do consumidor. Portanto, estamos a assumir que existe sempre um mínimo de procura turística direcionada para o turismo dito de massas ou indiferenciado.

Verifica-se $0 < \alpha_{CON} < \alpha_{MED} < \alpha_{LUX} < 1$, $\alpha_{CON} + \alpha_{MED} + \alpha_{LUX} = 1$, sendo α_C, α_M e α_L os índices de qualidade associados aos produtos turísticos congestionado, mediano e de luxo. q_{CON} é um bem de primeira necessidade, q_{MED} é um bem normal e q_{LUX} é um bem de luxo[17]. p_{CON}, p_{MED} e p_{LUX} são os respetivos preços. r corresponde ao rendimento destinado ao consumo turístico[18]. O parâmetro θ indica o nível mínimo de procura do produto turístico congestionado.

Das condições de primeira ordem do problema de maximização da utilidade resultam as seguintes funções procura[19]:

$$q_{CON} = \frac{r}{p_{CON}}\alpha_{CON} + (\alpha_{MED} + \alpha_{LUX})\,\theta, \tag{21}$$

$$q_{MED} = \frac{r}{p_{MED}}\alpha_{MED} - \alpha_{MED}\frac{p_{CON}}{p_{MED}}\,\theta, \tag{22}$$

$$q_{LUX} = \frac{r}{p_{LUX}}\alpha_{LUX} - \alpha_{LUX}\frac{p_{CON}}{p_{LUX}}\,\theta. \tag{23}$$

As funções procura deduzidas revelam que o consumo de cada bem aumenta com o nível de rendimento do turistas e com o grau de preferência por cada produto turístico, e diminui com o respetivo preço. Constata-se que caso θ seja diferente de zero, e mesmo que o rendimento seja igual a zero, a procura de turismo de qualidade baixa é sempre não nula. Se θ for igual a zero as funções procura obtidas corresponderão ao caso que resultaria da consideração inicial de uma função utilidade de tipo Cobb-Douglas. Este parâmetro está fortemente dependente do perfil dos consumidores. Por exemplo, mercados emissores mais ricos são mercados cujos turistas têm um poder de compra superior e, por conseguinte, são menos propensos a consumir um produto turístico massificado, sendo o correspondente valor de θ mais baixo.

4.4. Equilíbrio final: receitas turísticas de longo prazo

Para uma economia pequena especializada em turismo, a qualidade do seu produto depende da dimensão dos recursos turísticos disponíveis. Assim, uma economia com uma dotação reduzida apenas pode produzir produtos turísticos de qualidades média ou baixa, ao passo que outra com uma dotação elevada pode optar pela produção de produtos turísticos de qualidades média ou alta[20]. As receitas provenientes da especialização em turismo de qualidades baixa, média ou alta são dadas, respetivamente, por:

$$R_{CON} = p_{CON}q_{CON}, \tag{24}$$

[17] Portanto, o grau de preferência por cada produto turístico coincide com o índice de qualidade respetivo.

[18] Ou seja, a diferença entre o rendimento total, y, e a despesa realizada no consumo de bens manufaturados, $P_M Q_M$.

[19] Vd. deduções em apêndice.

[20] Ver equações (16), (17) e (18).

$$R_{MED} = p_{MED} q_{MED}, \tag{25}$$

$$R_{LUX} = p_{LUX} q_{LUX}. \tag{26}$$

Estas receitas correspondem também às despesas realizadas pelos turistas em cada um dos tipos de produtos turísticos. Assim, à medida que o rendimento real aumenta,[21] o quociente entre as despesas realizadas em produtos turísticos de qualidades elevada e média tende a aumentar[22] e a aproximar-se de $\alpha_{LUX}/\alpha_{MED}$. Por seu turno, o quociente entre as despesas em produtos turísticos de qualidades média e baixa tende a crescer[23] e a aproximar-se de $\alpha_{MED}/\alpha_{CON}$. Como $\alpha_{CON} < \alpha_{MED} < \alpha_{LUX}$, este resultado significa que as economias especializadas em turismo de maior qualidade convergem para níveis de receitas – e, portanto, de desenvolvimento económico – de longo prazo mais elevadas.

4.5. Comparação entre as receitas turísticas das economias especializadas em turismo de qualidades baixa, média e elevada

Para uma economia com uma dotação de recursos turísticos elevada, a especialização em turismo de qualidade elevada é preferível à especialização em turismo de qualidade média se, no longo prazo, as receitas associadas à primeira alternativa forem superiores às receitas associadas à segunda. Formalmente, dever-se-á verificar a condição $R_{LUX} > R_{MED}$. Por sua vez, uma economia com uma dotação de recursos turísticos reduzida verá o turismo de qualidade média como vantajoso se, no longo prazo, se verificar a condição $R_{MED} > R_{CON}$. De qualquer uma destas duas condições resulta $(Q_A/Q_B)^{\beta} > 1$.

Esta condição significa que a especialização em turismo da melhor qualidade possível proporciona receitas tanto mais altas quanto mais acentuada for a discrepância entre os volumes alto e baixo de produção de bem turístico e quanto maior for a elasticidade da qualidade turística em relação ao grau de congestionamento turístico. Por outras palavras: num contexto no qual umas economias optam por oferecer um produto turístico de massas (Q_A alto) e outras optam por oferecer um produto turístico seletivo (Q_B baixo), e onde os turistas são avessos à congestão turística (β alto), a opção pela oferta de um produto turístico de luxo permitirá às economias especializadas neste tipo de oferta alcançar um nível de desenvolvimento económico mais alto do que as economias especializadas em turismo de massas.

[21] Num mundo sem rendimentos marginais decrescentes (como acontece no modelo de crescimento endógeno de Lucas, 1988), o rendimento real per capita tende a crescer indefinidamente ao longo do tempo.

[22] Demonstra-se que $\partial(R_{LUX}/R_{MED})/\partial(r/p_{MED}) > 0$ e $\lim_{r/p_{MED}\to\infty} R_{LUX}/R_{MED} = \alpha_{LUX}/\alpha_{MED}$ (vd. apêndice).

[23] Demonstra-se que $\partial(R_{MED}/R_{CON})/\partial(r/p_{CON}) > 0$ e $\lim_{r/p_{CON}\to\infty} R_{MED}/R_{CON} = \alpha_{MED}/\alpha_{CON}$ (vd. apêndice).

5. Conclusão e implicações

Este trabalho abordou a problemática da especialização produtiva em turismo por parte de uma pequena economia aberta. Procurou-se dar resposta a duas questões interligadas. Em primeiro lugar, procurou-se saber quais são as condições que se devem verificar para que a especialização em turismo não conduza a taxas de crescimento económico mais baixas do que as registadas por economias especializadas em atividades nas quais a produtividade é superior. Em segundo lugar, e assumindo que a especialização em turismo é uma opção viável do ponto de vista das taxas de crescimento económico, procurou-se saber se a dimensão da dotação de recursos turísticos afeta (ou não) os níveis de desenvolvimento económico alcançados no longo prazo.

A resposta à primeira questão foi obtida através do desenvolvimento de uma versão simplificada da adaptação que Lanza e Pigliaru (1994) fizeram a partir do modelo de crescimento endógeno de Lucas (1988) com *learning-by-doing*. Concluiu-se que para que a especialização em turismo seja uma opção preferível à especialização noutras atividades de maior produtividade, nomeadamente a manufatura, basta que a elasticidade de substituição entre o consumo desses dois bens seja baixa.

A resposta à segunda questão, objetivo primordial deste trabalho, baseou-se na análise do efeito da existência de dotações turísticas de diferente dimensão, conjugadas com diferentes níveis de oferta turística disponível. Dita conjugação repercutiu-se primeiro na qualidade dos produtos turísticos e depois nas receitas de longo prazo das economias especializadas em turismo. Concluiu-se que quanto maior for a disparidade entre os níveis de oferta turística (avaliados, por exemplo, em termos de capacidade hoteleira) disponibilizados pelas diferentes economias, maior será o benefício da especialização em turismo de qualidades alta (no caso das economias com dotações turísticas de grande dimensão) ou média (no caso das restantes economias). Este benefício é igualmente afetado pela perceção dos turistas em relação à qualidade dos produtos turísticos: quanto maior o grau de aversão dos turistas em relação ao turismo de massas, maior será o benefício da especialização em turismo da melhor qualidade possível. Concomitantemente, concluiu-se que o nível de rendimento – e, portanto, de desenvolvimento económico – alcançado no longo prazo é tanto maior quanto maior for a preferência dos consumidores pelos produtos turísticos de melhor qualidade.

