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IS THERE A TRADE CONVERGENCE BETWEEN SOUTH EAST EUROPEAN AND CENTRAL EUROPEAN ECONOMIES?

ABSTRACT: *Given the importance of trade performance to overall economic fundamentals, the question arises as to the extent that South East European Countries (SEEC) have successfully followed the successful transition path of Central and Eastern European Countries (CEEC). To address this issue, we use similarity indicators to calculate possible convergence between the export structures of SEEC and CEEC from 2007–2008 to 2018–2019. We then compute the value of the similarity coefficients of SEEC and CEEC export structures and compare them with EU import structures, and intra-industry trade for both SEEC and CEEC. Next, we calculate the qualitative changes of both SEEC and CEEC merchandise trade through the tendency of technology-intensive products. The results of these two groups are compared to determine whether SEEC trade performance is converging to that of the CEEC. The results show structural improvements and an above-average increase in SEEC trade since 2007. However, given the simultaneous, moderate qualitative trade progress in the CEEC, the convergence between these two groups is insufficient to close the gap in the foreseeable future.*

KEY WORDS: *trade structures, convergence, South East European Countries, Central European Countries, similarity indices, intra-industry trade.*

JEL CLASSIFICATION: F14, F15, C44

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1. INTRODUCTION

The aim of this paper is to investigate convergence between the merchandise trade structures of South East European countries (SEEC) and Central and Eastern European countries (CEEC), especially in the period since 2007 when European Commission statements (European Commission 2019) indicated that SEEC had achieved some progress. Additionally, it analyses the pace of change from 2007 to 2019 by applying different statistical indicators to determine the differing progress of the economies belonging to these two groups. For example, if medium- and high-tech products in SEEC have increased and therefore narrowed the 'qualitative gap' with some of the Central European economies, it is regarded as a sign of convergence.

To avoid excessively deviating or divergent results in one year – which would become inexplicable – we deployed the additional years of 2008 and 2018 to serve as a kind of control variable.

To determine which countries constitute South East Europe and Central and Eastern Europe we draw on a study by Leitner & Holzner (2008) who, analysing economic inequality in the transition economies of Central, Eastern, and South East Europe, define SEEC as Albania, Bosnia and Herzegovina (B&H), Bulgaria, Croatia, North Macedonia, Romania, Serbia, and Montenegro, and the CEEC as the Czech Republic, Hungary, Poland, Slovakia, and Slovenia. The South-East European Cooperation Process offers a more inclusive definition and includes Turkey in its membership. Since we consider the analyses of Turkey and UNMIK-Kosovo* (hereinafter Kosovo) to be very important, especially given the former's potential EU candidate status, we include these two SEE countries so that we cover five CEEC and ten SEEC.

2. RELATED LITERATURE

There are no studies that specifically compare those particular regions, but there are many articles dedicated to the trade structure dynamics of CEEC and SEEC. Few studies look at SEEC separately, especially in the context of the trade indicators which are applied here. Despite using different methods and covering different periods, the bulk of the abundant empirical literature – some of it listed below – confirms the convergence of CEEC towards Western Europe while providing crucial findings and a model for SEEC.

Kaitila (2013, p. 12, 21–22) analyses EU countries' specialisation in value-added exports and manufacturing and their degree of structural similarity using the similarity index developed by Finger and Kreinin (1979), which is also used in this paper. The convergence of GDP growth rates with similarity in exports is also scrutinized, showing different results for the exports of 10 ex-transition countries that reflect their degree of successful economic transformation. In the 1999–2010 period, the author discovers a dramatic increase in similarity coefficients for the Baltic countries, Bulgaria, and Romania. Linnemann and Van Beers (1988, pp. 447–449) apply practically the same methodology to examine the similarity of export and import structures. They use two similarity coefficients, Finger and Kreinin and Cosines, also used in our paper. Integrated Similarity Indices are also used in some articles (for example, Kovacs 2004, p. 12), and are also applied in our paper. Kovacs points out that the Europe-wide convergence in trade structures together with real economic convergence is to be expected, because countries at a similar level of development will have similar trade structures. The Bray-Curtis index, used in this article, has also been deployed in previous papers (for example, De Benedictis & Tajoli, 2003) to detect possible structural convergence between the EU and accession countries (Poland, Hungary, Romania, and Bulgaria), showing how their export structures have changed with respect to the EU export structure. Generally, the results support the view that the evolution of trade patterns is in line with the evolution of other economic indicators – a finding important for our research.

The transformation of CEEC and SEEC export structures and their possible structural convergence with other EU members has also been a subject of interest (Fontoura & Crespo 2007, 2005, pp. 13–14). Fontoura & Crespo show that in the period 1995–2001 the export structure of these economies was transformed: the share of unskilled labour-intensive products declined and technology and skilled labour-intensive products grew. Hungary was the most dynamic economy in this respect, as reflected in its significant and increasing share in high-technology and high-skill industries (the same goods classification is used in this article), followed by Czechia and Slovakia, while most of Bulgaria's and Romania's labour-intensive exports were concentrated in low-skill sectors. The decisive shift from unskilled labour to skilled labour-intensive and technology-based products was largely due to FDI activity, mostly thanks to their economic geography, that is, their centrality.

Kaminski & Ng (2001) study the dynamics of intra-industry trade in transition countries in 1993–1998, using the standard Grubel Lloyd index, also used in this article. They find that intra-industry trade increased in all countries apart from Bulgaria, Lithuania, and Latvia. The highest increase in the value of the index was registered in Estonia, followed by Slovakia, Czechia, Romania, and Poland. This was a very important topic in 2001, as it was often argued that deeper EU integration would not increase the risk of external macroeconomic shocks due to the high level of intra-industry trade. However, the new EU members from 2004 lagged unambiguously behind: their Gruber-Lloyd coefficients were lower by 0.15–0.20 percentage points on average, excluding the results achieved by Czechia, a country already at the level of the old EU member states (Ševela 2005, pp. 200–201).

3. DATA AND METHODOLOGY, AND DYNAMICS OF SEEC TRADE SINCE 2007

This study analyses the period from 2007 to 2019. Additionally, we analyse absolute trade growth for 1994–2000 and 2000–2007. The initial year is 2007 because it was the year before the Great Recession and the final year of the period of transition in CEEC. Another reason that we took 2007 as our starting point is that we expected the two groups of economies to take a somewhat different path from that point on. The last year with available data is 2019.

The data on the countries' export and import structures are taken from the United Nations Commodity Trade Statistics Database (COMTRADE 2020), covering 261 merchandise groups at the three-digit-level Standard International Trade Classification (SITC), Revision 4. For data on the absolute values of trade we also used the UN COMTRADE database (2020), as well as national statistical sources, as was the case for Kosovo, Czechia, and Slovenia for 1996–2000. For comparative insight into the dynamics of SEEC and CEEC merchandise exports we calculated the average annual growth rate for international trade expressed in current US dollars.

Previous studies do not offer quantitative comparisons, the only exception being the intra-industry coefficients provided by Kawecka-Wyrzykowska (2008).

Calculations presented by other authors cover different periods and are therefore not fully comparable with this study. In addition, they are usually based on different data sources or are presented at different levels of aggregation.

What is especially important is that SEEC's average export and import growth in 2007–2019 was significantly higher than the average growth rate of international trade, which increased at a rate of only 2.2% in volume and 2.5% expressed in USD, largely due to the dramatic decline in 2009 and a moderate decrease in 2019 (WTO 2020; WTO 2009). Also, the SEEC average export growth rate was higher than that of CEEC, especially for Hungary (2.1%) and Slovenia (2.9%), again implying the above-average trade growth of these economies from a comparatively low base. There are exceptions: in Montenegro exports declined, and Croatia showed only modest growth of both exports and imports (2.7% and 0.7% respectively). The cumulative growth of SEEC merchandise exports between 2007 and 2019 shows roughly the same picture: generally, it increased by almost three-fifths in this period, while growth in CEEC was more modest, with the same indicator for Hungary being only 29%. Regarding imports the general picture is different, as SEEC recorded slower growth than their northern counterparts due to balance of payment limitations and excessive trade imbalances until the Great Recession.

The initial transition phase was a very important moment in this large disbalance in absolute trade performance, especially the period 1994–2000 (and several years before), when CEEC – excluding Slovenia, whose trade practically stagnated – roughly doubled their exports and imports in only six years. In the same period, SEEC merchandise exports practically stagnated, excluding modest growth in Turkey and Romania, while Serbia, Montenegro, and B&H experienced very disappointing economic conditions during the 1990s. In the second phase (2000–2007) almost all of the observed economies experienced very high export and import growth, fuelled by large capital inflows, which ended with the Great Recession. In the third phase, which is the object of this study, SEEC recorded faster export growth than their CEEC counterparts, but this modest difference was not enough to significantly improve their relative position. Most SEEC are small and open economies and, apart from domestic demand, their economic growth is mainly driven by export performance. Import growth was very low due to financing problems.

Table 1: Average annual growth of CEEC and SEEC merchandise trade (current USD)

	1994–2000	2000–2007	2007–2019	Cumulative 2007–19	Per Capita 2019	1994–2000	2000–2007	2007–2019	Cumulative 2007–19	Per Capita 2019
	EXPORTS					IMPORTS				
Czechia	12.8	22.6	4.2	64.5	18.558	13.7	20.2	3.6	52.8	16.664
Hungary	17.5	18.9	2.1	29.0	12.630	14.1	16.7	1.7	23.1	12.067
Poland	10.3	23.9	5.1	80.5	6.654	14.4	19.2	3.5	50.2	6.516
Slovakia	10.1	25.4	3.7	55.2	16.602	11.6	24.5	3.6	53.7	16.773
Slovenia	1.0	17.2	2.9	41.5	18.065	1.3	16.5	2.2	29.5	18.347
Romania	9.1	21.4	5.6	92.0	4.024	10.7	27.1	2.7	38.2	5.031
Bulgaria	–0.4	21.2	5.0	80.0	4.813	6.4	24.5	1.8	23.9	5.369
Croatia	0.7	15.8	2.7	38.0	4.161	7.1	18.5	0.7	8.4	6.829
Serbia	/	28.1	6.9	122.5	2.819	/	27.8	3.1	44.1	3.838
N. Macedonia	1.9	14.2	6.5	114.1	3.448	4.0	14.0	5.1	81.2	4.544
B&H	/	/	3.9	58.4	2.008	/	/	1.2	14.8	3.406
Albania	5.5	22.4	8.0	152.3	944	3.8	21.3	2.9	40.6	2.052
MNE	/	/	–3.3	–33.3	666	/	/	–0.6	–6.9	4.252
Kosovo	/	/	5.5	90.3	239	/	/	5.1	81.5	2.180
Turkey	7.2	21.5	4.4	68.6	2.175	15.1	17.8	1.8	23.7	2.530

Notes: Slovenia, N. Macedonia, and Albania for 1995–2000; Bulgaria for 1996–2000.

Source: Authors' own calculation based on the United Nations COMTRADE database (2020); Kosovo Agency of Statistics (2020); MONSTAT (2020); Institute of Statistics, Albania (2020); UN Data – A World of Information (2020).

Finally, to provide additional comparative insight, we obtained data on per capita exports and imports for all these economies in 2019. These data are disappointing, even for the three most advanced SEEC (Romania, Croatia, and Bulgaria), as exports per capita in 2019 were roughly four times lower than in the three best-performing CEEC, Czechia, Slovakia, and Slovenia. For per capita imports the situation is somewhat different because almost all SEEC have large deficits. Generally, the low level of per capita exports (and, to a lesser extent, per capita imports) indicates unfavourable trade and reflects the overall economic performance of SEEC.

When it comes to the used Regarding methodology, we first applied four indicators of similarity: Cosines, the Finger-Kreinin similarity coefficient, Bray-Curtis, and the Integrated Similarity Index. The coefficients indicate the probability of expected total bilateral trade, i.e., the intensity. For both CEEC and SEEC the analyses encompass the following years: 2007, 2008, 2018, and 2019. We used the structure of exports and imports according to the SITC at the three-digit level, covering 261 merchandise groups for both imports and exports for every year.

The main aim is to reveal possible convergence between 2007 and 2019 of the export structures of SEEC and CEEC, and consequently to determine the extent to which SEEC have successfully followed the transition path of the CEEC, especially regarding trade performance. To this end we compared the absolute level and trend of the similarity coefficients of the export structures of the 10 SEEC with those of the export structures of the 5 CEEC. Increased similarity or overlap indicates a better match between merchandise export structures and suggests a positive change in the trade structure of SEEC, given the more advanced export structure of CEEC. The second goal of this part of the paper is to analyse how well the export profile of SEEC matches the import profile of the EU. Increased similarity – i.e., a better match with the merchandise import structure of the EU – would indirectly imply the potential for further growth and qualitative improvement of SEEC merchandise exports and the opportunity for these economies to make the best use of their comparative advantages.

The Finger and Kreinin (FKISij) coefficient (Finger and Kreinin 1979, pp. 906–907) estimates export similarity by computing the relative importance of various merchandises in the export structure of pairs of countries, and then using a filtering technique.

$$FKIS_{ij} = \sum_{k=1} min\,(E_{ik}, M_{jk}) \tag{1}$$

where *k* is an item in SITC, *k = 1 ... 261* (for three-digit classification), *Ei* is the exporting country, and *Mj* is the importing country.

Additionally, as a kind of control variable we used three more methods that are coefficients: the Cosines index, normalised Manhattan distance with the Bray-Curtis formula, broadly used in geo-statistics and biometrics (Michie 1982, pp. 661-667), and the Integrated Similarity Index, that is, inverse values (Kovacs, 2004). All these indices are used in international trade analyses. Apart from the cited articles of the authors who developed them, Nikolić (2013, pp. 11–14) provides the mathematical formulations of these indicators. Since the Bray-Curtis index (*B-C jk*), whose mathematical expression is provided below, truncated at three decimals, is always identical to the Finger Kreinin coefficient, we did not show it in our tables, but it played a controlling role in our study.

$$B-C_{jk}=\frac{\sum_i\left|x_{ij}-x_{ik}\right|}{\sum_i\left(x_{ij}+x_{ik}\right)} \tag{2}$$

where x_{ij} is the share of the product group in the total exports or imports of country *j* in the observed year, x_{ik} is part of the section of country *k* (in total exports or imports) in the observed year, and *j, k* is the observed country (or country in different periods).

If the index value is 0, the two structures are totally different, while when the two structures are identical the maximum value is 1. The Finger and Kreinin index, as well as the other three coefficients, provides information on how well the export profile of one country matches the import profile of another country. Calculating the index over time shows whether the trade profiles of trade partners are becoming more or less compatible, with more compatibility implying higher competitiveness.

These indices have methodological problems. Due to structure configurations, coefficients may occasionally indicate totally inexplicable values in the economic sense. For example, in this study this is the case with the inexplicably low similar indices of Slovakia's exports and EU imports.

Given the key role in boosting economic performance of upgrading skill levels and products' technological composition, we investigated the quality of SEEC exports by dividing them into medium-tech and high-tech or high-skill-intensive categories. We used the same four categories as in Nikolić (2020), applied by economists and international organisations such as UNCTAD. Generally, export databases were decomposed into different categories based on skill level and technology composition. The 261 export merchandise groups were used to compute different indicators – including high R&D investment and high technology intensity – to indicate how countries are moving from primary commodities to skilled manufacturing and technological sectors, including high-tech products. Among others, we used the shares of high-skill and technology-intensive manufactures (H-S&T-I), as defined by UNCTAD (2019). Additionally, qualitative changes in SEEC exports were measured through tendencies in high-tech products (H-T) and combined medium- and high-tech products (M&H-T), both given by Muncacsi (2009), and through shares of skill-intensive manufactures (S-I), the methodology developed by Mayer and Wood (2001 pp. 9–10), where a higher level usually indicates better quality. A detailed explanation of all four classifications is also given in Nikolić (2020, pp. 3462–3463), but what is common to all of them is that they are based on the extraction of a high number of SITC technologically sophisticated and factor-intense merchandise groups, divisions, and sectors. These classifications have been used in numerous studies (Crespo and Fontoura 2007; Fabrizio et al. 2006; Lall 2000; Landesmann and Wörz 2006).