É importante salientar as diferenças entre o trabalho que nos serviu de inspiração – Lanza e Pigliaru (1994) – e o nosso. Aqueles autores concluem que no longo prazo uma economia especializada em turismo de qualidade elevada pode, não só, registar taxas de crescimento económico superiores às registadas pelas economias especializadas em manufatura como também alcançar níveis de desenvolvimento económico mais elevados do que as economias especializadas em turismo de baixa qualidade. Nós concluímos que só as economias que disponham de uma elevada dotação de recursos turísticos são suscetíveis de oferecer um produto turístico de elevada qualidade e, por essa via, alcançar os resultados económicos de longo prazo preconizados por Lanza e Pigliaru (1994).

Os modelos apresentados e desenvolvidos, bem como as respetivas conclusões, permitem retirar algumas ilações particularmente úteis para as entidades públicas e privadas ligadas ao desenvolvimento turístico.

Em primeiro lugar, ressalta a ideia de que apesar da importância da existência de uma dotação de recursos abundantes, a capacidade de um destino se demarcar da tendência para a massificação é fundamental. De facto, se a vantagem decorrente da especialização em turismo depende do seu preço relativo e sendo necessário assegurar a competitividade do produto turístico, requer-se, necessariamente, o aumento da qualidade do mesmo através do incremento do seu valor acrescentado. Dito de outra forma, é necessário acrescentar valor ao produto turístico para que daí decorra um aumento da qualidade do mesmo que justifique um preço mais elevado.

Em segundo lugar, abre-se espaço para a intervenção dos poderes públicos. Tal acontece, por um lado, porque como o turismo de baixa qualidade é um bem de primeira necessidade, sempre existe procura para ele, o que constitui motivação suficiente para a sua proliferação. Assim, compete às entidades públicas criar um sistema de incentivos que contribua para a mitigação da oferta turística de baixa qualidade. Entre as várias medidas possíveis e apenas para ilustrar a tónica a imprimir, sugere-se: a criação de requisitos a que as empresas devem obedecer se se quiserem dedicar à atividade turística (em termos de qualidade das estruturas e infraestruturas, formação da mão-de-obra, etc.); a proteção dos recursos turísticos, vedando ou condicionando o seu acesso; a penalização do alojamento clandestino, etc. Por outro lado, a intervenção pública é igualmente justificada pela própria necessidade de assegurar a qualidade dos produtos turísticos. Não se deve esquecer que é o Estado quem fornece muitas das infraestruturas básicas que dão suporte à atividade turística (aqui, estamos a falar de estradas, saneamento básico, parques de estacionamento, serviços de saúde, sinalética, informação turística, etc.). Uma vez que a qualidade varia de forma diretamente proporcional à dotação de recursos turísticos (S) e de forma inversamente proporcional ao volume de produção turística (Q), tudo aquilo que o Estado possa fazer para aumentar o primeiro e diminuir ou conter o crescimento do segundo vai contribuir para melhor a qualidade do produto turístico.

Em terceiro lugar, ganham relevância as atividades de planeamento turístico. Como a maximização das receitas decorrentes da especialização turística exige a presença de uma elevada dotação de recursos turísticos, sugere-se o cuidadoso levantamento dos recursos turísticos existentes e aproveitáveis, bem como a avaliação da capacidade competitiva dos produtos turísticos neles baseados. As preocupações em termos de planeamento devem ser tanto maiores quanto maior for a dependência do produto turístico face a recursos naturais, ambientais ou de alguma forma perecíveis. Isto porque a degradação destes não só compromete a sustentabilidade do padrão de especialização produtiva escolhido, como pode conduzir a economia à completa estagnação económica, pois os fatores produtivos canalizados para o turismo dificilmente são aplicáveis noutras atividades com idêntica expetativa de rentabilidade.

A importância da dimensão da dotação de recursos turísticos merece uma ressalva. É verdade que se os recursos naturais e ambientais não são os únicos suscetíveis de aproveitamento turístico, então também é verdade que qualquer economia pode aumentar a sua dotação através da criação ou aproveitamento de outros tipos de recursos. Temos como exemplos a realização de festivais e feiras, a construção e dinamização de centros de congressos, etc. No entanto, estes tipos de atrações turísticas, concebidas pelo ser humano, sem tradição histórica e não necessariamente específicas do local onde são implantadas, são muito mais

fáceis de replicar. Em linguagem económica, constituem produtos com muitos substitutos próximos e, por isso mesmo, com uma procura muito mais sensível (ou seja, mais elástica) em relação ao preço. Assim, estes produtos, mesmo que tenham muito valor acrescentado, oferecem sempre uma margem muito menor à aplicação de estratégias baseadas nos preços.

Em quarto e último lugar, sugere-se a canalização dos esforços de marketing para as camadas populacionais detentoras de níveis de rendimento mais elevados. Uma primeira justificação reside no facto de que se um produto turístico de qualidade elevada é, ao mesmo tempo, um produto de elevado valor acrescentado, então ele também é, tendencialmente, mais caro e, por isso mesmo, apenas acessível a quem tem capacidade para o adquirir. Uma outra justificação reside no diferencial entre os níveis de procura enfrentados pelos vários destinos e, concomitantemente, entre os níveis de qualidade dos mesmos. Assim, quanto maior for o número de destinos que, por opção, por mau planeamento ou ausência de intervenção pública, se converterem em destinos de menor qualidade, maior será a escassez relativa de produtos turísticos de elevada qualidade. Logo, maior será a disponibilidade do consumidor com elevados grau de aversão ao congestionamento turístico e capacidade financeira para pagar um preço mais alto.

A evidência empírica tem sugerido que o turismo, sobretudo o internacional, é um produto de luxo, o que torna a sua procura bastante sensível às oscilações do ciclo económico. Sendo assim, uma última justificação para a aposta no segmento populacional detentor de rendimentos elevados é o facto de o padrão de consumo desta categoria de indivíduos ser pouco sensível às oscilações do rendimento subjacente ao ciclo económico. Dito de outra forma, destinos que oferecem produtos turísticos de elevada qualidade direcionados para as camadas socioeconómicas elevadas estão menos dependentes dos ciclos económicos internacionais. Como tal, também sofrem com menos agressividade alguns dos custos subjacentes ao desenvolvimento da atividade turística (como seja a dependência económica relativamente à própria atividade turística).

Obviamente, as conclusões e ilações aqui apresentadas estão intimamente ligadas ao enquadramento teórico assumido, à forma como certos conceitos foram definidos e introduzidos na análise e às formas funcionais escolhidas. Em estudos futuros, seria interessante testar a sensibilidade das nossas conclusões face a diferentes enquadramentos teóricos (nomeadamente o sugerido por Baumol, 1967), definições e formas funcionais.

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APÊNDICE

Dedução da equação (12)

Dada a relevância dos preços no contexto das atividades turísticas, a taxa de crescimento de uma economia especializada em turismo corresponde à taxa de crescimento das respetivas receitas totais (RT) em termos do produto manufaturado, ou seja, à taxa de crescimento de:

$$RT_t = P_t \times Q_{T_t}.$$

Nesta expressão o subscrito t designa o momento do tempo e P_t e Q_{T_t} correspondem, respetivamente, aos termos de troca (i.e. ao quociente entre o preço do produto turístico e o preço do produto manufaturado) e ao produto turístico. Supondo que ambas as variáveis evoluem exponencialmente às taxas $\frac{\dot{P}}{P}$ (equação 9) e λ_T (equação 4), respetivamente, teremos:

$$P_{t+1} = P_t \times e^{\frac{\dot{P}}{P}},$$

$$Q_{t+1} = Q_t \times e^{\lambda_T},$$

bem como

$$RT_{t+1} = RT_t \times e^{\frac{\dot{P}}{P}+\lambda_T} \Rightarrow \frac{RT_{t+1}}{RT_t} = e^{\frac{\dot{P}}{P}+\lambda_T}.$$

Como tal, a taxa de crescimento discreta da economia completamente especializada em turismo (Υ_T) será dada por:

$$\Upsilon_T = (e^{\frac{\dot{P}}{P}+\lambda_T} - 1) \times 100\%,$$

e a respetiva taxa de crescimento instantânea por:

$$\Upsilon_T = \frac{\dot{P}}{P} + \lambda_T.$$

Uma vez que $\frac{\dot{P}}{P} = (\lambda_M - \lambda_T)\sigma^{-1}$ (equação 11), teremos

$$\Upsilon_T = \lambda_T + (\lambda_M - \lambda_T)\sigma^{-1},$$

o que corresponde à equação (12).

Dedução das equações (21), (22) e (23):

O lagrangiano relativo ao problema do consumidor é dado por:

$$\mathcal{L} = (q_{CON} - \theta)^{\alpha_{CON}}(q_{MED})^{\alpha_{MED}}(q_{LUX})^{\alpha_{LUX}} + \lambda(r - p_{CON}q_{CON} - p_{MED}q_{MED} - p_{LUX}q_{LUX}),$$

cujas condições de primeira ordem correspondem a:

$$\begin{cases} \alpha_{CON}(q_{CON}-\theta)^{\alpha_{CON}-1}(q_{MED})^{\alpha_{MED}}(q_{LUX})^{\alpha_{LUX}} - \lambda p_{CON} = 0 \\ \alpha_{MED}(q_{CON}-\theta)^{\alpha_{CON}}(q_{MED})^{\alpha_{MED}-1}(q_{LUX})^{\alpha_{LUX}} - \lambda p_{MED} = 0 \\ \alpha_{CON}(q_{CON}-\theta)^{\alpha_{CON}}(q_{MED})^{\alpha_{MED}}(q_{LUX})^{\alpha_{LUX}-1} - \lambda p_{LUX} = 0 \\ r - p_{CON}q_{CON} + p_{MED}q_{MED} + p_{LUX}q_{LUX} = 0 \end{cases}$$

A resolução das condições de primeira ordem permite obter as seguintes funções procura:

$$\begin{cases} q_{CON} = \dfrac{r}{p_{CON}}\alpha_{CON} + (\alpha_{MED} + \alpha_{LUX})\theta \\ q_{MED} = \dfrac{r}{p_{MED}}\alpha_{MED} - \alpha_{MED}\dfrac{p_{CON}}{p_{MED}}\theta \\ q_{LUX} = \dfrac{r}{p_{LUX}}\alpha_{LUX} - \alpha_{LUX}\dfrac{p_{CON}}{p_{LUX}}\theta, \end{cases}$$

que correspondem às equações (21), (22) e (23), respetivamente.

Demonstração das notas de rodapé 21 e 22:

As receitas provenientes da especialização em turismo de qualidades baixa, média ou alta são dadas, respetivamente, por:

$R_{CON} = p_{CON}q_{CON}$,

$R_{MED} = p_{MED}q_{MED}$,

$R_{LUX} = p_{LUX}q_{LUX}$.

Substituindo as respetivas funções procura em cada uma das expressões obtemos:

$$R_{CON} = p_{CON}\left[\frac{r}{p_{CON}}\alpha_{CON} + (\alpha_{MED} + \alpha_{LUX})\,\theta\right],$$

$$R_{MED} = p_{MED}\left(\frac{r}{p_{MED}}\alpha_{MED} - \alpha_{MED}\frac{p_{CON}}{p_{MED}}\,\theta\right),$$

$$R_{LUX} = p_{LUX}\left(\frac{r}{p_{LUX}}\alpha_{LUX} - \alpha_{LUX}\frac{p_{CON}}{p_{LUX}}\,\theta\right).$$

De forma perfeitamente equivalente, temos:

$R_{CON} = r\alpha_{CON} + (\alpha_{MED} + \alpha_{LUX})\theta p_{CON}$,

$R_{MED} = r\alpha_{MED} - \alpha_{MED}\theta p_{CON}$,

$R_{LUX} = r\alpha_{LUX} - \alpha_{LUX}\theta p_{CON}$.

O quociente entre R_{LUX} e R_{CON} é dado por:

$$\frac{R_{LUX}}{R_{CON}} = \frac{r\alpha_{LUX} - \alpha_{LUX}\theta p_{CON}}{r\alpha_{CON} + \left(\alpha_{MED} + \alpha_{LUX}\right)\theta p_{CON}} = \frac{\frac{r}{p_{CON}}\alpha_{LUX} - \alpha_{LUX}\theta}{\frac{r}{p_{CON}}\alpha_{CON} + \left(\alpha_{MED} + \alpha_{LUX}\right)\theta}.$$

A derivada daquele quociente em relação a r/p_{CON} é dada por:

$$\frac{\partial\left(\frac{R_{LUX}}{R_{CON}}\right)}{\partial\left(\frac{r}{p_{CON}}\right)} = \frac{\alpha_{LUX}\left[\frac{r}{p_{CON}}\alpha_{CON} + \left(\alpha_{MED} + \alpha_{LUX}\right)\theta\right] - \alpha_{CON}\left(\frac{r}{p_{CON}}\alpha_{LUX} - \alpha_{LUX}\theta\right)}{\left[\frac{r}{p_{CON}}\alpha_{CON} + \left(\alpha_{MED} + \alpha_{LUX}\right)\theta\right]^2}.$$

Demonstra-se facilmente que esta derivada apenas é positiva se:

$\alpha_{MED} + \alpha_{LUX} > \alpha_{CON}$.

Uma vez que $0 < \alpha_{CON} < \alpha_{MED} < \alpha_{LUX} < 1$, a condição encontrada é universal, pelo que a derivada em questão é estritamente positiva.

Por sua vez, o limite do quociente R_{LUX}/R_{CON} à medida que r/p_{CON} tende para o infinito é dado por:

$$\lim_{(r/p_{CON})\to\infty}\left(\frac{r_{LUX}}{r_{CON}}\right) = \lim_{(r/p_{CON})\to\infty}\left[\frac{\frac{r}{p_{CON}}\alpha_{LUX} - \alpha_{LUX}\theta}{\frac{r}{p_{CON}}\alpha_{CON} + \left(\alpha_{MED} + \alpha_{LUX}\right)\theta}\right].$$

Aplicando a regra de Cauchy, obtemos

$$\lim_{(r/p_{CON})\to\infty} \frac{\left(\frac{r}{p_{CON}}\alpha_{LUX} - \alpha_{LUX}\theta\right)'}{\left(\frac{r}{p_{CON}}\alpha_{CON} + \left(\alpha_{MED} + \alpha_{LUX}\right)\theta\right)'} = \lim_{(r/p_{CON})\to\infty} \frac{\alpha_{LUX}}{\alpha_{CON}} = \frac{\alpha_{LUX}}{\alpha_{CON}},$$

o que permite demonstrar o resultado apresentado na nota de rodapé 21.

Procedendo de forma idêntica para o quociente entre R_{MED} e R_{CON} demonstra-se que a derivada desse quociente em relação a r/p_{CON} é estritamente positiva e que o limite desse quociente à medida que r/p_{CON} tende para o infinito é igual a $\alpha_{MED}/\alpha_{CON}$, o que nos permite demonstrar o resultado apresentado na nota de rodapé 22.