To measure intra-industry trade we used the well-known Standard Grubel-Lloyd index (Grubel and Lloyd 1975, pp. 21–23) given in Formula 3. It measures the degree of intra-industry trade due to product differentiation in economies of scale, indicating how a country simultaneously imports and export varieties of a particular product. The index is expressed as the ratio of intra-industry trade to total trade. The coefficient will be zero in the absence of intra-industry trade and one in the absence of inter-industry trade.

$$GL_j = \frac{\sum_{i=1}(X_{ij} + M_{ij}) - \sum_{i=1}\left| X_{ij} - M_{ij}\right|}{\sum_{i=1}(X_{ij} - M_{ij})} \qquad (3)$$

where *GLj* is the intra-industry trade index for total trade between the two countries, and *Xij* (*Mij*) is exports (imports) of product *i* for country *j* where *i* (sector, merchandise group) = *1…N.*

4. RESEARCH RESULTS

4.1. Convergence or divergence between SEEC and CEEC

The results presented in Table 2 are based on our calculation of the similarity between SEEC and CEEC export structures in 2007–2008 compared with 2018–2019.

Table 2: Similarity between SEEC and CEEC Export Structures, 2007–2019

Country:		Czechia			Poland			Slovenia		
Index:		Finger	Cosines	i ISI	Finger	Cosines	i ISI	Finger	Cosines	i ISI
ROM	2007	0.505	0.533	0.533	0.552	0.630	0.623	0.495	0.448	0.445
ROM	2008	0.547	0.579	0.579	0.558	0.645	0.638	0.501	0.481	0.480
ROM	2018	0.630	0.779	0.777	0.593	0.761	0.720	0.564	0.646	0.646
ROM	2019	0.631	0.779	0.776	0.591	0.749	0.716	0.560	0.572	0.565
TUR	2007	0.482	0.563	0.562	0.559	0.642	0.640	0.436	0.556	0.547
TUR	2008	0.468	0.511	0.511	0.554	0.610	0.603	0.437	0.515	0.514
TUR	2018	0.497	0.622	0.593	0.559	0.646	0.644	0.515	0.644	0.621
TUR	2019	0.500	0.602	0.567	0.566	0.645	0.645	0.529	0.562	0.518
MAC	2007	0.226	0.115	0.101	0.226	0.146	0.121	0.225	0.120	0.111
MAC	2008	0.238	0.147	0.134	0.283	0.190	0.165	0.247	0.172	0.162
MAC	2018	0.315	0.198	0.184	0.352	0.309	0.232	0.276	0.174	0.159
MAC	2019	0.320	0.204	0.190	0.348	0.304	0.236	0.280	0.165	0.156
SRB	2007	0.434	0.301	0.300	0.495	0.409	0.408	0.470	0.336	0.330
SRB	2008	0.459	0.330	0.330	0.514	0.411	0.410	0.484	0.352	0.349
SRB	2018	0.488	0.507	0.487	0.569	0.590	0.585	0.515	0.545	0.529
SRB	2019	0.474	0.431	0.415	0.575	0.569	0.565	0.488	0.426	0.403
KOS	2007	0.208	0.119	0.107	0.220	0.135	0.114	0.209	0.120	0.113
KOS	2018	0.249	0.148	0.147	0.304	0.273	0.240	0.255	0.181	0.179
CRO	2007	0.292	0.146	0.145	0.342	0.194	0.198	0.292	0.132	0.132
CRO	2008	0.446	0.278	0.244	0.487	0.425	0.409	0.480	0.313	0.312
CRO	2018	0.484	0.398	0.376	0.572	0.564	0.563	0.580	0.625	0.597
CRO	2019	/	/	/	/	/	/	/	/	/
BUG	2007	0.397	0.190	0.186	0.448	0.343	0.327	0.393	0.205	0.204
BUG	2008	0.419	0.223	0.216	0.452	0.341	0.320	0.404	0.253	0.250
BUG	2018	0.471	0.303	0.297	0.510	0.447	0.437	0.482	0.423	0.417
BUG	2019	0.476	0.322	0.313	0.515	0.451	0.446	0.489	0.454	0.433
ALB	2011	0.217	0.140	0.125	0.217	0.136	0.109	0.232	0.134	0.120

ALB	2018	0.069	0.025	0.014	0.099	0.052	0.021	0.076	0.038	0.017
MNE	2011	0.115	0.025	0.016	0.114	0.034	0.019	0.116	0.052	0.040
MNE	2018	0.182	0.133	0.123	0.213	0.164	0.123	0.305	0.385	0.351
B&H	2008	0.424	0.376	0.375	0.492	0.535	0.526	0.468	0.419	0.419
B&H	2011	0.356	0.266	0.266	0.452	0.504	0.485	0.444	0.443	0.440
B&H	2018	0.396	0.300	0.303	0.488	0.580	0.556	0.439	0.364	0.363
B&H	2019	0.403	0.310	0.307	0.490	0.586	0.567	0.436	0.318	0.312

Table 2 cont.

Country:		Hungary			Slovakia		
Index:		Finger	Cosines	i ISI	Finger	Cosines	i ISI
ROM	2007	0.458	0.442	0.412	0.553	0.492	0.461
ROM	2008	0.493	0.494	0.481	0.576	0.533	0.497
ROM	2018	0.639	0.804	0.804	0.228	0.154	0.151
ROM	2019	0.630	0.808	0.807	0.581	0.645	0.561
TUR	2007	0.424	0.399	0.383	0.489	0.620	0.565
TUR	2008	0.412	0.354	0.345	0.471	0.526	0.490
TUR	2018	0.481	0.623	0.608	0.503	0.673	0.540
TUR	2019	0.473	0.620	0.598	0.493	0.640	0.481
MAC	2007	0.203	0.078	0.075	0.282	0.158	0.157
MAC	2008	0.223	0.115	0.113	0.297	0.210	0.209
MAC	2018	0.294	0.208	0.185	0.287	0.116	0.116
MAC	2019	0.295	0.197	0.178	0.293	0.110	0.110
SRB	2007	0.376	0.214	0.205	0.451	0.283	0.257
SRB	2008	0.414	0.267	0.256	0.476	0.314	0.286
SRB	2018	0.518	0.554	0.545	0.448	0.502	0.411
SRB	2019	0.493	0.486	0.476	0.455	0.376	0.296
KOS	2007	0.173	0.074	0.073	0.192	0.071	0.071
KOS	2018	0.207	0.126	0.123	0.210	0.081	0.079
CRO	2007	0.295	0.136	0.135	0.265	0.088	0.084
CRO	2008	0.392	0.212	0.211	0.438	0.226	0.219
CRO	2018	0.502	0.725	0.692	0.444	0.321	0.253
CRO	2019	/	/	/	/	/	/
BUG	2007	0.379	0.213	0.213	0.442	0.263	0.258
BUG	2008	0.399	0.241	0.241	0.435	0.272	0.269
BUG	2018	0.504	0.384	0.382	0.411	0.209	0.179

BUG	2019	0.510	0.394	0.388	0.420	0.213	0.171
ALB	2011	0.170	0.070	0.070	0.200	0.110	0.110
ALB	2018	0.071	0.066	0.035	0.069	0.024	0.019
MNE	2011	0.120	0.020	0.020	0.120	0.030	0.030
MNE	2018	0.190	0.168	0.150	0.172	0.118	0.118
B&H	2008	0.340	0.234	0.230	0.378	0.214	0.202
B&H	2011	0.350	0.280	0.280	0.400	0.250	0.250
B&H	2018	0.347	0.292	0.293	0.361	0.173	0.155
B&H	2019	0.350	0.296	0.289	0.361	0.166	0.142

Source: Authors 'own calculation based on the United Nations COMTRADE database (2020) and Kosovo Agency of Statistics (2020).

Table 2 shows that between the observed years there was a moderate increase in the similarity between SEEC and CEEC in a large majority of the analysed cases. The absolute level of the similarity coefficient is mostly higher in 2018 and 2019 than in 2007 and 2008. However, regarding the Slovakia anomaly, with motor vehicles constituting more than one-quarter of merchandise exports, when Slovakia's export structures are matched with SEEC the results in roughly half of the cases showed opposite patterns. There is a significant decline in the similarity between the export structures of Bulgaria and B&H, with similar coefficient levels to the export structures of Turkey and North Macedonia oscillating or, at best, stagnating. Among other surveyed pairs of countries, Albania recorded a decrease in the observed coefficients regarding all five CEEC. Additionally, B&H's export structure also fell compared to that of Slovenia and Czechia (and the already-mentioned Slovakia). However, the overall picture is clear: since 2007 the similarity between the export structures of SEEC and CEEC has shown a solid growth.

The greatest similarity is recorded for Romania, while Croatia, which also recorded a strong rise in export similarity with all CEEC, is the most economically developed SEEC. A solid growth of similarity indices was also detected in Serbia and Bulgaria. The situation is, as expected, less favourable in other SEEC: Montenegro, Kosovo, and North Macedonia recorded growth but their coefficient levels remained low, and Turkey achieved a substantially higher similarity level but recorded only a modest increase after 2007.

In general, these results showed that SEEC export structures have converged with those of CEEC, implying their improved quality. However, SEEC are still a long way from the trade performance of CEEC, which is evidenced by looking at the similarity between the export structures of CEEC economies. In 2007 and 2018–2019 Czechia and Poland show a high level of similarity and even a mild negative tendency.[1] A similar conclusion can be drawn from the similarity between the export structures of Poland and Hungary, which are high and modestly rising. [2] It is unsurprising that these export structures are more similar to each other than they are with the SEEC because the exports of CEEC economies are more sophisticated.

After this analysis, the question remains of whether SEEC's moderately positive direction is sufficient to constitute a turning point in the development of this group of countries. To address this issue, we will compare the export structures of all ten SEEC with the import structure of the EU, their main trading partner.

4.2. Comparison of SEEC and CEEC export and EU import structures

By comparing the merchandise export structures of SEEC and CEEC (as well as the US as an aspirational export structure) with EU merchandise import structures in 2007–2008 and 2018–2019, at the three-digit level of SITC (Revision 4), we obtained the similarity coefficients presented in Table 3.

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1 Finger-Kreinin was 0.668 in 2007, 0.644 in 2018, and 0.637 in 2019; Cosines also decreased slightly from 0.776 to 0.738 and 0.724, and inverse ISI was 0.771 in 2007, 0.682 in 2018, and 0.671 in 2019.

2 Finger-Kreinin was 0.587 in 2007, 0.618 in 2018, and 0.604 in 2019. Cosines were 0.642, 0.696, and 0.725, while inverse ISI amounted to 0.603 in 2007, 0.692 in 2018, and 0.663 in 2019.

Table 3: Similarity between CEEC and SEEC Export Structures and EU Import Structures, 2007–2019

	Finger	*Cosines*	*i ISI*	*Finger*	*Cosines*	*i ISI*	*Finger*	*Cosines*	*i ISI*	*Finger*	*Cosines*	*i ISI*
	2007			*2008*			*2018*			*2019*		
POL	***0.449***	***0.307***	***0.296***	***0.439***	***0.274***	***0.251***	***0.521***	***0.384***	***0.370***	***0.525***	***0.403***	***0.394***
CZE	***0.471***	***0.328***	***0.319***	***0.472***	***0.309***	***0.294***	***0.497***	***0.414***	***0.411***	***0.507***	***0.455***	***0.448***
HUN	***0.487***	***0.425***	***0.423***	***0.488***	***0.390***	***0.389***	***0.528***	***0.437***	***0.437***	***0.539***	***0.463***	***0.460***
SVK	***0.418***	***0.260***	***0.252***	***0.413***	***0.220***	***0.219***	***0.462***	***0.319***	***0.282***	***0.451***	***0.321***	***0.268***
SVN	***0.393***	***0.262***	***0.263***	/	/	/	***0.464***	***0.360***	***0.453***	***0.463***	***0.372***	***0.362***
TUR	0.419	0.295	0.289	0.398	0.245	0.235	0.460	0.354	0.348	0.483	0.412	0.406
ROM	0.439	0.306	0.304	0.442	0.304	0.293	0.461	0.354	0.353	0.467	0.378	0.377
BUG	0.442	0.278	0.278	0.433	0.265	0.264	0.497	0.365	0.364	0.502	0.394	0.393
CRO	0.434	0.273	0.273	0.426	0.227	0.225	0.492	0.414	0.404	/	/	/
SRB	0.374	0.193	0.189	0.381	0.172	0.163	0.439	0.308	0.304	0.440	0.301	0.300
MAC	0.271	0.144	0.134	0.270	0.157	0.156	0.280	0.153	0.135	0.281	0.164	0.141
KOS	0.165	0.076	0.072	/	/	/	0.204	0.106	0.103	/	/	/
ALB	/	/	/	0.371	0.628	0.607	0.133	0.198	0.104	/	/	/
B&H	/	/	/	0.297	0.133	0.130	0.328	0.207	0.207	0.324	0.211	0.211
MNE	/	/	/	0.145	0.033	0.025	0.208	0.166	0.146	/	/	/
USA	**0.613**	**0.452**	**0.433**	**0.600**	**0.430**	**0.385**	**0.642**	**0.630**	**0.630**	**0.650**	**0.673**	**0.673**

Note: Data for Albania and Montenegro in the 2008 columns are for 2011.

Source: Authors' own calculation based on the United Nations COMTRADE database (2020) and Kosovo Agency of Statistics (2020).

Table 3 shows that between the two pairs of observed years there was a moderate increase in the similarity of the two structures in almost all cases, so that the absolute level of the similarity coefficient is nearly always higher than at the beginning of the period. As expected, we detected a modest fall in similarity and other indicators in most cases in 2008 due to the Great Recession. In general, these results show that CEEC and SEEC export structures have changed in a positive direction. In CEEC, as expected, the greatest similarity was recorded for the most highly developed countries: Czechia and Hungary. It is also unsurprising that US and EU import structures are the most similar and are even becoming more so, because these are the most sophisticated economies.

These results also show that in 2007 and 2008, SEEC export structures had a significantly lower similarity level than those of the CEEC and, especially important in 2018 and 2019, they imply that SEEC exports are low quality in the European context. Yet, despite this, there are some positive changes. Excluding Albania, where a decline was detected, and N. Macedonia, with indices that were rather stagnant and then rose slightly, the similarity between the export structures of all other SEEC and EU import structures increased. This trend has been detected previously in the studies of Nikolić (2011, 2013) on Turkey and Serbia (both for the period 2000–2007), B&H (2005–2011), and Montenegro (2005–2012), which reveal rising similarity coefficients (with 2-digit SITC data) between the exports of the four observed economies and EU import demand.