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IPO Patterns in Euronext After the Global Financial Crisis of 2007-2008

Padrões dos IPOs na Euronext Após a Crise Financeira Global de 2007-2008

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ABSTRACT
This paper looks into the pricing patterns of 161 IPOs that occurred in 2009-2017 in the Euronext markets of Amsterdam, Brussels, Lisbon and Paris. Across all the IPOs, we find a first-day raw return of 1.4% and an industry-adjusted return of 1.2%. After one year, the average raw returns are slightly higher (around 4.5%) and the average adjusted returns are negative (around -2.7%). These first-day returns are lower whilst the long-run returns are higher than those reported in other studies, most notably in those that use periods that overlap our sample. Healthcare is the industry that presents higher initial underpricing (2.3% industry-adjusted return), whilst the Technology industry presents the highest one-year underperformance (-29.5% industry-adjusted return). Our findings are in line with the market conditions and investor sentiment hypotheses according to which, when market conditions are poor (crises), uninformed investors are not so active and optimistic in the IPO market, hence underpricing and subsequent underperformance tend to be lower. A possible explanation for the different outcomes is that the global financial crises dampened persistently the activity and optimism of uninformed IPO investors, even when the European stock market and the economy in general were already recovering.
Keywords: IPO; Euronext; underpricing; market conditions; investor sentiment.

JEL Classification: G12; G14; G24.

RESUMO
O presente artigo analisa os padrões de avaliação de 161 IPOs que ocorreram entre 2009 e 2017 nos mercados Euronext de Amesterdão, Bruxelas, Lisboa e Paris. Em média, para

todos os IPOs, o primeiro dia do evento apresenta um retorno de 1,4% e um retorno ajustado ao setor de 1,2%. Após um ano, os retornos médios são ligeiramente maiores, cerca de 4,5%, enquanto os retornos médios ajustados são negativos, cerca de -2,7%. Os retornos do primeiro dia são menores enquanto os retornos de longo prazo são maiores do que aqueles apresentados noutros estudos, em particular naqueles que consideram um período que se sobrepõe, pelo menos em parte, àquele utilizado na presente análise. O setor dos Cuidados de Saúde é aquele que apresenta uma maior subavaliação inicial, com um retorno ajustado ao setor de 2,3%, enquanto os IPOs no sector Tecnológico apresentam o pior desempenho anual, com um retorno ajustado de -29,5%. Os resultados suportam as hipóteses de condições de mercado e de sentimento do investidor, de acordo com as quais, quando as condições de mercado são más (crises), os investidores não-informados não são tão ativos e otimistas no mercado dos IPOs, o que resulta numa subavaliação inicial e num subdesempenho de longo prazo menores. Uma explicação possível para estes resultados é que a crise financeira global reduziu persistentemente a atividade e o otimismo dos investidores não-informados no mercado de IPOs, mesmo quando o mercado acionista europeu e a economia em geral já se encontravam numa fase subsequente de recuperação.
Palavras-chave: IPO; Euronext; subavaliação; condições de mercado; sentimento do investidor.

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1. Introduction

Research on the IPO market has been mainly centred on the US (see, for instance, Ritter and Welch, 2002), however the literature on other countries has been building up in the last fifteen years. Among others, Jenkinson and Ljungqvist (2001), Ritter (2002), Ljungqvist (2007), and Boutron et al. (2007) survey the IPO literature and discuss the empirical evidence on other countries rather than the US. These studies point out that although the IPO market presents time-varying features that also vary across countries, some patterns seem to be pervasive. Notably, initial offer prices are substantially lower than the subsequent trading prices, which indicates initial underpricing, IPO stocks present long-run underperformance (1 to 5-year low returns) and IPO volume is related to the business and financial cycles.

There are several theories on IPO patterns, which, according to Ljungqvist (2007), may be grouped under four broad headings: asymmetric information, institutional, control, and behavioural. Arguably, all these theories have their explanatory merits; however, at least since the seminal work of Ritter and Welch (2002), the behavioural theories have gathered more consensus. Large variation in the number of IPOs, particularly the drop of issuing volume following bear markets, and the huge amounts of "money left on the table" in hot markets, such as the internet bubble of 1998-2000, suggest that market conditions are the most important factor in the decision to go public, while bounded rationality behaviour is behind the underpricing and long-run underperformance patterns. This is the main perspective undertaken in the present paper.

This study aims at contributing to the empirical literature on IPOs, by looking at the pricing patterns of IPOs that occurred in 2009-2017 in the Euronext markets of Amsterdam, Brussels, Lisbon, and Paris. When choosing a particular set of countries to study IPO patterns one must adopt a given criterion, such as geographical proximity, or degree of similarity in economic size, sector structure, or institutional framework. There are strong theoretical grounds to favour the institutional criteria, as one strand of literature points out that institutional features have a non-trivial impact on IPO patterns. Accordingly, we chose these markets because they share common listing rules, devised and supervised by the pan-European stock market Euronext. The period under scrutiny allows the examination of these patterns after the global financial crisis of 2007-2008. The studies on IPOs in this latter period in Europe are still scarce, and, to the best of our knowledge, Dorsman and Gounopoulos (2013) is one of the few papers to address this issue, finding that the crisis has increased underpricing and deepened the long-term underperformance of IPOs in the NYSE Euronext Amsterdam Stock Exchange. However, this conclusion is at odds with the market conditions and investor sentiment hypotheses.

The remainder of the paper is structured as follows. Section 2 reviews the theoretical and empirical literature, with a focus on the market conditions and investor sentiment hypotheses. Section 3 presents the data used in this study and shows the distribution of IPOs per year and industry and their returns across industries and markets for different time horizons. Section 4 describes the procedures used to compute the IPO abnormal returns and test their significance, and presents the variables used to proxy for the market conditions and investor sentiment, which are then used in regression analyses of the first-day abnormal returns. Section 5 shows the main results and Section 6 concludes the paper.

2. Literature review

The variability of underpricing and underperformance across time, industries and countries is easily recognized when one compares the results documented in the literature. For instance, Ritter and Welch (2002) report that the average first-day return of 6,249 IPOs based in the US from 1980 to 2001 was 18.8%, but Loughran and Ritter (2004) show that these initial returns were 7% in the 1980s, doubled to almost 15% during 1990-1998, jumped to 65% during the internet bubble years of 1999-2000 and then reverted to 12% during 2001-2003. Schuster (2003) distinguishes between New Economy industries (Technology, Media, Telecommunication and Healthcare) and Old Economy Industries and indicates that the initial returns and 3-year buy-and-hold returns for the former group were always higher in Germany, France, Italy, Switzerland, Netherlands, Spain, and Sweden during the period 1988-1998. Hence the observation that there is a positive link between the degree of a country's involvement in New Economy IPO activity and their IPO long-run performance. Ritter (2003) compares the IPO markets in US and Europe and gathers empirical evidence on the first-day returns for 38 countries mainly during the eighties and nineties, showing that initial underpricing ranges from around 6% (Austria, Canada and Denmark) to as much as 104% (Malaysia) and 257% (China). Boutron et al. (2007) conclude that the European IPO market has been characterized by a higher performance of New Economy IPOs and that long-term performance of European IPOs is generally superior to that measured in the US and is even positive in some countries.

IPO volume tends to be higher during economic expansions, when economy-wide demand for capital is higher (Lowry, 2003), in periods of excessive optimism (Loughran et al., 1994) and lower macroeconomic uncertainty (Thanh, 2019). Brau and Fawcett (2006) surveyed 336 chief financial officers (CFOs) in the USA in 2003, finding that the primary motivation for going public is to facilitate acquisitions and that CFOs base IPO timing on overall market conditions and take into account market and industry stock returns. Lowery (2003) shows that capital demands (proxied by the change in the number of new corporations since the last three quarters prior to the IPO) and investor sentiment (proxied by the market index returns over the four quarters subsequent to the IPO) are important determinants of IPO volume. Thanh (2019) uses the Macro Uncertainty Index of Jurado et al. (2015), which is a simple average of the standard deviations of the 1-step-ahead forecast error of 132 macroeconomic variables, and emphasizes that an increase in macroeconomic uncertainty by one standard deviation lowers the number of monthly IPOs by roughly four in the long-run. Ivanov and Lewis (2015) show that time variation in business conditions, which encompasses the cost of capital (measured by the return on the benchmark stock index over the 180--day period immediately preceding the issue and the first-difference in the monthly term spread), changes in expected profitability (first-difference in the monthly levels of an index of leading indicators), and changes in the consumer sentiment are important determinants of monthly issuing activity.

Pastor and Veronesi (2005) develop a model of optimal IPO timing in which IPO volume fluctuates due to time variation in market conditions. The empirical application of their model highlights that IPO volume is positively (negatively) related to the total market return over the previous two quarters (in the subsequent quarter) and negatively related to past and

present changes in market volatility. Çolak and Günay (2011) construct a game-theoretic model where some high-quality firms may strategically delay their initial public offering until a favourable signal about the economic conditions is generated by other issuing firms. By the time the signal spread among waiting private firms, the stock market is already rising, and the private firms' cash flows are at high levels due to the same underlying economic reasons that caused an increase in the IPO activity.

According to the investor sentiment hypothesis of Loughran et al. (1994), Ritter and Welch (2002) and Ljungqvist et al. (2006), over-enthusiasm of individual investors may drive up IPOs first-day returns, then eventually overpriced IPOs revert to their fundamental value, which causes long-run underperformance. Loughran et al. (1994) reinforce this claim by arguing that institutional investors maintain stock prices – thereby extracting surplus from sentiment investors – by holding IPO stocks in inventory and restricting the availability of shares. Underpricing emerges as a fair compensation to institutional investors for expected inventory losses arising from the possibility that sentiment demand may cease. Ljungqvist et al. (2006) highlight that both the initial price run-up and subsequent underperformance are more dramatic in "hot" periods of high IPO volume, implying that the impact of investor sentiment is particularly acute in hot markets. Over time, investor exuberance fades away, resulting in long-run underperformance. In fact, the IPO market is perceived as so intimately related to investor sentiment that first-day returns on IPOs have been proposed as a proxy for investor sentiment (Baker and Wurgler, 2006; Santos, 2017).

Several studies support empirically the investor sentiment hypothesis. For instance, this empirical evidence is found in Cornelli et al. (2006), Kaustia and Knüpfer (2008), Dorn (2009), Da et al. (2011), Aissia (2014), Saade (2015) and Santos (2017). Cornelli et al. (2006) use prices from the grey market (the market that precedes European IPOs) to proxy for small investors' valuations. High grey market prices (indicating over-optimism) are found to be a very good predictor of first-day prices, while low grey market prices (indicating excessive pessimism) are not. They find long-run price reversal only following high grey market prices. This asymmetry occurs because large institutional investors can choose between keeping the shares they are allocated in the IPO and reselling them when small investors are overoptimistic. Kaustia and Knüpfer (2008) use data on 183,000 retail investors in 57 Finnish IPOs that occurred from 1995 to 2000, and find a strong positive link between past IPO returns and future subscriptions at the investor level, which goes beyond the patterns related to the IPO cycle or wealth effects. This behaviour is consistent with reinforcement learning, where individuals repeat the strategies that have produced good outcomes in the past, overweighting in the process their personal experience. Using German data on IPO trading by 5,000 retail customers of an online broker during 1999 and 2000, Dorn (2009) documents that retail investors consistently overpay for IPOs following periods of high underpricing in recent IPOs. It is also shown that hot IPOs pass from institutional into retail hands, and over time, high initial returns are reversed as net purchases by retail investors subside, eventually resulting in underperformance over the first 6 to 12 months after the IPO. Da et al. (2011) use weekly Google searches to capture the attention of less sophisticated individual investors towards stocks. The authors point out that these investors are net buyers of attention-grabbing stocks and thus an increase in individual investor attention and related retail investor sentiment results in temporary positive price pressure,

hence abnormally higher number of internet searches should predict higher stock prices in the short term and price reversals in the long-run. The results show that the group of IPOs that experiences more attention during the week prior to the IPO outperforms the other group by 6% during the first trading day and that the long-run return reversals are more acute in the former group. Aissia (2014) examines a sample of 234 French IPOs performed between 2002 and 2012 and concludes that high initial returns are associated with higher idiosyncratic skewness and investor sentiment (measured by turnover and momentum in the first trading month). The two effects are stronger during periods of favourable market conditions. Saade (2015) decomposes the individual and institutional investor sentiment into rational and irrational components and examines their effects on the overall market at the time of IPO and on the aftermarket performance. The study, which is based on 1,346 US technology IPOs completed between 1992 and 2009, shows that the irrational component of individual investor sentiment negatively affects the performance of issued shares 6 months up to 36 months after the IPO. On the other hand, the rational component of institutional investor sentiment does not affect short-run performance (within 6 months), yet positively affects their long-run performance (24 and 36 months after the IPO). This finding suggests that in the short-run the market may be dominated by noise trading due to over-optimistic sentiment prevailing at the time of IPO. Using data on 6,858 US IPOs from 1973 to 2009 and considering IPO first-day returns as a proxy for retail demand, Santos (2017) finds that issuers in high-underpricing periods tend to underperform in the long-run, while issuers in low-underpricing periods do not. Most notably, the 5-year value from investing in IPO firms in low-underpricing periods is not different from investing in the control group; however, for firms going public in high-underpricing periods, the 5-year buy-and-hold return is -1.3%, far below the 69.9% return of their peers.

Additional evidence on the investor sentiment hypothesis comes from the analysis of the relevant information market. Arguably, if the investor sentiment is the main driving force behind underpricing, then the way that information is conveyed to less informed traders has an impact on their beliefs and, in turn, drives their demand for share and first-day returns. Loughran and McDonald (2013) show that higher levels of uncertain embedded in the compulsory filings (S-1 forms) in the US have a positive impact on first-day returns, absolute offer price revisions, and subsequent volatility. Using US data, Liu et al. (2014) show that pre-IPO media coverage, proxied by the number of newspaper articles, is positively related to the level of underpricing, long-term stock value, liquidity, analyst coverage, and institutional investor ownership. Using data between 1995 and 2005, Carey et al. (2016) investigate the influence of optimistic news stories on first-day pricing of IPOs in Australia, where, unlike the US, there is no quiet-period regulation limiting the dissemination of information from media before IPO listing dates. They find that optimistic news stories are negatively associated with IPO underpricing, suggesting that optimistic news stories mitigate information asymmetry and adverse selection problems. Conversely, Bajo and Raimond (2017) show that positive tones in the news are positively associated with IPO underpricing, especially if this news is in more reputable newspapers and is reported close to the IPO date.

3. Data and preliminary analysis

Our database includes all IPOs that occurred in the Euronext markets of Amsterdam (21 IPOs), Brussels (15 IPOs), Lisbon (3 IPOs), and Paris (122 IPOs), from 2009 to 2017. Data on the IPO dates and prices, as well as the ICB industry classification of the companies that went public, were collected from the Euronext website. We also obtained the post-IPO adjusted stock daily closing prices, the level 1 industry indexes for each country, the all-share country indexes, from 2008 until the end of 2018 from the Thomson Reuters Eikon, and the Business Confidence Index (BCI) from the OECD site.

Table 1 shows the distribution of all the IPOs by industry and year. The IPO activity is slow at the beginning of the sample due to the worldwide financial crisis. Then, it increases steadily until it peaks in the year 2015, with 40 IPOs. Finally, it decreases in 2016 and 2017. The Healthcare industry is responsible for the largest number of IPOs, 58, which represents around 36% of the total number of IPOs in the sample.

Table 1: Number of IPOs by year and industry

Year → Industry ↓	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Basic Materials			1	1						2
Consumer Goods	1		1			1	5	2	2	12
Consumer Services		2	4		2	2	4	3		17
Financials		2			2	5	7	2		18
Healthcare		6	4	7	4	12	15	4	6	58
Industrials			2	1	6	7	3	1	6	26
Oil & Gas		1	1			1	2	2		7
Technology				2	1	3	4	4	2	16
Telecommunications				1		2		1		4
Utilities				1						1
Total	1	11	13	13	15	33	40	19	16	161

Source: Euronext website.