It is hypothetically possible that the rise in the similarity indices was caused by deterioration in the more advanced EU import structure. To address this issue, we analysed changes in EU imports through the movement of technology-intensive products, where a strong decrease would suggest a weakening of the EU import structure and thus explain the rise in SEEC and CEEC similarity indices. The results are as expected: there is moderate growth in import structure quality seen through the growth of skill-intensive manufactures and medium- and high-tech products. The share of medium- and high-tech products in the total external imports of the EU28 was 40.6% in 2007 and 46% in 2019. A similar, generally mild rising tendency was detected in skill-intensive manufactures (34% in 2007 and 43.4% in 2018). Evidently, there is a moderate increase in the sophistication of external EU import demand, which is a global tendency, especially in developed countries.

In the technology context, the results are indicative. Given the high sophistication of EU import demand, every convergence with it is a sign of progress almost by definition because of the growing share of products (merchandise groups) 'matching' EU imports. However, looking at the level of 'overlapping' characteristics in US export and EU import structures – and, to a lesser extent, between CEEC export and EU import structures – it is clear how distant the turning point for SEEC is.

Generally, the growth of SEEC similarity indices relative to both the EU and the CEEC correlates with the beginning of strong export-oriented inflows of FDI – the arrival of foreign export-oriented companies, mostly producing components for parent companies – which, to meet the demand of the sophisticated EU market, improved the export offer of SEEC economies. This tendency is closely connected with the partial involvement of SEEC economies in global value chains (GVCs).

4.3. Technological-structure and factor-intensity CEEC trade trends

In the export structures of most of the 15 observed economies, all four product categories show similar tendencies in the period under review. Table 4 shows that the shares of high-tech, high-skill, and technology-intensive manufactures, (combined) medium- and high-tech products, and skill-intensive manufactures in the exports of 13 of these 15 countries have moderately increased since 2007–2008, the exceptions being Albania and Kosovo, where all these categories recorded a decrease.

The trends of the first two narrower categories covering more technology- and skill-intensive products differ significantly from the remaining two, which are more inclusive and encompass practically all merchandise groups from SITC sector 5 (Chemicals and related products) and sector 7 (Machinery and transport equipment). In some of the economies, high-tech and high-skill and technology-intensive manufactures only modestly increased their shares, or even showed a decrease, as in Turkey and Montenegro (or stagnated, as in B&H). Serbia experienced a slight decline regarding high-skill and technology-intensive manufactures.

Given the importance of technology- and skill-intensive exports, these results are not encouraging. Even worse, for practically all SEEC the share of these types of products in 2007–2019 was low compared to that of their CEEC counterparts. Generally, the low level of this type of product suggests the relatively low value of goods with the best chance of placement in sophisticated markets such as the EU. Given that these groups of products are mainly those that have the largest innovation content (R&D) and potential, the implication is that the performance of the SEEC export sector in this important domain is weak.

Table 4: Share of medium- and high-tech products, high-skill and technology-intensive manufacture products, and skill-intensive manufactures in CEEC and SEEC exports, 2007–2019

	2007	2008	2018	2019	2007	2008	2018	2019	2007	2008	2018	2019	2007	2008	2018	2019
	High-Tech				High-Skill Tech-Intensive				Skill-Intensive Manufactures				Medium + High			
POL	***9.7***	***11.3***	***11.9***	***12.6***	***14.6***	***16.5***	***18.6***	***18.2***	***44.8***	***45.9***	***44.4***	***44.7***	***49.8***	***50.8***	***48.4***	***48.9***
CZE	***20.5***	***20.6***	***22.4***	***23.5***	***22.6***	***23.1***	***24.9***	***26.0***	***60.0***	***58.4***	***65.1***	***66.0***	***63.5***	***61.8***	***67.6***	***68.7***
HUN	***29.3***	***30.0***	***24.4***	***25.3***	***31.6***	***32.1***	***27.2***	***27.5***	***66.8***	***65.8***	***68.8***	***70.0***	***68.3***	***67.3***	***70.5***	***71.7***
SVK	***17.6***	***20.3***	***18.4***	***18.0***	***20.2***	***22.4***	***19.4***	***18.5***	***56.5***	***57.4***	***64.5***	***66.6***	***60.8***	***61.3***	***67.5***	***69.5***
SVN	***14.7***	***16.2***	***20.3***	***23.8***	***18.0***	***19.6***	***22.6***	***26.0***	***53.9***	***54.2***	***58.9***	***58.4***	***57.1***	*57.3*	***62.0***	***61.3***
TUR	4.5	3.7	3.6	4.1	9.2	8.1	10.9	11.8	34.0	31.6	36.0	36.2	39.6	38.0	39.3	39.4
ROM	6.4	8.8	9.1	9.8	8.7	11.3	10.9	11.7	35.8	38.2	53.2	53.8	40.6	43.0	56.0	56.4
BUG	7.3	7.7	10.4	10.6	10.8	11.4	13.8	15.2	22.5	23.2	30.6	32.1	24.2	24.4	33.0	35.1
CRO	10.5	11.3	13.3	/	14.6	14.4	18.2	/	29.5	30.9	35.1	/	42.0	44.9	39.4	/
SRB	6.4	8.3	7.5	8.2	13.5	14.2	12.8	12.1	23.4	25.1	36.7	36.9	25.4	28.3	38.4	38.8
MAC	2.9	3.1	4.1	4.2	4.4	5.4	25.0	25.2	7.9	8.9	34.9	36.1	27.2	22.2	58.3	60.5
KOS	2.2	/	1.7	/	9.8	/	7.1	/	14.3	/	10.0	/	27.1	/	27.1	/
B&H	/	3.8	3.2	3.8	/	10.9	10.3	10.9	/	23.8	21.5	23.8	/	22.5	20.5	22.5
ALB	/	2.2	0.1	/	/	2.4	0.1	/	/	4.4	0.4	/	/	12.2	2.0	/
MNE	/	3.3	0.7	/	/	6.4	1.0	/	/	9.9	15.4	/	/	12.0	16.6	/

Notes: Data for Albania and Montenegro in the 2008 columns are for 2011. There are no data for Albania and Montenegro in 2019; data for Croatia are only partial and hence inadequate.

Source: Authors' own calculation based on the UN COMTRADE database (2020) and Kosovo Agency of Statistics (2020).

It should be noted that the growth trend of all four analysed indicators is a worldwide phenomenon, but SEEC recorded solid growth in the two more inclusive indices (medium- and high-tech products and skill-intensive manufactures) in a relatively short period. However, compared to the improvement in export structure in 2007– 2008, that in 2018–2019, even if solid, is still far from the level achieved by most CEEC, implying that although SEEC export quality might be improved in the European context it is still inadequate.

Table 4 shows that between 2007–2008 and 2018–2019, most of the observed CEEC moderately increased their share in most of the four product categories. As expected, Hungary achieved the best results, with medium- and high-tech products accounting for 71.7% of exports in 2019 and high-tech products making up as much as one-fifth of the country's exports (although their share was even larger in 2007). Czechia has similar results, with medium- and high-tech products amounting to 68.7% of its exports in 2019 and high-skill and technology-intensive manufactures 26%. The findings for those two countries in particular demonstrate their higher innovation capacity, which translates into three or more times higher exports per capita than in SEEC. Hungary's problem is its virtually stagnating structure at the high level it has achieved, which is also the case for Poland, while the other three observed CEEC improved somewhat.

Among SEEC, as expected, the Romanian by-the-book example of success is very indicative. Romania radically improved its export quality in the period under review and also achieved strong absolute growth. The structure of all four categories substantially improved in Bulgaria (and, incidentally, to a large extent in North Macedonia), as well as in Serbia where skill-intensive manufactures and medium- and high-tech products achieved strong growth in the analysed 12 years. The export structures of Turkey and B&H, and to some extent Montenegro, were practically stagnant in the observed period, while until 2018 Croatia achieved modest positive improvements in all categories except medium- and high-tech products.

In general, CEEC have a significantly higher share of technology-intensive product export than SEEC. Regarding convergence, the only exception is Romania, with its shares in the two most inclusive product groups: in 2019 its skill-intensive manufactures and medium- and high-tech products were substantially higher than Poland's, while its high-tech and high-skill tech-intensive products remained well below those of Poland.

In summary, Table 4 shows that in almost all of the economies the shares of technology-intensive products were constantly increasing in the observed period. Generally, this is a good sign, but it is small consolation for SEEC, given the growing trend of this kind of product in international trade and the significantly better results of CEEC.

4.4. Intra-industry trade

The standard Grubel-Lloyd index was calculated for 2007, 2008, 2018, and 2019. We calculated the same coefficients for CEEC to allow comparison and prove possible convergence. The obtained results are presented in Table 5.

Table 5: Standard Grubel-Lloyd index for selected CEEC and SEEC

	2007	**2008**	**2018**	**2019**
Poland	***0.624***	***0.640***	***0.682***	***0.682***
Czechia	***0.692***	***0.694***	***0.732***	***0.745***
Hungary	***0.725***	***0.714***	***0.735***	***0.738***
Slovakia	***0.546***	***0.569***	***0.639***	***0.605***
Slovenia	***0.653***	***0.662***	***0.728***	***0.753***
Turkey	0.404	0.415	0.442	0.465
Romania	0.427	0.468	0.614	0.595
Bulgaria	0.440	0.439	0.592	0.611
Croatia	0.429	0.515	0.611	/
Serbia	0.420	0.434	0.540	0.535
B&H	/	0.398	0.430	0.426
N. Macedonia	/	0.289	0.365	0.355
Kosovo	0.085	/	0.127	/

Source: Authors' own calculation based on the United Nations COMTRADE database (2020) and Kosovo Agency of Statistics (2020)

The SEEC intra-industry indices suggest moderate growth with an unquestionable growing tendency, which is a good sign. CEEC also showed moderate growth in practically all the selected economies in all observed years.

However, despite almost constantly rising in the period under review, the SEEC level of intra-industry trade was significantly lower than that of the CEEC.

Additionally, we empirically detected a general growing trend of these coefficients. Since the 1990s these indicators have also been growing in European transition countries, suggesting a positive change in both their total foreign trade and their trade with the EU. For example, Kawecka-Wyrzykowska (2008; p. 15) shows that the combined intra-industry trade index for the 10 advanced CEE countries that joined the EU in 2004 increased from 0.419 in 2000 to 0.508 in 2007 (the index was calculated at the five-digit SITC level). The evolution of trade specialisation in these economies has clearly been one-directional, consisting of an increasing role for intra-industry trade. This shows that these countries have drastically shifted their production structures and made their economies more similar to EU economies as part of the so-called 'catching-up' process.

However, it is clear that the SEEC intra-industry trade index is still relatively low, indicating unfavourable trade structures. These indices are significantly lower than the same indicators for all CEEC. Some small SEEC economies, like Kosovo, have a very low level of intra-industry trade – a corollary of its inadequate trade diversification, which is a natural consequence of the small size of its overall economy.

However, three SEEC have achieved significantly better results: Romania, Bulgaria, and Croatia increased this index very rapidly and became comparable with Slovakia in 2019 (admittedly, Slovakia is not a good example for comparison because its trade structure is atypical, as mentioned above). Romania has already been recognized as the champion among SEEC, with Bulgaria substantially increasing its intra-industry coefficient over the last decade.

Although all SEEC lag behind their CEEC counterparts, our overall findings support positive expectations. The volume and structural changes of SEEC trade relations have led to increased interdependence, deeper cooperation, and the development of existing international production chains. Thus, the transformation of the SEEC trade pattern from an inter-industry to an intra-industry model is evident – a positive development that has resulted in increased interdependence, even if it is not comparable with the CEEC.

5. CONCLUDING REMARKS

The evidence presented in this study shows that the transformation of SEEC export structures has resulted in a convergence towards the corresponding CEEC structures and EU external import structures. SEEC displayed a clear-cut export convergence towards both the CEEC and EU import demand structures in 2007–2019. The process of catching up with the CEEC, and also with the EU, was expressed in a quality upgrading of SEEC total exports, which can be traced through increasing shares of technology-intensive products. Furthermore, intra-industry trade growth showed a positive trend in all SEEC.

However, despite the above-average increase in SEEC trade since 2007 and solid structural improvements, and because of solid CEEC performance over the same period, the signs of convergence between the two groups of countries are not sufficient to close the gap between them in the foreseeable future. The considerable economic gap between the two groups of economies is mirrored in their foreign trade structure and volume of exports (absolute and per capita). The difference between SEEC and CEEC in the quality of trade is expressed through a lower share of technology-intensive products, substantially smaller intra-industry trade coefficients, and significantly lower similarity with external EU import structures.

It is obvious that since the 1990s the SEEC have not succeeded in replicating the rapid adjustment of the CEEC export structure to the EU market. The SEEC did not come close to the CEEC achievement of a large reduction in the share of unskilled labour-intensive products and a substantial growth in technology and skilled labour-intensive goods, and the same applies to the integration of SEEC in GVCs. That is especially important given that CEEC exports – and, to a lesser extent, SEEC exports – are influenced by different forms of integration, such as the integration of production fragmentation with processing trade ability to foster both convergence and divergence in trade structures. The main reason that CEEC trade specialisation evolved so quickly to match that of Western partners was strong FDI inflows, which was not replicated to the same extent in SEEC.

The analysis of the dynamics of the SEEC specialisation and its convergence with EU import structures and CEEC export structures shows that the process of re-shaping SEEC trade patterns has been long and will have to continue. The research revealed that the SEEC that are EU members (Croatia, Bulgaria, and especially Romania) are the most advanced according to the analysed indicators, evidencing the significance of being a member of the EU and the associated FDI inflows; that is, integration in GVCs. For example, Romania has a significant and increasing share of technology-intensive products, the highest coefficients of intra-industry trade, and the highest similarity indices. Countries that are in an advanced phase of the EU integration process and the larger and more developed SEEC economies – Turkey and Serbia – perform better according to the obtained indicators (these two economies are also – as expected – the most integrated in GVCs). Hence, our analysis also indicates that the countries with less convergence and lower quality trade structures are those considered not ready for EU accession or are still in the initial phases of the EU accession process. This supports the view that trade patterns develop in parallel with the evolution of other economic indicators. There are reasons to assume that the trade adjustment process is incomplete and that with EU accession (discounting the three SEEC that are already EU members) there will be further restructuring of export-oriented manufacturing in the SEEC as the deeper economic integration affects the structure of exports and production through lower trade and investment costs. Trade integration, especially through the process of EU accession, and globalisation have had a positive effect and continue to influence economic and trade performance in SEEC and CEEC alike.

Our results have a number of policy implications. Catching up is not an automatic process and policymakers need to make real convergence tendencies sustainable. Institutional reforms are very important for achieving this goal. Continued FDI inflows, largely from the EU, along with further integration in GVCs, are essential to sustain trade convergence. SEEC should keep their economies open to trade and FDI, as openness acts as a catalyst for innovation and technological progress, helps attract capital, and positively influences productivity and competitiveness.

This paper contributes to a better understanding of trade convergence patterns in peripheral European economies, providing policymakers with useful insights into the role of different trade components in the convergence process. The SEEC face several challenges in the convergence process, including reinvigorating and sustaining investment – especially export-oriented FDI – and enhancing institutional quality and innovation. The CEEC experience of the trade convergence process could be useful in SEEC policymaking. Domestic policymakers should pay attention to these challenges in an effort to continue, and possibly accelerate, the process of catching up with the EU and, indirectly, with the CEEC. Consequently, if similarity in trading structures is to be a criterion of a country's readiness to join the EU – or an indicator of expected adjustments – the method for measuring similarity and convergence is a subject that should also be scrutinized.

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DRIVERS OF LIFE INSURANCE CONSUMPTION - AN EMPIRICAL ANALYSIS OF WESTERN BALKAN COUNTRIES

ABSTRACT: *Life insurance in the Western Balkan Countries is underdeveloped, but it has huge potential for development in the future. The scope of this article is to examine whether and how economic, socio-demographic, and institutional factors determine the demand for life insurance in the Western Balkans, using life insurance density and life insurance penetration as indicators of life insurance demand during 2006–2019. In order to conduct a cross-country analysis we use panel data regression models and a feasible generalised least squares regression model. The analysis reveals that the most significant factors are income per capita and changes in the urban population. The article contributes to the existing literature by identifying the variables that affect demand for life insurance in the Western Balkans and by providing evidence for insurance operators, authorities, and governments of the respective countries to find ways to further develop the insurance market.*

KEY WORDS: *life insurance demand, life insurance density, life insurance penetration, panel data model, Western Balkan Countries*

JEL CLASSIFICATION: G22, C23, O52

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1. INTRODUCTION

The life insurance industry has experienced high growth in the last 30 years. Many studies have focused on explaining the factors that influence the development of this industry. However, the development indicators of this industry in different countries vary hugely. According to the data, there is a significant difference between advanced developed countries and emerging countries: about USD 2,056 are spent on life insurance products in advanced developed countries and only USD 93 in emerging countries (Swiss Re Institute, 2020). Further studies are needed to identify the causes of the differences between countries and the determinants of life insurance consumption. Despite the high number of studies, research focusing on the life insurance in the Western Balkans is scarce.

The purpose of this paper is to identify the factors that affect consumption of life insurance in five Western Balkan countries (Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia) for the period 2006–2019. We aim to identify which economic, socio-demographic and institutional factors have the greatest impact on life insurance development in these countries.

The empirical analysis estimates two different panel data regression models. They differ because life insurance demand is measured using two dependent variables: life insurance density and life insurance penetration. The influence of economic factors is investigated through the indicators of income level, inflation rate, and financial development index. The impact of socio-demographic factors is analysed through the indicators of education, urbanisation, and health expenditure. The impact of institutional framework is studied through the Worldwide Governance Indicators such as government effectiveness, regulatory quality, rule of law, and corruption level. The selected countries are similar regarding geographic position, history, economic development, and aspirations to join the EU.

This study contributes to the existing literature first by focusing on the variables that affect life insurance consumption, and second by observing different aspects of life insurance, using two indicators to measure life insurance consumption: insurance penetration and insurance density. The results of this study will help both domestic insurance companies and international insurance companies that are interested in expanding into the region, as well as helping policymakers identify the factors that promote or hinder the development of the life insurance market in the Western Balkans.

The rest of the paper is organised as follows: section 2 describes the characteristics of the life insurance market in five Western Balkan countries; section 3 reviews previous studies on the impact of economic, socio-demographic, and institutional factors on the life insurance demand; section 4 describes the methodology and data used and discusses the preliminary results; and the last section presents the conclusions.

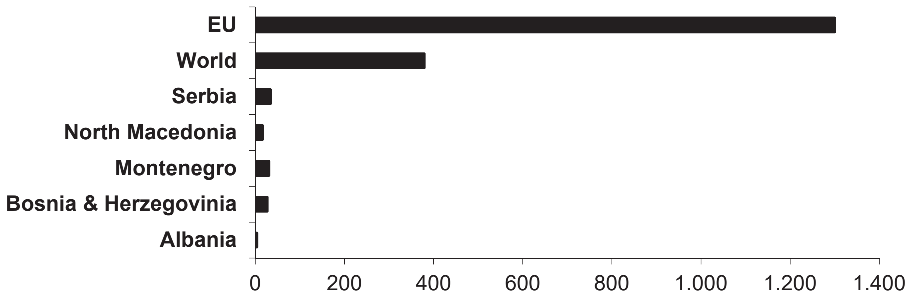
2. LIFE INSURANCE MARKETS IN THE WESTERN BALKAN COUNTRIES

This paper assesses the impact of economic, socio-demographic, and institutional variables on life insurance consumption in Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, and Serbia. The countries chosen in our study have some common features. They are neighbouring countries, four of the countries were part of former Yugoslavia, all of them spent more than 40 years under communist regimes, and all of them have experienced a long transition period and currently aspire to join the EU. In fact, EU integration is the goal of all political and economic reforms implemented in the region.

In contrast to more developed countries, the life insurance sector in Western Balkans is still underdeveloped, and significantly below the average of the EU member states. On average, an EU citizen spends USD 1,300 on life insurance sector products and USD 1,074 on non-life insurance sector products (Swiss Re Institute, 2020). In advanced developed countries, life insurance constitutes more than half of total gross written premiums, while in the Western Balkans the life insurance sector's share of total premiums is small. In 2019, life insurance premiums in Albania constituted about 7% (AFSA, 2019) of total insurance premiums, while in Bosnia and Herzegovina, Montenegro, North Macedonia, and Serbia this ratio was, respectively, 20.7% (IABH, 2019), 18% (ISA, 2019), 17.3% (ISA, 2019), and 23.3% (NBS, 2019). Life insurance products are sold on a voluntary basis. Most studies conclude that the low level of personal income and insurance culture explain this behaviour (Kozarevic et al., 2011).

In 2019, Serbia ranked first among the Western Balkan countries for life insurance density rate, followed by Montenegro. Figure 1 shows the insurance density index for the region, the EU, and globally in 2019:

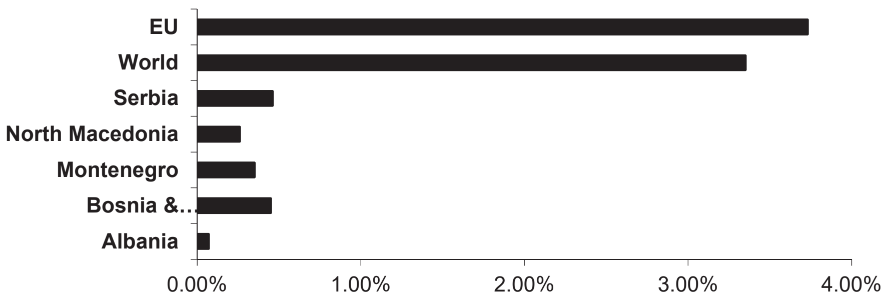
Figure 1: Life insurance density index 2019



Source: Sigma 2020, and National Insurance Supervisory Authorities Reports

The significance of the insurance industry to a country's economy is measured by the insurance penetration index. According to Swiss Re data, in 2019 the insurance industry accounted for about 7.23% of global GDP, with the life insurance sector constituting 3.35%. Again, Serbia ranked first among the Western Balkan countries, closely followed by Bosnia and Herzegovina. Figure 2 illustrates the life insurance penetration rates for the Western Balkans, the EU, and globally in 2019.

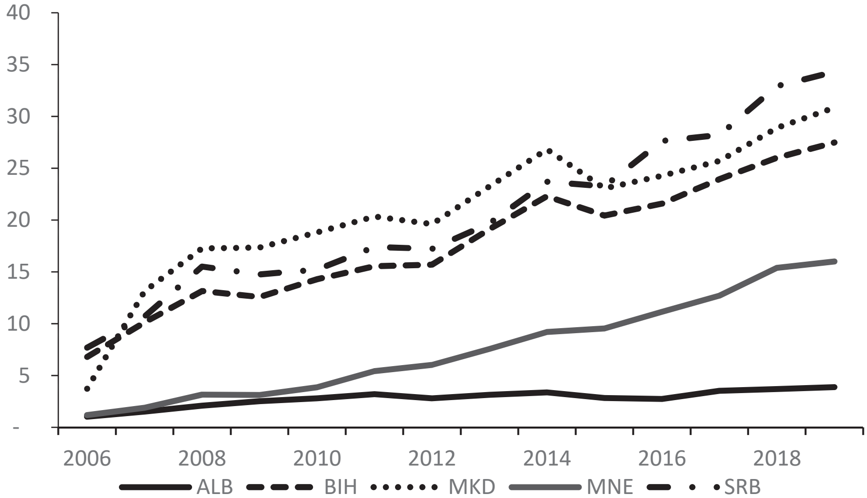
Figure 2: Life insurance penetration index 2019



Source: Sigma 2020, and National Insurance Supervisory Authorities Reports

Despite the low figures of the main indicators, the life insurance market has expanded over the years (Figures 3 and 4), especially after 2000, when an effective supervisory framework for the insurance industry was introduced.

Figure 3: Evolution of life insurance density in Western Balkan countries 2006–2019[1]



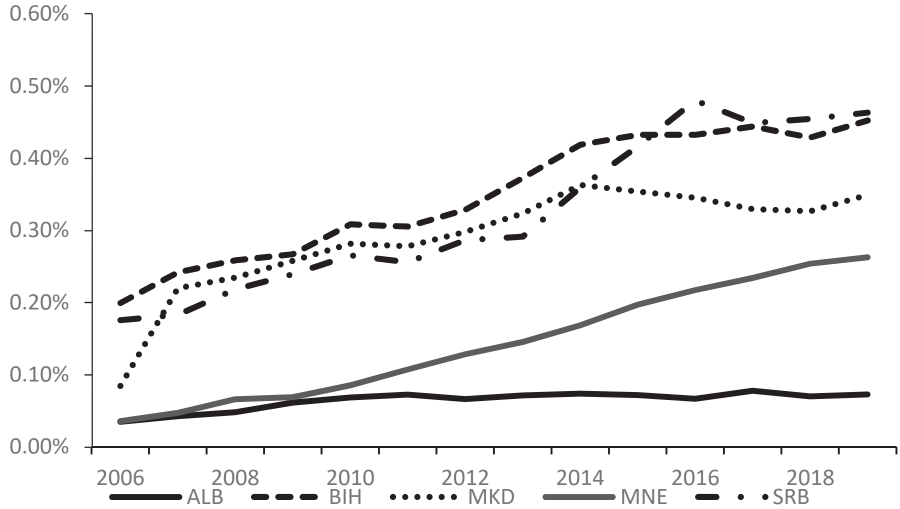
Source: Sigma 2020, and National Insurance Supervisory Authorities Reports

In 2019 the Serbians spent the most on life insurance products, followed by the North Macedonians.

In 2019 the life insurance sector was more significant in Serbia and Bosnia and Herzegovina with reference to GDP than in the other Western Balkan countries. The growth of life insurance indexes is evident in almost all Western Balkan countries, except Albania whose indexes are very low. The positive progress of the life insurance market demonstrates the unexploited potential in these countries, which can be used to promote their economic development.

1 Premiums have been converted to USD for the purpose of comparison

Figure 4: Evolution of life insurance penetration in Western Balkan countries 2006–2019[1]



Source: Sigma 2020, and National Insurance Supervisory Authorities Reports

3. LITERATURE REVIEW

The life insurance industry has experienced significant growth in the last 30 years. Due to the growing role (Satrovic, 2019) and size of this industry in the financial markets (Haiss & Sumegi, 2008), many theoretical and empirical studies have focused on identifying the factors that determine the demand for life insurance. These studies can be divided into two main branches: studies conducted from a microeconomic perspective and from a macroeconomic perspective. Empirical studies using the microeconomic perspective have assessed the determinants of households' life insurance demand by empirically testing the results of the life cycle framework and savings theory, using data from household surveys (Lee et al., 2010; Liebenberg et al., 2012). Meanwhile, the empirical studies conducted from a macroeconomic perspective have focused on identifying the factors that affect the consumption and development of life insurance based on cross-sections or panel/single country data (Beck & Webb, 2003; Kjosevski, 2012; Zerriaa et al., 2017). The variables that affect life insurance consumption identified in numerous studies can be classified as economic, institutional, demographic, socio-cultural, and psychological (Browne & Kim, 1993; Ward & Zurbruegg, 2002; Beck & Webb, 2003; Zietz, 2003; Outreville, 2012; Kjosevski, 2012; Satrovic & Muslija, 2018.

Many studies of both developed and developing countries have shown that income level is one of the economic factors that positively impact life insurance demand (Ward & Zurbruegg, 2002; Beck & Webb, 2003; Li et al., 2007). A higher income level means a greater likelihood of affording life insurance. Beck and Webb (2003) apply panel and cross-country estimates for 68 countries for the period 1961–2000 and conclude that a higher level of income is one of the factors influencing the increase in demand for life insurance, as human capital grows together with income. Kjosevski (2012) analyses the demand for life insurance using two indicators, life insurance penetration and life insurance density demand, for a panel of 14 countries in Central and South-Eastern Europe over the period 1998–2010. The study suggests that a 1% increase in GDP per capita is accompanied by an increase of about 0.0168 percentage points in life insurance penetration, and a USD 1 increase in a person's income level increases life insurance density by USD 11.56. In addition, a study of the Western Balkans over an 11-year period from 2005–2015 by Novović et al. (2015) identifies GDP as statistically significant.

There is ample evidence showing a strong negative relationship between inflation and life insurance consumption (Outreville, 1996; Beck & Webb, 2003; Ward & Zurbruegg, 2002; Li et al., 2007; Kjosevski, 2012) . Using data from Brazil, Babbel (1981) proves that consumers reduce life insurance consumption when faced with rising inflation. Life insurance is considered a long-term investment whose benefits are received in the future, and so it is affected by inflation, which makes the monetary benefits uncertain and thus affects savings.

Outreville (1996) states that financial development is an important source of growth in the insurance industry. Countries that are highly developed financially also have a higher demand for life insurance. According to Ward and Zurbruegg (2002), in developed economies a 10% improvement in financial development results in a 12% increase in life insurance consumption, while in Asian countries where financial intermediation is not so widespread the impact on consumption is only 2%. Beck and Webb (2003) state that a developed banking sector promotes life insurance consumption. On the one hand, a well-functioning banking system guarantees an efficient payment system, and on the other it increases trust in other financial intermediaries. The authors also point out that insurance can stimulate the development of capital markets by increasing demand for long-term financial investment.

One of the most important demographic factors observed in the studies is the dependency rate. Many studies find a positive correlation between the dependency rate and insurance demand. Greater dependence increases the demand for life insurance as it guarantees financial security for dependent individuals by insuring against the premature death of the 'breadwinner' (Outreville, 1996; Li et al., 2007).

Using time series for the period 1960–1982 for the United States and Mexico in relation to education level, Truett and Truett (1990) show that a higher level of education is reflected in a stronger desire to protect dependents. In a cross-sectional study of 45 countries, Browne and Kim (1993) also find a significant positive impact of education on life insurance demand, arguing that a higher level of education increases individuals' degree of risk aversion and awareness of the importance of life insurance. The same argument is found in Dragos et al. (2017), who conclude that the more people enrolled in the tertiary system the higher the life insurance density rate. In addition, life insurance products are quite complex so more-educated people can better understand them, thus increasing demand.

Urbanisation is another demographic factor considered a possible determinant of life insurance demand. According to Outreville (2012), countries with a higher share of urban population to total population will have higher levels of life insurance consumption because urbanisation simplifies the distribution of these products. Examining the determinants of life insurance demand in China, Hwang and Gao (2003) find a positive impact of urbanisation, as it provides protection and financial security for small families. Other studies do not find a strong relationship between demand for life insurance and urbanisation. Beck and Webb (2003), Nesterova (2008), and Zerriaa and Noubbigh (2016) find that urbanisation is not significant for the life insurance market. Other empirical studies have produced controversial results regarding the impact of urbanisation depending on the region considered. Dragos (2014) finds that urbanisation positively influences the demand for insurance in Asian countries while it is not significant in the Central and Eastern Europe (CEE) market, and argues that the insignificance of urbanisation for life insurance density in CEE is a result of CEE countries having a similar urbanisation rate.