Table 2 exhibits the buy-and-hold average returns and their standard deviations for the full IPO sample, and the ten industries. The average first-day return across all the IPOs is 1.41%, which is considerably lower than the ones reported in prior studies. For instance, Giudici and Roosenboom (2006) analyse 532 IPOs listed in the European "new markets", since their creation until December 2002, and find that the average first-day return is 35.7%. Schuster (2003) reports average 1-day returns in Dutch IPOs of 6.4%, 1.2% and 18.9% for the periods 1988-1990, 1991-1994 and 1995-1998, respectively. Dorsman and Gounopoulos (2013) show that average market-adjusted initial returns of Dutch IPO amounted to 5.13%, from 1990 to 2008, and 18.7% afterward until 2012. Boelen and Hübner (2006) find an average first-day return of 10.4% for 49 IPOs on the First Market of the Euronext Brussels

Stock Exchange from January 1989 to March 2004. Aissia (2014) considers a sample of 234 French IPOs from 2002 to 2012 traded on Euronext and Alternext markets and finds an average first-day return of 34.8%. Using data on 43 IPOs from 1987 to 2004, of which 19 are privatizations (there were no IPOs on the Lisbon Stock Exchange after 2001 until 2004), Borges (2007) finds an average first-day market-adjusted return of 11.1%.

For the other time-horizons, the average return is slightly higher: it attains 4.48% after one week, increases to 5.3% at the end of the first month, and then decreases to 4.49% at the end of the first year. The standard deviation increases with the investment horizon, as expected, which shows that the cross-section return variability is higher for longer time-horizons.

At the industry level, the first-day returns are similar across industries (between 0% for Basic Materials and Utilities and 2.35% for Healthcare). The dispersion of average returns is higher at the end of the first year. The Oil & Gas (-22.16%) and Technology (-17.34%) industries significantly underperform the remaining ones, while Telecommunications (65.48%) presents the highest average return.

Table 2: Descriptive Statistics – Industries

	Day	Week	Month	Year
All	1.41% 9.66%	4.48% 18.48%	5.30% 45.24%	4.49% 79.11%
Basic Materials	0.00%* 0.00%	-3.01%** 4.25%	-9.40%*** 2.42%	-14.33% 19.69%
Consumer Goods	1.12% 6.44%	3.50% 10.11%	-2.11% 14.97%	-16.35% 52.26%
Consumer Services	1.00% 5.91%	1.78% 7.96%	-2.97% 17.03%	9.18% 46.63%
Financials	0.43% 4.67%	3.18% 9.87%	27.27% 113.2%	8.54% 30.07%
Healthcare	2.35% 13.7%	8.17% 27.97%	8.22% 36.77*	3.02% 115.4%
Industrials	1.23% 4.39%	1.16%* 8.33%	1.52% 16.09%	3.45% 52.65%
Oil & Gas	1.32% 11.53%	0.65% 12.65%	-7.9%* 18.44%	-22.16%** 22.93%
Technology	0.40% 9.92%	4.89% 11.57%	-0.41% 13.78%	-17.34%* 43.70%
Telecommunications	1.34% 1.36%	3.07% 3.20%	2.14% 9.00%	65.48% 100.5%
Utilities	0.00% –	-1.11%% –	-5.56% –	-10.00% –

Notes: Cross-section means (top) and standard deviations (bottom) of the buy-and-hold returns on the first day, week (5 days), month (22 days) and year (260 days) after the IPO date. The 1%, 5%, and 10% significance of a difference--in-means test between each industry average return and the average return of the remaining industries is denoted by "***", "**" and "*", respectively.
Sources: Euronext website and Thomson Reuters Eikon.

Table 3 shows that the first-day average return in Lisbon (-0.24%) is significantly lower than the ones in the other markets. Only 3 firms went public in Lisbon, thus, this result may be explained by the importance of firms' idiosyncratic factors, that is the negative first-day return is most probably explained by the low initial investment attractivity of these particular firms. At the 1-year horizon, Amsterdam outperforms the rest of the markets, while Paris exhibits a negative return. The cross-section variability of IPO returns is the highest in Paris, particularly at longer horizons.

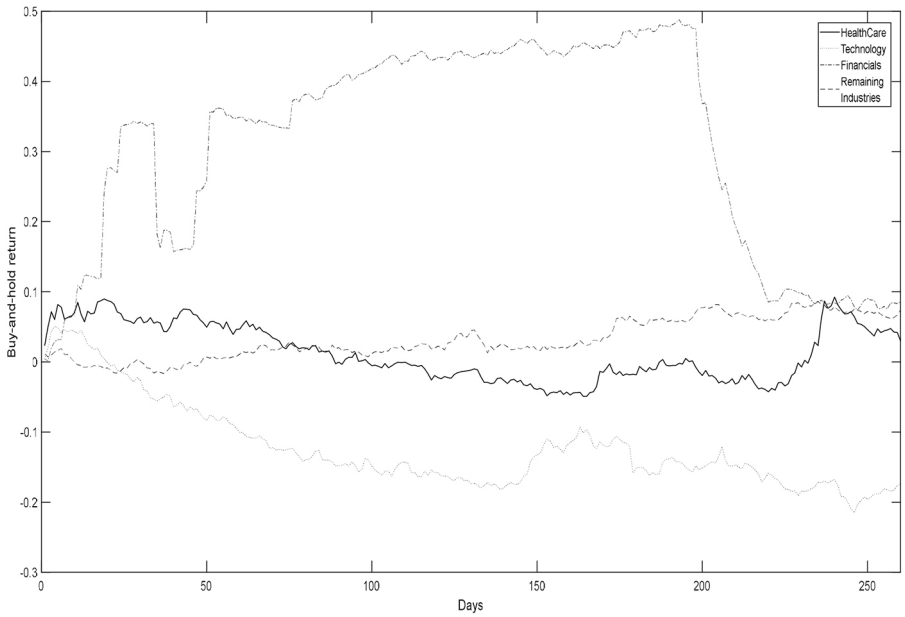
Table 3: Descriptive Statistics – Markets

	Day	Week	Month	Year
All	1.41% 9.66%	4.48% 18.48%	5.30% 45.24%	4.49% 79.11%
Amsterdam	2.10% 8.14%	4.60% 14.71%	2.27% 9.83%	28.52%** 48.09%
Brussels	2.16% 5.94%	5.73% 14.62%	4.02% 12.08%	9.62% 38.03%
Paris	1.24% 10.40%	4.39% 19.75%	6.02% 51.67%	-1.94%** 86.99%
Lisbon	-0.24%** 0.21%	0.98% 4.43%	3.69% 6.82%	18.37% 25.12%

Notes: Cross-section means (top) and standard deviations (bottom) of the buy-and-hold returns on the first day, week (5 days), month (22 days) and year (260 days) after the IPO date. The 1%, 5%, and 10% significance of a difference--in-means test between each market average return and the average return of the remaining markets is denoted by "***", "**" and "*", respectively.
Sources: Euronext website and Thomson Reuters Eikon.

Figure 1 displays the evolution of the buy-and-hold average returns for Healthcare, Financials, Technology, and the remaining industries. The average performance of Finance firms after their IPOs is quite atypical: stock prices surge during the first month after the IPO, but, in the last quarter of the first year, they strongly underperform the rest of the industries and revert towards the overall average performance. Healthcare, the industry with the largest number of IPO, shows a better than average performance during the first week, then underperforms from the second to the tenth months, and finally recovers at the end of the year. Technology stock prices increase during the first week, but, after that, they decrease substantially, leading to one of the worst average one-year returns amongst all industries.

Figure 1: Average buy-and-hold return in the first year after the IPO



Sources: Euronext website and Thomson Reuters Eikon.

4. **Methodology**

This section describes the procedure used to compute the IPO abnormal returns and the three tests designed to evaluate their significance. It also presents the variables used to proxy for the previous and expected market conditions and investor sentiment, which are then used in univariate and multivariate regression analyses of the first-day abnormal returns.

4.1. Abnormal return tests

Let BHR_t^j denote the discrete buy-and-hold return for firm j in the first t days following its IPO, such that

$$BHR_t^j = \frac{P_t^j}{P_0^j} - 1, \qquad (1)$$

where P_o^j represents the IPO price of firm j, and P_t^j represents its adjusted stock price at the end of day t. The buy-and-hold abnormal return of firm j, BHR_t^j, is computed as the excess return relative to its corresponding industry-country index return

$$BHAR_t^j = BHR_t^j - \left(\frac{I_t^j}{I_0^j} - 1 \right), \tag{2}$$

where I_t^j and I_0^j represent the index values at the end of days t and 0, respectively. The average buy-and-hold abnormal return for firms belonging to the industry i is

$$ABHAR_t^i = \frac{\sum_{j \in i} BHAR_t^j}{N^i}, \tag{3}$$

where N^i is the number of firms belonging to the industry i in the IPO sample.