Studies that assess the impact of social security expenditure on life insurance consumption are divided into those that support the thesis that social security expenditure has a positive impact (Browne & Kim, 1993; Outreville, 1996; Kjosevski, 2012) and those that support the thesis that it has a negative impact (Ward & Zurbruegg, 2002). Studies that find a negative impact refer to the substitution hypothesis, where an increase in social protection by the government makes people feel more secure and thus less likely to access protection from private schemes. Li et al. (2007) explain this negative correlation by the fact that public social spending is financed through tax increases which reduce the available income to buy life insurance. Those that find a positive impact of social spending on life insurance consumption embrace the hypothesis that social insurance programmes complement private insurance consumption. Kjosevski (2012) argues that as social security benefits increase household finances they also increase family consumption, and therefore social security expenditure is positively related to life insurance consumption.

The legal and institutional framework has a large impact on the development of the insurance industry. A low level of rule of law, a lack of property protection, improper contract enforcement, political instability, and a low-quality institutional framework hamper the development of a vibrant life insurance market. Beck and Webb (2003) find that institutional differences can explain some of the variation in life insurance consumption across countries. An improved legal system in developing countries affects the demand for life insurance (Browne & Kim, 1993; Celik S., 2009), while in developed countries the marginal effects of improvement are insignificant (Ward & Zurbruegg, 2002). The lack of a sound legal environment and incomplete implementation of contracts in developing countries hinder the development of the life insurance market (Dragos et al., 2017).

4. METHODOLOGY

4.1 Data and variables

This paper aims to identify the factors that affect life insurance consumption in five Western Balkans countries in the period 2006–2019. The economies were selected based on their similar development and history and the availability of data. The panel data for the five selected countries from the Western Balkans cover 14 years from 2006–2019, which is the period during which the insurance market was properly supervised and regulated (for example, in the case of Albania the first insurance market law was designed in 2004 in line with EU directives and the Supervisory Authority was established in 2006). Data for Albania and Bosnia and Herzegovina before 2006 is incomplete, so to have standard data quality we have chosen 2006 as the starting year.

The panel data is constructed using annual aggregate data from different secondary sources. Life insurance data was collected from various issues of the Swiss Re publication, Sigma, and from annual reports of the National Insurance Supervisory Authorities. Economic and demographic variables were obtained from the World Development Indicators and National Statistic Institutes databases. Our analysis assessing the impact of the institutional environment on life insurance consumption is based on four factors obtained from six dimensions of the Worldwide Governance Indicators initiated by Kaufmann et al. (2010).

The first dependent variable we used is life insurance density (L.I.D), which is defined as per capita premium expenditure and describes how much each inhabitant of a country spends on average on life insurance, expressed in U.S dollars. This measure is used by Beck and Webb (2003), Ward and Zurbruegg (2002), and Kjosevski (2012) in their respective studies on the determinants of life insurance demand. In our regression models, L.I. D is used in the logarithmic form. The data on insurance premiums have been converted into US dollars for the purpose of comparison.

Life insurance penetration (L.I.P) is another dependent variable used as a proxy in many other studies, such as Beck and Webb (2003) and Kjosevski (2012). L.I.P is defined as the ratio of life insurance gross written premium volume to GDP and indicates the significance of the life insurance sector in economy activity.

The dependent variables, the explanatory variables, and the data sources used in our study are summarised in Table 1.

Table 1: Dependent and independent variables used in the regression models and data sources

Variable	Source	Expected sign of the regression coefficient for the independent variable
L.I.D	National Insurance Supervisory Authorities and Swiss Re	
L.I.P	National Insurance Supervisory Authorities and Swiss Re	
Income – GDP per capita	World Development Indicators	Positive
Inflation – GDP deflator (annual %)	World Development Indicators	Negative
Financial Development – Domestic credit / GDP	World Development Indicators	Positive
Age dependency ratio	World Development Indicators	Positive
Education –Tertiary School enrolment	National Statistic Institutes	Positive
Urbanisation	World Development Indicators	Positive
Health Expenditure – Health expenditure per GDP	National Statistic Institutes	Ambiguous
Government effectiveness	Worldwide Governance Indicators	Positive
Regulatory quality	Worldwide Governance Indicators	Positive
Rule of law	Worldwide Governance Indicators	Positive
Control of corruption	Worldwide Governance Indicators	Positive

Source: The Authors

4.1.1 Economic variables

The GDP per capita level of income is measured in US dollars. This indicator is used in other studies (Outreville, 1996; Beck & Webb, 2003). 'GDP per capita (constant 2010 U.S. dollars)' is gross domestic product divided by mid-year population. We expect a positive significant relationship between GDP per capita and life insurance density and the penetration index.

The GDP deflator in annual percentage is used in our study to represent the inflation rate. 'Inflation (annual %)' as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. A negative correlation between life insurance demand and GDP deflator is expected.

The WBC are characterised by underdeveloped financial markets and the dominance of the banking sector. Since the banking sector predominates in many countries, several studies have assessed the role of the banking sector in financial development (Arena, 2008; Avram et al., 2010). We have used the domestic private credit indicator as a proxy for financial development in the Western Balkans following the arguments of Levine et al. (2000), Arena (2008), Avram et al. (2010), and Akhter et al. (2019), who believe that higher levels of private credit result in a higher level of services, and therefore greater development of financial intermediation. Countries with a high degree of financial market development are expected to have higher life insurance consumption (Beck & Webb, 2003; Li et al., 2007). Therefore, we expect a positive correlation between life insurance demand and the domestic private credit indicator. Developments in the banking sector also increase the demand for life insurance: life insurance in the WBC is compulsory if an entity needs financing, and insurance companies seek to expand their network by involving banking customers. 'Domestic credit to private sector (% of GDP)' refers to financial resources provided to the private sector, such as loans, purchase of non-equity securities, trade credits, and other accounts receivable that establish a repayment claim.

4.1.2 Socio-demographic variables

One of the main purposes of life insurance is to provide financial protection for dependents in case of the premature death of the person providing the family income. Therefore, a higher dependency rate results in a greater demand for life insurance. To capture this relationship in aggregate data, some studies use the dependency ratio defined as the ratio of dependents (under 15 and over 64) to the working-age population aged between 15 and 64 (Browne & Kim, 1993; Ward & Zurbruegg, 2002; Zerriaa et al., 2017). This variable is also used in our study. Data for this variable are shown as the proportion of dependents per 100 of the working-age population. A positive correlation of this variable with life insurance demand is expected.

A higher level of urbanisation means greater independence from informal insurance arrangements (Beck & Webb, 2003). As former communist countries, the WBC are characterised by strong informal support in both the family and the social circle as a demonstration of moral and social obligations. If a family member dies prematurely it is considered essential that the family and social circle provide support. However, in recent years the urban population has increased, the composition and number of family members has changed, and family and social solidarity has decreased, especially in urban areas. We have used the indicator 'urbanisation (% of total population)' to refer to people living in urban areas as defined by national statistical offices, and we expect it to be positively correlated with the demand for life insurance products.

Outreville (1996) and Beck and Webb (2003) state that a higher level of education results in a greater ability to understand and manage risk, thus increasing the demand for insurance; however, they fail to empirically prove the link between the two. Due to a lack of data on financial literacy in all the WBC, we have used the tertiary gross enrolment ratio as an indicator of the level of education across countries, based on previous studies (Kjosevski, 2012; Dragos et al., 2017). 'Tertiary School enrolment (number per 1000 inhabitants)' is the number of students enrolled in tertiary education in a given academic year per 1,000 inhabitants. It is calculated by dividing the total number of students enrolled in tertiary education in a given academic year by the country's population and multiplying the result by 1,000. Zietz (2003) provides a review of the literature on socio-demographic factors, listing studies documenting both the positive link between education and life insurance and the negative link. Li et al. (2007) state that more years of education mean an increase in the dependence rate, a factor which influences increased demand for insurance in order to protect dependents. On the other hand, they emphasise the ambiguity of the impact of education: if more individuals are in education there will be less manpower, thus reducing the country's GDP. A positive effect of education on life insurance demand is expected.

Kjosevski (2012) uses the ratio of health expenditure to gross domestic product to represent social security expenditure. The author argues that as social security benefits increase household finances, they also increase family consumption; therefore, social security expenditure is positively related to life insurance and consumption. Studies that find a negative impact claim that an increase in social protection by the government results in people feeling more secure and so reduces protection from private schemes (Ward & Zurbruegg, 2002). Given these opposite effects of social security expenditure on life insurance as per the literature review, an ambiguous correlation with life insurance is expected. We have used 'health expenditure per GDP (% of GDP)' as the percentage of total government expenditure spent on health. Due to a lack of data in the World Health Organization (WHO) database, these data are gathered from the National Accounts of the Statistics Institute of each country.

4.1.3 Institutional variables

In order to evaluate the impact of institutional variables, we have used the Worldwide Governance Indicators provided by the World Bank, which summarise the views on the quality of governance of a large number of enterprises, citizens, and expert surveys in industrial and developing countries. The dimensions of governance that have been selected in this study are the capacity of the government to effectively formulate and implement sound policies, and the respect of citizens and the state for the institutions that govern economic and social interactions among them.

The variable 'government effectiveness' captures perceptions of the quality of public services, the quality of the civil service and the degree of government independence from political pressure, the quality of policy development and implementation, and the credibility of the government's commitment to such policies. The variable 'regulatory quality' captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. The variable 'rule of law' captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police and the courts, and the likelihood of crime and violence. The variable 'control of corruption' captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'state capture' by elites and private interests.

4.2 Descriptive Statistics

Table 2 displays the summary statistics for the regression variables. The averages for income per capita and life insurance premium per capita are USD 5,470 and USD 13.94 respectively. This reflects the very small fraction of income, 0.25% on average, that life insurance consumption represents. The average life premium density is very diverse across the region, varying from USD 1.03 to USD 34.3.

Table 2: Summary statistics for our sample of five Western Balkan countries

	Mean	**Median**	**Min**	**Max**	**Std. Dev**
Life premium density	13.94	14.53	1.03	34.29	9.40
Life insurance penetration	0.23	0.25	0.03	0.48	0.14
GDP per capita	5,470	5,274	3,263	8,545	1165
Inflation, GDP deflator	3.4	2.4	-0.6	16.0	3.1
Domestic credit / GDP	47.7	47.4	22.4	86.5	12.
Age dependency ratio	46.2	46.9	41.2	52.6	3.2
Urban population (% total population)	55.8	56.2	44.3	67.1	6.34
Tertiary students per 1000 population	34.4	32.1	24.8	60.7	8.2
Health expenditure / GDP (%)	3.8	3.8	1.7	5.6	0.88
Government effectiveness	-0.1465	-0.0778	-0.8444	0.2652	0.2771
Regulatory quality	0.0755	0.0872	-0.4643	0.5264	0.2360
Rule of law	-0.2653	-0.2676	-0.6848	0.0984	0.1899
Control of corruption	-0.3341	-0.3217	-0.8038	0.0228	0.1842

Source: Authors' calculations from World Bank World Development Indicators and Worldwide Governance Indicators

4.3 Model Specification

As we are conducting a cross-country analysis, we have used a country-specific fixed effects (FE) panel data regression model and random effects (RE) model with common coefficients across all cross-section members of the pool. According to Li et al. (2007) a log-linear model is commonly specified in studies of the determinants of life insurance demand, as it is indicated for demand functions specified in macroeconomic variables, which tend to display exponential growth. Use of log-log estimation for GDP per capita allows for interpretation of income elasticities. The models are specified below:

Ln (*Life premium density*) = $\beta_0 + \beta_1$ ln (GDP per capita) + β_2 (inflation) + β_3 (domestic credit/GDP) + β_4(age dependency ratio) + β_5(urban population) + β_6(tertiary students per 1000 population) + β_7(health expenditures per GDP) + β_8(government effectiveness) + β_9(regulatory quality) + β_{10}(rule of law) + β_{11}(control of corruption) + ε (1)

Life premium penetration = $\beta_0 + \beta_1$ ln (GDP per capita) + β_2 (inflation) + β_3 (domestic credit/GDP) + β_4(age dependency ratio) + β_5(urban population) + β_6(tertiary students per 1000 population) + β_7(health expenditures per GDP) + β_8(government effectiveness) + β_9(regulatory quality) + β_{10}(rule of law) + β_{11}(control of corruption) + ε (2)

Before estimating the models, we performed the Im, Pesaran, and Shin panel unit-root test to test the stationarity of the variables (Im et al., 2003) The results are shown in Table 3. While the null hypothesis of the unit root was rejected for seven of the variables, implying stationarity I(0), six other variables have a unit root. These variables were differenced at the first level and tested again – while all of them display stationarity at their first difference implying first level integrated series I(1). Hence, the model is corrected with the I(1) variables included as first differences.

Table 3: Panel unit root test – Im, Pesaran, and Shin (IPS)

	Im-Pesaran-Shin Test	p-value	Stationarity
Ln (Life premium density)	−4.2897	0.0002	I(0)
Life premium penetration	−3.8479	0.0003	I(0)
Ln (GDP per capita)	−3.5213	0.0103	I(0)
Inflation, GDP deflator	−2.4557	0.0289	I(0)
Domestic credit / GDP	−4.2233	0.0000	I(0)
Age dependency ratio	−0.6158	0.9977	I(1)
Urban population	−0.3302	1.0000	I(1)
Tertiary students per 1000 population	−1.3693	0.5656	I(1)
Health expenditure per GDP	−1.9549	0.1378	I(1)
Government effectiveness	−1.7381	0.2092	I(1)
Regulatory quality	−3.5917	0.0012	I(0)
Rule of law	−2.3985	0.0337	I(0)
Control of corruption	−1.1307	0.8262	I(1)

Source: Authors' calculation using STATA 13 software

We ran estimations for both RE and FE models, and the results are shown in Table 4. We noticed significant differences between the coefficients of the two estimators. We used the Housman specification test to determine which of the two models to consider. As the p-value is less than 0.05 for both models (premium density and penetration) we considered the estimators of the FE model. Focusing only on the FE model, we performed the Wooldridge test for autocorrelation, with the null hypothesis of no first-order autocorrelation. As the p-value is less than 0.05 for both models, it shows the presence of autocorrelation. Furthermore, Pesaran's test of cross-sectional independence fails to reject the null hypothesis of no cross-sectional dependence (value =1.213, p = 0.225), suggesting cross-sectional independence. Hence, we estimated the model using a feasible generalised least squares (FGLS) regression model to account for autocorrelation – and interpret the coefficients resulting from FGLS regressions.