In order to evaluate if the average buy-and-hold abnormal return is different from zero, we use the skewness-adjusted t-test proposed by Hall (1992), which corrects the cross--sectional standard t-test for skewed abnormal returns distribution. This test has a standard normal asymptotic distribution. The estimates of the significance test for the buy-and-hold abnormal returns within t-days for industry i, $t_{Skew,t}^i$, are computed as

$$t_{Skew,t}^i = \sqrt{N^i} \left(S_t^i + \frac{1}{3} \gamma_t^i S_t^{i2} + \frac{1}{27} \gamma_t^{i2} S_t^{i3} + \frac{1}{6N^i} \gamma_t^i \right), \tag{4}$$

where S_t^i is the ratio between the average abnormal return for industry i and its cross-section standard deviation:

$$S_t^i = \frac{ABHAR_t^i}{\sigma_t^i}, \tag{5}$$

$$\sigma_t^{i2} = \frac{1}{N^i - 1} \sum_{j \in i} (BHAR_t^j - ABHAR_t^i)^2, \tag{6}$$

and γ_t^i is the corresponding skewness estimate, given by

$$\gamma_t^i = \frac{N^i}{(N^i - 1)(N^i - 2)} \frac{\sum_{j \in i} (BHAR_t^j - ABHAR_t^i)^3}{\sigma_t^{i3}}. \tag{7}$$

It is well known that the previous skewness-adjusted t-test rests on specific assumptions about the return distributions. Thus, we evaluate the robustness of our results using two alternative non-parametric tests, namely, the sign test and the Wilcoxon signed-rank test.

The sign test rests on the assumption that abnormal returns are independent across IPOs, and that positive and negative abnormal returns are equally likely. Let $N_t^{i,+}$ represent the number of firms from the industry i with positive t-days abnormal returns. Then, the sign test, which follows an asymptotic standard normal distribution, is given by

$$Sign_t^i = \left[\frac{N_t^{i,+}}{N^i} - 0.5\right]\frac{N^{i0.5}}{0.5}. \tag{8}$$

The Wilcoxon signed-rank test considers not only the signs of the abnormal returns but also their size. In this test, the absolute values of abnormal returns are ordered from the lowest to the highest, and a ranking number is attributed to each observation according to its position. Then, a sign is given to each rank, equal to the sign of the corresponding abnormal return. The test is computed as the sum of the signed-ranks divided by their standard deviation.

$$Wilcox_t^i = \frac{W_t^i \pm 0.5}{\sigma_{w,t}^i}. \tag{9}$$

In the previous formula, W_t^i is the sum of the signed-ranks corresponding to the t-day returns from the industry i, "$\pm$ 0.5" is a correction for continuity which is negative (positive) if W_t^i is positive (negative), and the standard deviation equals

$$\sigma_{w,t}^i = \left[\frac{N^i(N^i + 1)\,(2N^i + 1)}{6}\right]^{0.5}. \tag{10}$$

4.2. First-day abnormal returns, market conditions and investor sentiment

There is no consensus on how to measure the market conditions and investor sentiment, and several proxies have been proposed in the literature. For instance, Butler et al. (2014) select, from an initial set of 48 variables, a parsimonious list of 14 variables that are robustly related to the initial IPO returns. This list includes, besides firm- and IPO-specific variables, prior 30-days market and industry returns and volatility.

Lowry et al. (2010) document the monthly dispersion of IPO initial returns and demonstrate that the volatility of initial returns is large on average and varies considerably over time. The dispersion of initial IPO returns each month has a strong positive correlation with average initial returns each month. The 1-month post-IPO returns and their volatility are highly positively correlated with the previous 1-month market returns.

Ellul and Pagano (2006) argue that, besides risk, IPO investors also worry about the after-market illiquidity that may result from asymmetric information after the IPO. The less liquid the aftermarket is expected to be, and the less predictable its liquidity, the larger will be the initial IPO underpricing.

Following the authors mentioned above, we test whether market conditions and investor sentiment influence the first-day IPO return, using:

(i) The average return of the all-share country index in the 15 days before the IPO;
(ii) The standard deviation of the all-share country index in the 15 days before the IPO;
(iii) The average return of the industry index in the 15 days before the IPO;
(iv) The standard deviation of the industry index in the 15 days before the IPO;
(v) The number of IPOs in the past six months;
(vi) The last available value of the Business Confidence Indicator at the IPO date[1].
(vii) The Amihud (2002) illiquidity measure, computed using the first 15 days after the IPO date.

In sum, variables (i) to (vi) are proxies for the market conditions and investor sentiment, while variable (vii) is a proxy for asymmetric information after the IPO. So, if at least one of the initial six variables is statistically significant, one may argue that there is a weak evidence that the behavioural arguments have some explanatory power, or, in other words that, the market conditions and investment hypotheses hold.

5. Empirical results

In the first part of this section, we report the values of the abnormal returns for the full sample and ten industries, as well as their statistical significance. The second part presents the estimation results of the first-day returns on the possible explaining variables.

Table 4 shows that there is a modest first-day underpricing in the full sample which, although statistically significant according to the skewness-adjusted t-test, is substantially lower than the underpricing found in previous studies, such as Dorsman and Gounopoulos (2013), or Giudici and Roosenboom (2006). During the remainder of the first week and first month, the IPO firms continue to exhibit higher returns than the benchmark industry indexes, but afterward, their performance reverts. At the end of the year, their adjusted return becomes negative (-2.74%).

[1] According to OECD, the BCI "provides information on future developments, based upon opinion surveys on developments in production, orders, and stocks of finished goods in the industry sector. It can be used to monitor output growth and to anticipate turning points in economic activity. Numbers above 100 suggest increased confidence in near future business performance, and numbers below 100 indicate pessimism towards future performance." We use, as an explanatory variable, (BCI-100)/100.

Table 4: Buy-and-hold abnormal returns and significance tests

	Day	Week	Month	Year
All	1.22% (1.9)* (0.71) (0.66)	4.15% (3.67)*** (0.71) (1.58)	5.17% (2.06)** (-1.34) (-0.81)	-2.74% (-0.31) (-3.55)*** (-3.29)***
Basic Materials	0.26% (0.24) (0.00) (0.22)	-7.38% (-3.58)*** (-1.41) (-1.12)	-12.94% (-1.55) (-1.41) (-1.12)	-19.86% (-36.29)*** (-1.41) (-1.12)
Consumer Goods	0.93% (0.55) (0.58) (0.06)	2.82% (0.93) (0.58) (1.00)	-3.54% (-1.06) (-0.58) (-0.84)	2.79% (0.25) (0.00) (0.22)
Consumer Services	-0.14% (-0.10) (0.73) (0.49)	1.82% (0.89) (1.21) (1.05)	-2.46% (-0.64) (-1.21) (-0.77)	8.55% (0.78) (0.24) (0.53)
Financials	0.17% (0.14) (0.00) (0.40)	2.06% (1.03) (0.00) (0.53)	27.45% (1.60) (1.41) (1.06)	9.19% (1.29) (0.94) (1.27)
Healthcare	2.34% (1.68)* (-0.79) (-0.60)	8.06% (2.80)*** (-0.53) (0.11)	7.98% (2.11)** (-1.31) (-0.18)	-5.59% (-0.19) (-3.94)*** (-3.79)***
Industrials	1.17% (1.36) (0.78) (1.30)	1.64% (1.05) (0.78) (1.23)	2.09% (0.82) (0.39) (0.44)	-0.33% (0.05) (-1.18) (-0.97)
Oil & Gas	0.68% (0.27) (-0.38) (-0.46)	-0.98% (-0.17) (-0.38) (0.04)	-8.87% (-1.28) (-1.89)* (-1.48)	-19.14% (-3.58)*** (-1.13) (-1.82)*
Technology	0.32% (0.16) (1.50) (0.66)	4.44% (1.68)* (1.00) (1.33)	-1.07% (-0.31) (-0.50) (-0.50)	-29.46% (-2.06)** (-2.50)** (-2.31)**
Telecommunications	2.16% (0.79) (1.00) (1.37)	1.29% (0.53) (0.00) (0.27)	5.22% (0.44) (1.00) (0.64)	51.52% (0.62) (1.00) (1.00)
Utilities	-0.05% – – –	0.91% – – –	-10.71% – – –	-13.69% – – –

Notes: The top number in each cell is the buy-and-hold average abnormal return in the first day, week (5 days), month (22 days) and year (260 days) after the IPO date, for the full sample (All) and ten industries. The bottom numbers (in parentheses) are the skewness-adjusted t-test value, Sign test, and Wilcoxon signed-rank test, respectively. Significance at the 1%, 5% and 10% levels is denoted by "***", "**" and "*", respectively.
Sources: Euronext website and Thomson Reuters Eikon.