Table 4: Estimation results

	REM	FEM	FGLS	REM	FEM	FGLS
VARIABLE	**Ln (L.I.D)**	**Ln (L.I.D)**	**Ln (L.I.D)**	**L.I.P**	**L.I.P**	**L.I.P**
ln (GDP per capita)	2.7790***	1.9430***	2.8538***	0.1944**	0.1110	0.1544***
	(0.5352)	(0.3723)	(0.3094)	(0.0978)	(0.1122)	(0.0462)
Inflation	–0.0403**	–0.0195**	–0.0286**	–0.0111***	–0.0062**	–0.0081**
	(0.0202)	(0.0092)	(0.0098)	(0.0037)	(0.0028)	(0.0014)
Domestic credit / GDP	0.0167***	0.0064**	0.0076**	0.0013	–0.0004	0.0011*
	(0.0050)	(0.0028)	(0.0032)	(0.0009)	(0.0009)	(0.0006)
Δ Age dependency ratio	0.4072***	0.0792	0.1912**	0.1079***	0.0487**	0.0663***
	(0.0998)	(0.0630)	(0.0759)	(0.0182)	(0.0190)	(0.0108)
Δ Urban population	–0.6364***	2.3454***	1.6754***	–0.0796***	0.3064***	0.0195**
	(0.1393)	(0.2881)	(0.2030)	(0.0255)	(0.0868)	(0.071)
Δ Tertiary students per 1000 population	0.0215	0.0154*	0.0186*	0.0071**	0.0047**	0.0008
	(0.0181)	(0.0076)	(0.0087)	(0.0033)	(0.0023)	(0.0010)
Δ Health expenditures per GDP	0.0366	–0.0530	–0.0584	–0.0232	–0.0317*	–0.0113
	(0.1542)	(0.0624)	(0.0755)	(0.0282)	(0.0188)	(0.0095)
Δ Government effectiveness	0.7441*	0.1581	0.2625**	0.0690	–0.0201	0.0356*
	(0.4156)	(0.1707)	(0.1257)	(0.0760)	(0.0514)	(0.0197)
Regulatory quality	–0.8324***	0.4766**	–0.3999	–0.2617***	–0.0224	–0.0471
	(0.2419)	(0.1804)	(0.2466)	(0.0442)	(0.0544)	(0.0353)
Rule of law	–0.8251	0.5404*	0.1861	–0.0148	0.2052**	0.1193***
	(0.6487)	(0.3124)	(0.3125)	(0.1186)	(0.0942)	(0.0369)
Δ Control of corruption	–0.7735	–0.2006	–0.0267	–0.1140	–0.0248	–0.0211
	(0.5946)	(0.2554)	(0.2298)	(0.1087)	(0.0770)	(0.0290)
Constant	–22.0895***	–15.3990***	–22.0333***	–1.4056	–0.7382	–1.0975***
	(4.8212)	(3.1932)	(2.7449)	(0.8811)	(0.9624)	(0.3879)
Observations	65	65	65	65	65	65
Number of C_C	5	5	5	5	5	5
R-squared		0.9277			0.7938	

F-test (P-value)		F(11,49)=57.16 (0.0000)			F(11,49)=17.15 (0.0000)	
Wald test (P-value)	494.89 (0.0000)		381.65 (0.0000)	323.76 (0.0000)		381.65 (0.0000)
Hausman test (P-value)		45.52 (0.0000)			32.65 (0.0000)	
Wooldridge test (P-value)		19.569 (0.0115)			228.352 (0.0001)	

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors' calculation using STATA 13 software

4.4 Empirical Results

The findings displayed in Table 4 indicate that the variation in life insurance density across the region significantly and positively depends on income level, domestic credit to the private sector, changes in urban population, changes in the age dependency ratio, the number of students enrolled in the tertiary education system, and changes in government effectiveness, while it significantly and negatively depends on inflation. The results for health expenditure/GDP, regulatory quality, rule of law, and changes in the control of corruption are less robust. Furthermore, proceeding with the penetration regression, the results indicate the following relationship: income level, domestic credit to the private sector, changes in the urban population, changes in the age dependency rate, changes in government effectiveness, and the rule of law all have a significant positive impact on the demand for life insurance.

As suggested in previous studies, GDP per capita has a significant influence on life insurance density. The coefficient of GDP per capita is statistically significant and has a positive effect on life insurance density. This result suggests that as the countries' income increases, so does the life insurance density, implying that life insurance becomes relatively more affordable. Specifically, an increase of 1% in GDP per capita increases the life premium density by 2.8%, representing high income elasticity. The results are consistent with other findings in the literature (Kjosevski, 2012; Novović, et al., 2015). An increase in GDP per capita will also increase life insurance penetration. In the second model, a 1% increase in GDP per capita increases the life insurance penetration rate by about 0.00115 percentage points – a positive and statistically significant impact.

The results are consistent with the models of Beck and Webb (2002) and Kjosevski (2012). Our findings also support the results of earlier studies (Outreville, 1996; Ward & Zurbruegg, 2002; Beck & Webb, 2003; Li et al., 2007; Kjosevski, 2012). The coefficient of inflation is statistically significant, and it suggests that a one percentage point increase in inflation decreases life insurance density by 0.028%. The results are also confirmed by the second model, as the coefficient is negative and statistically significant.

Our proxy for financial development in the region is domestic credit to the private sector (% of GDP). Domestic credit/GDP is also statistically significant. A one percentage point increase in the ratio increases life insurance density by 0.0076% and the life penetration rate by 0.0011%. We expected the domestic credit variable to have a stronger impact on life insurance demand, as a considerable amount of life insurance is bought by debtors. In Albania, for example, debtors' life insurance premiums constituted 63% of the total life premiums written in 2019 (AFSA, 2019).

Changes in the age dependency ratio also have a positive and statistically significant effect on life insurance density. A one percentage point increase in the age dependency ratio increases life insurance density by 0.19% and the life insurance penetration rate by 0.066%, confirming that life insurance demand increases with an increased age dependency ratio (Li et al., 2007). However, the scale of the effect is smaller than for changes in the urban population.

Changes in urban population have a positive and statistically significant effect on life insurance density and penetration. A one percentage point increase in change in the urban population increases life insurance density by 1.68% and life insurance penetration by 0.0195 percentage points. Urbanisation in the region has transformed the family typology: extended families have been rapidly replaced by nuclear families. Individuals can no longer rely on relatives or friends to provide support when they face financial losses but have to manage financial uncertainty on their own. Thus, individuals are more willing to arrange formal private and public contracts for their future protection and security. The results are consistent with Beck and Webb (2003).

Education level also has a positive effect on life insurance density. A one unit increase in tertiary students per 1,000 population increases life insurance density by 0.018%. However, the education level appears to have no impact on the penetration rate, so the overall impact of education on life insurance is ambiguous. Dragos (2014) suggests that using the level of financial literacy instead of the level of tertiary education is more appropriate for the life insurance sector because of the complexity of wealth accumulation and distribution. This ambiguity may also result from steady improvement in education in the Western Balkans. The education system in the region has been reformed, replacing quantity with quality, leading to a contraction in the number of students enrolled in tertiary education. In Albania, higher education reform aims to integrate the teaching process with scientific research, improving the quality of higher education to meet contemporary standards and become labour-market oriented. The number of tertiary enrolled students in all the countries of the region fluctuated during the period concerned: initially it rapidly increased and later it moderately decreased, whereas the insurance density rate continuously increased.

Contrary to expectations, health expenditure as a factor determining life insurance demand in the region showed a weak effect. The results show a negative influence on life insurance density and insurance penetration which is not statistically significant. Possibly health expenditure is not a good proxy for social security expenditure. The result may be skewed due to a lack of data on the private health sector and the high degree of informality in the health sectors of these countries (Mejsner & Karlsson, 2017). Health expenditure was considered as an independent variable in the model due to a lack of data on social security for all the countries of the region and based on the previous literature. The results might be different if social security expenditure were taken into consideration. The life insurance demand in the private market will be decreased, if the governments were to provide more support to the old age population by increasing social security expenditures.

Changes in the effectiveness of governance have a positive and statistically significant effect on life insurance density. A 0.1-point increase in the effectiveness of the governance indicator increases life insurance density and penetration by 0.026% and 0.0356% respectively. The rule of law is another institutional factor considered in the model that explains the variation in the demand for life insurance across the region. The results partly support the findings of previous studies which find that institutional factors have a greater negative effect in developing and emerging countries than in developed countries, and that financial intermediaries and services are provided efficiently in economies where property rights, contract enforcement, and the rule of law are protected (Dragos, 2014).

5. CONCLUSIONS

The study determines and evaluates the factors that influence life insurance demand in the Western Balkans for the period 2006–2019. In order to avoid the problem of variable correlation the analysis focuses on eleven indicators, selected on the basis of the data available over the chosen period of time. As in the previous theoretical and empirical literature, income level was found to be the most significant factor influencing life insurance consumption. Income per capita has a direct effect on life insurance demand and an indirect effect via urbanisation, which is the second most significant factor explaining life insurance demand. Our research finds inflation to have a negative influence on life insurance demand, which is widely supported in previous research. The results also imply that domestic credit to GDP is positively linked to life insurance demand. Therefore, economic factors, financial development, and macroeconomic stability are found to play important roles in the development of the life insurance market in the region.

Regarding demographic factors, the findings suggest that increasing urbanisation and changes in the age dependency ratio have a positive and statistically significant influence on the demand for life insurance in the Western Balkans. Consequently, insurance companies in the region should focus on urban centres when offering their products.

The influence of education and health expenditure were not as strong or significant as expected. Alternative proxy indicators should be considered in the future. Among the institutional factors, only government effectiveness and the rule of law showed a small positive effect on life insurance demand.

The results show that economic and demographic factors affect life insurance demand in the Western Balkans more than institutional factors. Even though the institutional factors are expected to be effective, in the Western Balkan Countries where the regulatory system is still weakly implemented by the governmental institutions, these factors result not to be very influential. It is the government's obligation to provide a safe and proper regulatory system in order to stimulate the demand for formal agreements and share its financial burden with insurance companies.

This study identifies the factors that promote and hinder development of the life insurance market in the Western Balkans and will help domestic insurance companies and international insurance companies that are interested in expanding into the region, as well as policymakers. This study considers insurance density and penetration indexes as proxies for life insurance consumption. Further studies may include other proxies such as the insurance growth index and other determinants such as life expectancy, social security expenditure, savings, cultural level, and religion in order to assess whether the findings are the same when different predictors of life insurance demand are considered.

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COMPLEMENTARY FUNDED PENSIONS AND ECONOMIC GROWTH: THEORETICAL AND EMPIRICAL EVIDENCE USING AN OVERLAPPING GENERATIONS MODEL APPLIED TO THE CASE OF TUNISIA

ABSTRACT: *This paper presents a prospective analysis to guide effective pension reform. Using an overlapping generations model with differing returns on free savings and compulsory returns on funded pensions, we put into perspective the results largely supported in the economic literature that assume that replacing a pay-as-you-go pension scheme by funded plans boosts economic growth. We show that this reform is not necessarily synonymous with economic growth due to a crowding-out effect. Our contribution is not limited to theoretical results: we also assess the impacts empirically. Thus, we extend the theoretical model to take into account several periods and 55 generations. Simulation results, using a dynamic overlapping generations computable general equilibrium model calibrated for the Tunisian case, indicate that whether pension reform promotes capital accumulation and economic growth depends on the rate of return on funded pension savings relative to free savings.*

KEY WORDS: *computable general equilibrium model, funded pension, overlapping generations, pay-as-you go pension system, financial markets, saving and capital investment, corporate finance and governance.*

JEL CLASSIFICATION: C68, D91, H55, O16

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INTRODUCTION

This paper examines the introduction of complementary pension funds and their effect on economic growth, via capital accumulation, in a context of pension system budget deficits and demographic ageing resulting from declining fertility and longer life expectancy. To this end, we use the overlapping generation models developed by Samuelson (1958), Diamond (1965), Aaron (1966), Feldstein (1974), and Samuelson (1975). This focus is quite developed in economics, but the present paper starts with the economic finding which assumes that in most countries pay-as-you-go pension schemes are affected by budget deficits, which threaten their financial viability in the mid and long terms.

Many countries have been widely debating the deteriorating financial situation of pension systems and whether the financing should be consolidated, adapted, or modified. The respective merits of the two modes of financing – pay-as-you-go versus funded schemes – have been the subject of several theoretical and empirical studies in economics.

Some studies, notably those of Feldstein (1995), Corsetti and Klaus (1995), Kotlikoff, Smetters, and Walliser (1998), Börsch-Supan (1998), Homburg (1990), and Feldstein and Samwick (1997), are in favour of the promotion of pension funds since they provide a return, corresponding to the remuneration of assets in financial markets, that is higher than that of the pay-as-you-go pension system. They also encourage long-term savings favourable to economic growth. However, these pension funds expose individuals to financial risks. Risk-pooling can solve this problem, but in practice this pooling does not occur spontaneously in a market economy – hence the need for the state to intervene as a regulatory authority and financial guarantor.

Pay-as-you-go pension systems are based on intergenerational solidarity and avoid financial risks. Some analyses (Artus 1993; Brown 1998; Artus & Legros 1999) propose keeping pay-as-you-go pensions and changing the system parameters by increasing the contribution rate, and/or increasing the retirement age, and/or decreasing the replacement rate. However, pay-as-you-go pension systems have the disadvantage of providing a relatively low return, estimated by the long-term growth rate, and they are vulnerable to demographic changes.

Taking into account the advantages and disadvantages of the two pension systems, some studies, particularly those of the World Bank (1994), Sinn (1999), Holzman, Orenstein, and Rutkoweski (2003), and Holzmann, Hinz, and Dorfman (2008), propose a mixed system. Since pay-as-you-go pension schemes create reserves, it is possible to combine the advantages of financial risk-pooling and high financial returns.

Given the diversity of the arguments in favour of one or the other scheme, in this paper we present a theoretical and empirical analysis to guide effective pension reform. Our study deals with a mixed pension system combining two pillars, pay-as-you go and complementary funded pensions. To this end, we first develop a growth model that combines overlapping generations and a pay-as-you-go pension system.

The results of this modelling are similar to those obtained by economic literature regarding effects on capital accumulation. In particular, introducing a funded pension, with savings remunerated at the same rate as free savings, has no effect on capital stock. Consumers are not encouraged to save under a funded system with returns identical to those of free savings. If this accumulation component is optional, consumers will not save beyond the savings obtained under a pure pay-as-you-go pension system. If it is mandatory, there will be substitutability between free savings and the funded pension scheme.

In the light of this last assumption, we carried out a more in-depth analysis in which we eliminated the returns equality hypothesis between free and funded savings. Our first concern was to avoid substitution between the two types of savings. We then adopted the returns differentiation hypothesis. Our second concern was to enrich the realism of the model by bringing it closer to concrete cases. In general terms, pension funds seek long-term profitability and can therefore afford investment with deferred returns over time.

Our contribution is not limited to these theoretical results, but tries to assess them empirically using a computable general equilibrium model with overlapping generations (CGEM-OLG), applied to the Tunisian case. Thus, we present an extension of the theoretical model which consists of generalising the theoretical model to take into account several periods. Initial versions of CGEM-OLG models date back to the early 1980s with Summers (1981), Seidman (1983), and Auerbach and Kotlikoff (1987).

The present work differs from the studies mentioned above by considering both the theoretical and empirical dimensions, and by highlighting three possible cases of savings return rate. We put into perspective the results, largely supported by the economic literature, that assume that replacing a pay-as-you-go pension scheme with a funded scheme boosts economic growth. We show that this latter scheme is not necessarily synonymous with capital stock growth due to a crowding-out effect. Simulation results indicate that it is possible to promote capital accumulation under particular conditions.

The next section presents the basic theoretical model. The third section discusses how to vary the equilibrium capital stock by changing some pay-as-you-go pension scheme parameters and introducing a complementary funded pension. The fourth section presents the CGEM-OLG and simulates complementary funded pillar effects on capital accumulation. Finally, the last section summarises the main findings and presents the conclusions.

1. THE BASIC MODEL

The overlapping generations model assumes that agents live two periods. L_t individuals are born in period t. During period t, L_t individuals live a first period and L_{t-1} individuals live a second period.[1] The population's growth rate is n. Every individual offers a labour unit during their youth and distributes their income between consumption and savings. During the second retirement period they consume the savings obtained in the first period and the earned interest.

We assume that a large number of firms have the same production function Y=F(K,L) and produce a unique homogeneous good whose price is equal to unity. In competitive markets, labour and capital receive their marginal products.

[1] Note that a person born in period t that consumes C_t^t and C_{t+1}^t in their life-time profile would belong to a cohort of L_t Individuals ($L_t = (1+n) L_{t-1}$), while in the same period t there are L_{t-1} individuals born in the previous period $t-1$.

In the production function F, Y is production, K is capital stock and L is labour.

1.1 The Consumers

An individual born at t successively consumes C_t^t and C_{t+1}^t, and their intertemporal utility is denoted $U_t(C_t^t, C_{t+1}^t)$. U takes the form:

$$U_t(C_t^t,\, C_{t+1}^t) = Log C_t^t + \frac{1}{1+\rho} Log\, C_{t+1}^t \tag{1}$$

where ρ represents the present preference rate.

The budget constraints are:

$$\begin{cases} C_t^t + e_t \le w_t \\ C_{t+1}^t = e_t\left(1 + r_{t+1}\right) \end{cases} \tag{2}$$

where C_t^t is consumption, e_t is free savings, w_t is the wage rate, and r_{t+1} is the interest rate.

They induce the following intertemporal budget constraint:

$$C_t^t + \frac{1}{1+r_{t+1}} C_{t+1}^t \le w_t \tag{3}$$

The consumer seeks an intertemporal consumption allowance that maximises their utility under the budget constraint:

$$\begin{cases} \max\limits_{C_t^t, C_{t+1}^t} U_t(C_t^t, C_{t+1}^t) \\ \qquad tq \\ C_t^t + \frac{1}{1+r_{t+1}} C_{t+1}^t \le w_t \end{cases}$$

The Lagrange function is written as:

$$\mathrm{L} = U_t(C_t^t, C_{t+1}^t) + \lambda\,(C_t^t + \frac{1}{1+r_{t+1}} C_{t+1}^t - w_t)$$

$$L = U_t(C_t^t, C_{t+1}^t) + \lambda\,(C_t^t + \frac{1}{1+r_{t+1}} C_{t+1}^t - w_t)$$

λ denotes the Lagrange multiplier. Through first order conditions, we obtain the following relationships:

$$\begin{cases} \dfrac{C_{t+1}^t}{C_t^t} = \dfrac{1+r_{t+1}}{1+\rho} \\ C_t^t + \dfrac{1}{1+r_{t+1}} C_{t+1}^t = w_t \end{cases} \qquad (4)$$

The equilibrium level of consumption and savings is then:

$$\begin{cases} C_t^t = \dfrac{1+\rho}{2+\rho} w_t \\ C_{t+1}^t = \dfrac{1+r_{t+1}}{2+\rho} w_t \\ e_t = \dfrac{1}{2+\rho} w_t \end{cases} \qquad (5)$$

1.2 The Producers

Production is assumed to have constant returns to scale. We assume that there are a large number of firms with same production function Y=F (K, L) and producing a single homogeneous good whose price is equal to unity. In competitive markets, labour and capital receive their marginal products.[2] The output per unit of labour is then $y_t=f(k_t)$. Under these competitive conditions, the producer maximises his profit:

$$\pi_t = Y_t - w_t L_t - r_t K_t \qquad (6)$$

2 Technical progress is not explicitly modelled in this version; we introduce it in the extended CGEM-OLG version.

This implies the following first order conditions:

$$\begin{cases} w_t = f(k_t) - k_t f'(k_t) \\ r_t = f'(k_t) \end{cases} \tag{7}$$

When we consider a Cobb-Douglas production function, $y=k^{\alpha}$, system (7) becomes:

$$\begin{cases} w_t = (1-\alpha) k_t^{\alpha} \\ r_t = \alpha k_t^{\alpha} \end{cases} \tag{8}$$

1.3 Steady State

Under equilibrium of the goods and services market, savings are equal to investment:

$$I_t = L_t e_t \tag{9}$$

Since investment of a period is equal to the capital stock of the period that follows:[3]

$$I_t = K_{t+1} \tag{10}$$

where

$$K_{t+1} = L_t e_t \tag{11}$$

or $L_{t+1} = (1+n) L_t$, then:

$$k_{t+1} = \frac{1}{1+n} e_t \tag{12}$$

Using conditions (5) and (8) the dynamic of capital stock is:

3 We suppose total capital depreciation; this hypothesis simplifies analytical model equations without modifying its fundamental logic.

$$k_{t+1} = \frac{1-\alpha}{(1+n)(2+\rho)} k_t^{\alpha} \tag{13}$$

At the steady state condition, capital stock is given by:

$$\frac{1-\alpha}{(1+n)(2+\rho)} (k^*)^{\alpha} - k^* = 0$$

Resolving this equation gives:

$$k^* = \left[\frac{1-\alpha}{(1+n)(2+\rho)} \right]^{\frac{1}{1-\alpha}} \tag{14}$$

The steady state condition for *k* depends on the economy's characteristics regarding technology, population growth, and psychological expectancy rate.

2. STEADY STATE WITH PENSION SYSTEMS

In a mixed pension financing system, combining a pay-as-you-go pillar and funded schemes, consumers earn a real wage w_t during an active period t, consume C_t^t, pay contributions under the pay-as-you-go scheme at a rate τ_t and contributions to the funded scheme at a rate σ_t, saving an amount e_t, which will be invested in financial markets beyond contributions to the funded scheme.[4] Once retired, at period t + 1, they consume C_{t+1}^t, receive a pension at replacement rate μ_t, receive the accumulated flow of their savings 'free', e_t $(1+r_{1+t})$, as well as that of the contributions to the funded scheme, σw_t $(1+r_{t+1})$, with r_{t+1} being the interest rate.[5]

We can distinguish three economies: without a pension system (τ=0, μ=0, σ=0), with a pure pay-as-you-go system (σ=0), or with a pure funded system (τ=0, μ=0).

---

4 If the pension system is a defined contribution system, then contributions are fixed and the pension amount is random.

5 If the pension system is a defined benefit system, the replacement rate is fixed.

2.1 Pure pay-as-you-go system

Consumers' budget constraints are written as:

$$\begin{aligned} C_t^t + e_t &\leq w_t\left(1-\tau_t\right) \\ C_{t+1}^t &= e_t\left(1+r_{t+1}\right)+\mu_t w_t \end{aligned} \tag{15}$$

The intertemporal budget constraint is:

$$C_t^t + \frac{1}{1+r_{t+1}} C_{t+1}^t \leq w_t\left(1-\tau_t\right) + \frac{1}{1+r_{t+1}} \mu_t w_t \tag{16}$$

Then, the consumer's programme is written as:

$$\begin{cases} \max\limits_{C_t^t, C_{t+1}^t} U_t(C_t^t, C_{t+1}^t) \\ tq \\ C_t^t + \frac{1}{1+r_{t+1}} C_{t+1}^t \leq w_t\left(1-\tau_t\right) + \frac{1}{1+r_{t+1}} \mu_t w_t \end{cases}$$

With a logarithmic utility, demand functions are written as follows:

$$\begin{cases} C_t^t = \frac{1+\rho}{2+\rho} R_t \\ C_{t+1}^t = \frac{1+r_{t+1}}{2+\rho} R_t \\ e_t = \frac{1}{2+\rho} w_t \left[\left(1-\tau_t\right) - \frac{1+\rho}{1+r_{t+1}} \mu_t\right] \end{cases} \tag{17}$$

with

$$R_t = w_t \left[\left(1-\tau_t\right) + \frac{1}{1+r_{t+1}} \mu_t\right]$$

Under positive savings, the condition for capital accumulation requires:

$$\left(1-\tau_t\right)-\frac{1+\rho}{1+r_{t+1}}\mu_t > 0. \qquad (18$$

Contribution and replacement rates should meet the relationship:

$$\frac{\left(1-\tau_t\right)}{1+\rho} > \frac{\mu_t}{1+r_{t+1}} \qquad (19)$$

or

$$\frac{\left(1-\tau_t\right)w_t}{1+\rho} > \frac{\mu_t w_t}{1+r_{t+1}}$$

Disposable income, divided by 1+ρ, should exceed the pension discounted at a rate *r*. The pension scheme should not be too generous in order not to interfere with savings behaviour. Realising that their future income will be less than present income, consumers will save to maintain their future standard of living. This savings effort will be all the greater as the preference for the present is low.

If we note e^{AR} as savings made in the presence of a pension system and e^{SR} as savings made in the absence of a pension system, we note that:

$$e_t^{AR} - e_t^{SR} = - \frac{w_t}{2+\rho}\left(\tau_t + \frac{\left(1+\rho\right)\mu_t}{1+r_{t+1}}\right) < 0$$

Then $e_t^{AR} < e_t^{SR.}$

Proposition 1:

Consumer savings in an economy without a pension system are higher than those in an economy with a pension system.

In the first case, without a pension system, consumers are forced to increase their future resources in order to satisfy their consumption at retirement. By introducing a compulsory pension system the incentive to save will be less: consumers are less concerned about their pensions because a minimum standard of living is guaranteed. In addition, compulsory schemes reduce present income and consequently current consumption. Bridging this gap can only be at the expense of savings (for a constant real income).

Firms' behaviour and equilibrium in the goods and services market are defined in the same way as above. Through the capital accumulation equation, the competitive demand for factors, and the savings function, we obtain the dynamics of capital stock:

$$k_{t+1} = \frac{(1+\rho)(1-\alpha)}{(1+n)(2+\rho)} k_t^{\alpha} \left[\frac{(1-\tau_t)}{1+\rho} - \frac{1}{1+r_{t+1}} \mu_t \right] \quad (20)$$

where $r_{t+1} = \alpha k_{t+1}^{\alpha-1}$.

Capital accumulation is obtained by positive savings with relationship (18).

The steady state is solved from the equation:

$$k^* - \frac{(1+\rho)(1-\alpha)}{(1+n)(2+\rho)} \left(k^*\right)^{\alpha} \left[\frac{(1-\tau)}{1+\rho} - \frac{1}{1+\alpha\left(k^*\right)^{\alpha-1}} \mu \right] = 0 \quad (21)$$

k^* is a function of ρ, α, τ, μ, and n:

$k^* = k^*(\rho, \alpha, n, \tau, \mu)$. (22)

In this case, capital stock depends on the economy's parameters and those of the pension system.

We check that the equilibrium level of the capital stock of an economy without a pension system is higher than that of an economy with a pension system:

$$k_t^{AR} = k_t^{SR}\left(1-\tau_t-\frac{1+\rho}{1+r_{t+1}}\mu_t\right)^{\frac{1}{1-\propto}}$$

knowing that $0 < 1-\tau_t-\frac{1+\rho}{1+r_{t+1}}\mu_t < 1$ then $k_t^{AR} < k_t^{SR.}$

This result confirms proposition (1), that significant savings involve a high capital stock. This is a standard result regarding economic growth in the presence of a pay-as-you-go pension system (particularly in Padison and Pestieau 2001).

In the following we examine the effects of a variation in the pension system's parameters on equilibrium capital stock.

Proposition 2:

In a pure pay-as-you-go pension system, equilibrium capital stock varies in the opposite direction to contribution and replacement rates.[6]

According to the previous relationships, we set:

$$\frac{\partial k^*}{\partial \tau} < 0 \qquad (23)$$

and

$$\frac{\partial k^*}{\partial \mu} < 0 \qquad (24)$$

Increase (or decrease) of the contribution rate improves (or deteriorates) the budget position of the scheme but reduces (or increases) the equilibrium level of capital stock (Appendix 1). This results from a fall (or rise) in young people's disposable income and consequently in their saving capacity. This result is in line with the conclusions of other authors, notably Artus and Legros (1999).

6 See Appendix 1

A decrease (or an increase) in the replacement rate results in an increase (or decrease) in the equilibrium level of capital stock. Anticipating a decrease (or an increase) in their pension, young consumers increase (or decrease) their savings, favouring (or even disfavouring) capital stock growth.

Adjusting pension systems by the replacement rate is not generally examined in the literature. This is probably because of the difficulty of changing return rates when engaged in a particular system: once an agent begins to contribute they know, depending on contribution duration, about the pension that they will receive.[7]

2.2. Mixed Pension System

Under this scheme, consumers' budget constraints are written as:

$$\begin{aligned} C_t^t + e_t &\le w_t\left(1-\tau_t-\sigma\right) \\ C_{t+1}^t &= (e_t + \sigma w_t)\left(1+r_{t+1}\right) + \mu_t w_t \end{aligned} \tag{25}$$

The maximisation programme gives the following demand functions:

$$\begin{cases} C_t^t = \dfrac{1+\rho}{2+\rho} R_t \\ C_{t+1}^t = \dfrac{1+r_{t+1}}{2+\rho} R_t \\ e_t = \dfrac{1}{2+\rho} w_t\left[\left(1-\tau_t\right) - \dfrac{1+\rho}{1+r_{t+1}}\mu_t\right] - \delta w_t \end{cases} \tag{26}$$

The savings equation shows a perfect substitutability between free savings (e_t) and funded savings (σw_t). Consumers are not encouraged to save in a funded system with a return similar to that of free savings. If this accumulation component is optional, consumers will not save beyond the savings made under a pure pay-as-you-go pension system. If it is mandatory, free savings will be substituted by the funded scheme.

7 If pension system equilibrium is required, adjustments by τ or by μ are equal.

This finding is standard in the economics literature: in an exogenous growth model with perfect capital markets, an exogenous labour supply, and a certain life expectancy, a funded pension does not affect capital stock as long as free savings and funded savings are perfectly substitutable. The following studies mention the possibility of a crowding-out effect: Barro (1974), Samuelson (1975), Blanchard and Fisher (1989), and Artus and Legros (1999). The common assumption is that funded savings partly substitute free savings. However, studies conducted in this context do not, at least to our knowledge, mention how this shift can be prevented. The literature typically models funded systems as pension institutions behaving competitively.[8]

In order to prevent this crowding-out effect, it is necessary to differentiate returns on funded savings from those on free savings. This assumption is all the more justified since pension savings seek long-term profitability: short-term risks can be allowed by choosing high profitability investments. As the individual moves closer to retirement, less profitable but safer investments are preferred to avoid financial risk.

In 2007 the OECD set a new direction that shifted investment from pension funds towards hedge funds.[9] Estimates show that 20% of European and US pension funds and 40% of those in Japan use hedge funds. According to the same study, pension funds tend to increase their investment in alternative management, suggesting that they look for a higher return than the market. Indeed, hedge funds have some specific characteristics, mainly high returns, which increasingly attract more investors.

The difference in returns between free savings and funded savings mainly results from the following capital market imperfections.

Information asymmetry: financial intermediaries have more information about investment risk than savers. As a result, they can increase the expected return on investments by increasing risk; savers, on the other hand, essentially perceive the first trend. For this reason, legislation may impose remuneration on funded savings that is different from that on free savings by requiring pensioners to invest

8 See Feldstein (1998).

9 Stewart (2007)

in shares and bonds considered as non-risky and having lower returns than the market. The aim is to avoid massive losses due to a stock market crash.

Tax benefits: The state can provide pension savings with tax benefits, which is equivalent to increasing the return rate on these savings. Tax incentives are designed to encourage this type of savings in order to reduce the burden on the pay-as-you-go pension system and contribute to economic growth. In a context similar to ours, Belan, Michel, and Wigniolle (2003) assume that companies whose capital consists of savings collected by pension funds coexist with companies in which funds do not participate. Firms of the first type behave non-competitively in the labour market, and contributions collected through pension funds are subsidised; consequently, these funds use their market power to maximise the return on these savings. Therefore, the funded pension scheme is differentiated from free savings. However, arbitrage between free savings and pension funds (non-compulsory) ultimately equalises both types of remuneration. Moreover, their study only considers free savings and pension funds as pension schemes. Consequently, they study the combined effects of non-competitive behaviour and savings incentives on the dynamics of capital accumulation and on well-being in the long term.