Amongst the ten industries, the only one that shows a positive first-day underpricing is Healthcare (2.34%). It is noticeable that the performance of this industry is very similar to the overall sample performance (positive adjusted returns during the first day, week, and month and negative 1-year adjusted returns), which is not surprising, given that approximately 36% of all the IPOs come from the Healthcare industry. At the end of the first week, Healthcare (8.06%) and Technology (4.44%) IPO stock returns are significantly higher than the ones from their respective indexes, while Basic Materials (-7.38%) underperforms. One month after the IPO date, Healthcare (7.98%) stocks continue performing better than their industry index, and the average adjusted return of Oil & Gas companies becomes significantly negative (-8.87%), according to the sign test. Several industries present negative adjusted returns by the end of the first year, which are significant according to, at least, one of the tests. The worst-performing stocks at this time-horizon are from Technology (-29.46%), followed by Basic Materials (-19.86%), Oil & Gas (-19.14%), and Healthcare (-5.59%).

Table 5: First-day regression analysis

	R1	R2	R3	R4	R5	R6	R7	R8
Constant	0.010 (0.007)	0.002 (0.02)	0.013* (0.007)	0.008 (0.017)	0.014* (0.008)	0.013 (0.015)	0.016 (0.008)	-0.008 (0.032)
μ-Ind(15)	5.31* (2.75)							5.36* (3.09)
σ-Ind(15)		1.07 (1.7)						1.09 (2.71)
μ-Mkt(15)			2.91 (2.56)					0.43 (2.32)
σ-Mkt(15)				0.68 (1.43)				0.62 (2.41)
BCI					-0.22 (0.68)			-0.05 (0.89)
Num-IPOs						0.00 (0.001)		0.00 (0.001)
Amihud							-0.03** (0.015)	-0.041* (0.023)
R-squared	2.07%	0.30%	0.57%	0.10%	0.01%	0.00%	0.57%	3.37%

Notes: Univariate and multivariate regressions of the first-day returns on the average industry return (μ-Ind(15)), standard deviation of the industry return (σ-Ind(15)), average country return (μ-Mkt(15)), standard deviation of the country return (σ-Mkt(15)), Business Confidence Indicator (BCI), number of IPOs (Num-IPOs), and Amihud illiquidity

ratio (Amihud). The top number in each cell is the coefficient and the bottom one is its robust standard deviation. Significance at the 5% and 10% levels is denoted by "**" and "*", respectively.
Sources: Euronext and OECD websites, and Thomson Reuters Eikon.

Table 5 exhibits the results of the univariate and multivariate regressions of the first-day returns on the explanatory variables described before in Subsection 4.2. The first column shows that past industry returns exert a positive influence on the first-day underpricing, which is consistent with Butler et al. (2014) and Edelen and Kadlec (2005). That is, firms that go public benefit from the positive market conditions and investor sentiment about their industry. This variable can explain 2.07% of the cross-section first-day return variability. Unlike, Butler et al. (2014), we find that the average country index returns and the standard deviations of the industry and country indexes returns cannot predict the first-day returns. There is also no evidence of any relation between the underpricing and either the Business Confidence Indicator or the number of IPOs. Column 7 shows that illiquidity harms first-day returns. This result runs contrary to Ellul and Pagano (2006), who report a positive relationship between illiquidity and underpricing. In the multivariate regression (last column), the average industry returns and the Amihud illiquidity measure are the sole significant variables. The inclusion of all the predictors simultaneously leads to an increase in the R-squared to 3.37%.

6. Conclusion

This paper analyses the IPOs that occurred in the Euronext markets of Amsterdam, Brussels, Lisbon, and Paris, from 2009 to 2017. This sample period allows the examination of IPOs' patterns after the global financial crisis of 2007-2008. During that period there were 161 IPOs, with the Healthcare industry being responsible for the largest number of IPOs (36%). The IPO activity began slowly at the beginning of the sample, then increased until it peaked in 2015, with 40 IPOs.

The average first-day raw return and industry-adjusted return across all the IPOs are 1.4% and 1.2%, respectively. For longer time-horizons, the average raw returns are slightly higher, achieving values of around 4.5% one week and one year after the IPO. During the first week and first month of trading, the IPO firms continue to exhibit higher returns than the benchmark industry indexes, but afterward, their performance reverts, and, at the end of the year, their average adjusted returns become negative (-2.7%). Hence, for the overall IPO sample, the raw and adjusted returns increase when longer time-horizons are considered, from one day to one week and from one week to one month, and then decrease from one month to one year. The only negative value is the yearly average adjusted return. This overall pattern is dominated by the Healthcare industry, which is not surprising given that approximately 36% of all the IPOs occurred in this industry.

First-day raw and adjusted returns are considerably lower, whilst those returns at one-year horizon are higher than those reported in the literature, most notably in those studies that use sample periods that overlap with the one under analysis (see, for instance, Giudici and Roosenboom, 2006; Dorsman and Gounopoulos, 2013; Aissia, 2014). Notably, our results do not corroborate the conclusion of Dorsman and Gounopoulos (2013) that the crisis has increased underpricing and deepened the long-term underperformance of IPOs. These

smoother patterns may be explained by a more conservative behaviour of some investors who suffered heavy losses in the global financial crisis and were unwilling to put their money in unknown stocks with no return history.

The dispersion of average raw returns across industries is higher at the end of the first year. At this time-horizon, the Oil & Gas (-22.2%) and Technology (-17.3%) industries significantly underperform the remaining industries while Telecommunications presents the highest average return (65.5%). Amongst the ten industries, the only one that shows a significant positive first-day underpricing is Healthcare (with an industry-adjusted return of 2.3%). By the end of one trading year after the IPO, several industries present significant negative adjusted returns according to, at least, one of the tests: Healthcare (-5.6%), Oil & Gas (-19.1%), Basic Material (-19.9%), and Technology (-29.5%). So, the results for the Technology industry are consistent with Saade (2015), who shows that Technology stocks underperform the respective index by 16.5% twelve months after the IPO date, but, unlike Aissia (2014) and Lowry et al. (2010), we find no evidence of short-term overperformance. On the other hand, for the Healthcare industry, in which most companies that went public are biotechnological, our findings agree with those from previous studies

The regression analysis highlights that only post-IPO illiquidity and most especially past industry returns exert a significant effect on the first-day underpricing. It worth noticing that the variable that we use to proxy for investor sentiment (Business Confidence Indicator) is not significant. The illiquidity variable impacts negatively on the first-day adjusted returns, which runs contrary to Ellul and Pagano (2006), who report a positive relationship between illiquidity and underpricing. This difference in the results may be due to the different metrics used to proxy for illiquidity.

In sum, one may conclude that our results on the Euronext IPO market after the financial crisis of 2007-2008 are in line with the market conditions and investor sentiment hypotheses according to which, when market conditions are bad (crises), uninformed investors are not so active and optimistic in the IPO market, hence initial underpricing and subsequent underperformance tend to be lower. The severity of the global financial crises and the aftermath sovereign crisis may have had a negative impact on the activity and optimism of uninformed investors in the Euronext IPO market for a longer period, that persisted even when the European economy in general and the European stock market were entering in a posterior recovery stage.

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