Our study differs from that of Belan, Michel, and Wigniolle (2003) in that it considers the competitive dimension of firms, both types of pension schemes (pay-as-you-go and funded), the compulsory dimension of the funded scheme, and the fact that returns on free and funded savings remain different.

Let i be the return rate of contributions under the funded scheme.[10] Consumers' budget constraints are then written:

[10] The exogenous return rate i for funded pensions may be founded in the following arguments:

- It is a stylised fact, taking into account observations of reality in the model. Moreover, savings by funded pension may be placed in secure assets, which generally have a fixed return rate.
- The analysis compares, for three possible cases of pension savings return rate (compared to free savings return rate), the levels of per capita capital stock with and without pension funds (in a steady state).

$$\begin{aligned} C_t^t + e_t &\leq w_t\left(1-\tau_t-\sigma\right) \\ C_{t+1}^t &= \mu_t w_t + e_t\left(1+r_{t+1}\right)+\sigma w_t\left(1+i\right) \end{aligned} \tag{27}$$

This gives the intertemporal constraint:

$$C_t^t + \frac{1}{1+r_{t+1}}C_{t+1}^t \leq w_t\left(1-\tau_t-\sigma\right)+\frac{1}{1+r_{t+1}}\mu_t w_t + \frac{1+i}{1+r_{t+1}}\sigma w_t \tag{28}$$

The maximisation programme is written as:

$$\begin{cases} \max\limits_{C_t^t, C_{t+1}^t} U_t(C_t^t, C_{t+1}^t) \\ tq \\ C_t^t + \frac{1}{1+r_{t+1}}C_{t+1}^t \leq w_t\left(1-\tau_t-\sigma\right)+\frac{1}{1+r_{t+1}}\mu_t w_t + \frac{1+i}{1+r_{t+1}}\sigma w_t \end{cases}$$

Demand functions are given by:

$$\begin{cases} C_t^t = \frac{1+\rho}{2+\rho}R_t \\ C_{t+1}^t = \frac{1+r_{t+1}}{2+\rho}R_t \\ e_t = \frac{1}{2+\rho}w_t\left[\left(1-\tau_t\right)-\frac{1+\rho}{1+r_{t+1}}\mu_t-\sigma\left(1+\frac{\left(1+i\right)\left(1+\rho\right)}{1+r_{t+1}}\right)\right] \end{cases} \tag{29}$$

with

$$R_t = w_t\left[\left(1-\tau_t-\sigma\right)+\frac{1}{1+r_{t+1}}\mu_t+\frac{1+i}{1+r_{t+1}}\sigma\right] \tag{30}$$

Total savings are:

$$e_t + \sigma w_t = \frac{1}{2+\rho} w_t \left[(1-\tau_t) - \frac{1+\rho}{1+r_{t+1}} \mu_t + \sigma (1+\rho) \left(1 - \frac{(1+i)}{1+r_{t+1}} \right) \right] \tag{31}$$

or even:

$$e_t + \sigma w_t = \frac{1}{2+\rho} w_t \left[(1-\tau_t) - \frac{1+\rho}{1+r_{t+1}} \mu_t \right] + \frac{(1+\rho)}{(2+\rho)(1+r_{t+1})} \sigma w_t (r_{t+1} - i) \tag{32}$$

The capital stock dynamic is given by:

$$k_{t+1} = \frac{(1+\rho)(1-\alpha)}{(1+n)(2+\rho)} k_t^{\alpha} \left[\frac{(1-\tau_t)}{1+\rho} - \frac{1}{1+r_{t+1}} \mu_t + \sigma \left(1 - \frac{(1+i)}{1+r_{t+1}} \right) \right] \tag{33}$$

Under the steady state condition

$$k^{*1-\propto} = \frac{(1+\rho)(1-\alpha)}{(1+n)(2+\rho)} \left[\frac{(1-\tau_t)}{1+\rho} - \frac{1}{1+r_{t+1}} \mu_t + \sigma \left(1 - \frac{(1+i)}{1+r_{t+1}} \right) \right] \tag{34}$$

where $r\left(k^*\right) = \alpha k^{*\alpha-1}$

Proposition 3:

The effect of a funded pension on equilibrium capital stock depends on the difference between the return on funded pensions and the interest rate of free savings:

- **If pension funds pay more (less) than free savings, then the contribution rate for funded pensions and equilibrium capital stock varies in the opposite direction (the same direction).**

- **If the two categories of savings have the same return, the equilibrium capital stock is indifferent to the contribution rate of the funded pension scheme.**[11]

These findings put into perspective the result largely retained in economics literature, where it is assumed that replacing a pay-as-you-go scheme with a funded scheme boosts economic growth.[12] Demange and Laroque (2000) implicitly point to this finding.[13] Proposition 3 is also true for the transitional dynamic (Appendix 2, Figures 2 and 3).

At this level, we recall that the theoretical properties of both pension systems are compared in the overlapping generations model of Diamond (1965).[14] However, in intertemporal models with uncertain life expectancy a negative effect on capital accumulation is found, particularly by Drouhin (1997),[15] who shows that taking into account life expectancy uncertainty coupled with an accidental inheritance hypothesis, introducing the pure funded pension scheme in an economy without a pension system entails a decline in capital accumulation.[16] Moreover, in our study, the funded scheme by itself has a negative effect on capital accumulation. Our modelling, on the other hand, highlights three possible cases.

1. If i=r then $\frac{\partial k^*}{\partial \sigma} = 0$

As mentioned above, total savings in a mixed system are similar to those under the pay-as-you-go scheme. The two types of savings can then be substituted: the funded scheme replaces free savings for an equal amount. Thus, the equilibrium capital stock does not vary.

---

11 See Appendix 1.

12 Total or partial.

13 In their study that formally examines the pure pay-as-you-go scheme, Demange and Laroque find that a decrease in contributions under the pay-as-you-go scheme in favour of the funded scheme may lead to a decrease in capital stock.

14 Started by Samuelson (1958) and in the line of thinking of Aaron (1966) and Samuelson (1975). Particularly, we refer to the certain life expectancy hypothesis.

15 Yaari (1965); Karni and Zilcha (1989).

16 Savings of deceased agents before retirement benefit the living of the same generation

2. If i> r then $\frac{\partial k^*}{\partial \sigma} < 0$

If i> r, consumers will be more encouraged to increase their savings under the funded scheme (with the highest return) than under the free savings scheme. This shift can be so strong that it leads to a decline in total savings and hence a decline in capital stock.

3. If i< r then $\frac{\partial k^*}{\partial \sigma} > 0$, we note that there can be no substitution of free savings with the funded scheme. On the contrary, savings under the funded scheme (compulsory) are added to free savings. The total savings increase and consequently capital stock also increases. This can be observed in the function of total savings:

$$e_t + \sigma w_t = \frac{1}{2+\rho} w_t \left[(1-\tau_t) - \frac{1+\rho}{1+r_{t+1}} \mu_t \right] + \frac{(1+\rho)}{(2+\rho)(1+r_{t+1})} \sigma w_t \left(r_{t+1} - i \right)$$

or even

$$e_t^{SM} = e_t^{RP} + \frac{(1+\rho)}{(2+\rho)(1+r_{t+1})} \sigma w_t \left(r_{t+1} - i \right)$$

where e^{SM} is the total savings of an economy with a mixed pension system and e^{RP} is the total savings of an economy with a pure pay-as-you-go system.

3. SIMULATIONS WITH A COMPUTABLE GENERAL EQUILIBRIUM MODEL WITH OVERLAPPING GENERATIONS

3.1 The Model

In this section we proceed to an extension of the theoretical OLG model. In CGEM-OLG, a representative agent of the entire cohort maximises their welfare, which is modelled by an inter-temporal utility function. An economic policy implementation will affect consumer behaviour through various impacts on their optimal choice. Our model's structure is similar to that of Kotlikoff and Auerbach

(1987), Rasmussen and Rutherford (2004), Abdessalem and Chekki Cherni (2010), Abdessalem and Chekki Cherni (2016 a and 2016 b). However, the present work differs mainly by changing the base year of the analysis, so we match more realistic observations and medium- and long-term forecasts, taking into account the new socioeconomic context of Tunisia after the 2011 revolution. The model is constructed of four blocks:[17] households, producers, the pension system, and equilibrium conditions. We suppose a closed economy and an exogenous labour supply.

3.1.1 Block 1: Household

Household behaviour assumes perfect foresight and rationality. A representative consumer of each generation maximises their intertemporal preferences represented by the following function:

$$U_{g,t}\left(c_{g,t}\right)=\sum_{t=g}^{g+N}\left(\frac{1}{1+\rho}\right)^{t-g} Log\left(c_{g,t}\right) \tag{35}$$

We choose a logarithmic form to follow the theoretical model developed in the previous sections. $c_{g,t}$ is the consumption of an individual member of age-group *g* at time *t* and ρ represents the pure rate of time preference.

At time *t*, when the agent is active they pay $\tau_t\ Wt$ as contributions to the PAYG pension system and $\sigma_t\ Wt$ to the complementary funded plan, and e_t denotes free savings. All funded benefits (*Cap*), remunerated at a rate of r_t^c, are supposed to be paid at first retirement. In the simulations procedure we consider three scenarios: r_t^c higher, lower, or equal to r_t . *Pen* is PAYG pension.

The intertemporal budget constraint is written as follows (Appendix 3):[18]

[17] For more details of the calibration procedure see Abdessalem and Chekki Cherni 2010, 2016 a).

[18] See Appendix 3 for proof.

$$
\begin{aligned}
& c_{g,g} + \sum_{t=g+1}^{g+N} \prod_{j=g+1}^{g+N} \left(1+r_{t+j}\right)^{-1} c_{g,t} \le W_g \left(1-\tau_g - \sigma_g\right) + \\
& + \sum_{t=g+R-1}^{g+R-1} \prod_{j=g+1}^{g+N} \left(1+r_{t+j}\right)^{-1} W_t \left(1-\tau_t - \sigma_t\right) + \\
& + \sum_{t=R+g}^{g+N} \prod_{j=g+1}^{g+N} \left(1+r_{t+j}\right)^{-1} Pen_t + \prod_{j=1}^{R} \left(1+r_{t+j}\right)^{-1} Cap_{g,t+g+R}
\end{aligned} \tag{36}
$$

where

$$
Pen_t = \mu_t W_t \tag{37}
$$

μ is the replacement rate.

$$
Cap_{t+g+R} = \sum_{t=g}^{g+R-1} \left(1+r_{t+1}^{c}\right) \sigma_t W_t \tag{38}
$$

Maximising the utility function (1) under intertemporal budget constraint (2) gives the optimal consumption of a household belonging to generation *g* at each period of its life cycle, according to the consumption of the previous period:

$$
c_{g+1,t+1} = c_{g,t} \left(\frac{1+r_{t+1}}{1+\rho} \right) \tag{39}
$$

The optimal choice for saving is then:

$$
e_{g,t} = e_{g,t-1} \left(1+r_t\right) + W_t \left(1-\tau_t - \sigma_t\right) - c_{g,t} \tag{40}
$$

3.1.2 Block 2: Producers

A perfectly competitive market is assumed.[19] A single composite good whose price is equal to unity is produced with a Cobb-Douglas production function:

---

19 This situation will be considered as the baseline scenario to which simulation results will be compared. The different return rates for free savings and pension savings will be considered in the simulation scenarios (model shocks).

$$Y_t = \Phi K_t^{\alpha} Le_t^{1-\alpha} \tag{41}$$

where *Y* is real output, *K* is real value of the capital stock, *Le is* the effective labour force, α is the capital income share, and Φ is a scaling variable.

$$Le_t = Lt\ A_t \tag{42}$$

where L_t is the number of workers and A_t is exogenous technical progress.

$$A_t = A_{t-1}(1+gpp) \tag{43}$$

From first-order conditions of profit maximisation:

$$r_t = \Phi \alpha K_t^{\alpha-1} Le_t^{1-\alpha} - \delta \tag{44}$$

$$w_t = \Phi(1-\alpha) K_t^{\alpha} Le_t^{-\alpha} \tag{45}$$

where r_t is the interest rate, δ is the rate of capital depreciation, and w *is* the wage rate per unit of effective labour.

The capital stock equation is:

$$K_{t+1} = I_t + (1-\delta) K_t \tag{46}$$

3.1.3 Block 3: Pension system

For the PAYG scheme we have $COT_t = \tau_t SM_t L_t$

$$L_t = (1+gap_t)L_{t-1} \tag{47}$$

$$Prest_t = \mu_t SM_t L_t^{Ret} \tag{48}$$

$$L_t^{Ret} = (1+gop_t)L_{t-1}^{Ret} \tag{49}$$

where COT_t *is* the total amount of contributions, SM_t is the average wage, gap_t is workers' growth rate, $Prest_t$ is benefits paid, L_t^{Ret} is the number of retirees, and gop_t is the retired population's growth rate.

For the complementary funded plan:

$$CAP_t = \sigma_t SM_t L_t \tag{50}$$

where CAP_t is funded benefits.

3.1.4 Block 4: Equilibrium conditions

For the purpose of model closure, three equilibrium conditions of the labour market, capital market, and composite goods market must be held:

Labour market:

$$L_t = \sum_{g=0}^{R-1} H_{g,t} \tag{51}$$

where $H_{g,t}$ is the number of workers in age-group g .

Capital market:

$$I_t = S_t + CAP_t \tag{52}$$

where S_t is aggregate free savings.

Composite goods market:

$$Y_t = C_t + I_t \tag{53}$$

where

$$C_t = \sum_{g=0}^{N} c_{g,t} H_{g,t} \tag{54}$$

3.1.5 Calibration to the case of Tunisia

i. The Tunisian pension system situation

The Tunisian pension system is a PAYG-defined benefit scheme. Depending on the sector of activity, the pension schemes are managed by two independent funds: the National Pension and Social Insurance Fund (NPSIF) for the public sector and the National Social Security Fund (NSSF) for the private sector. The gap between pension contributions and benefits has been growing for several years. The financial situation of the pension system is critical: to honour pension scheme commitments to current retirees the government needs to balance revenue and expenditure.

Financial pension system deficits are a structural problem that is caused by several factors, notably the lower economic growth (mainly) after the Tunisian social revolution, and the exacerbation of labour market problems, particularly wage base reduction and unemployment. This situation is detrimental not only to the pension system but also to the state's budget balance. Further pressure on the public budget would limit the possibility of government spending on social areas in general and pensions in particular.

In this context, it is important that financial pension system reforms do not make the situation even worse. For this reason, the main objective of calibrating the model to Tunisian data is to draw a prospective analysis of relevant reform policies and to quantitatively evaluate their economic impact. CGEM-OLG is used to quantify the consequences of various pension reform measures on the pension system and on the economic variables. Considering various scenarios and their numerical results can reveal the magnitude of changes in the different economic variables compared to a baseline scenario. Thus, it is possible to draw conclusions to guide governments in feasible pension system reform.

ii. Parameter calibration

Some parameters of CGE models are specified according to an econometric approach, while others are determined by a calibration procedure (Appendix 4). This involves solving the model by reversing the status of the variables: the values of the economic variables (in principle endogenous) are fixed at their levels observed during the base year, and the values of the parameters are left free. We then seek the values of the parameters that are consistent with social accounting matrix data; i.e., those which make it possible to reproduce reality (for more details of the calibration procedure see Abdessalem and Chekki Cherni 2010, 2016 a).

Preferences: Time preference rate ρ is calibrated using the first order conditions of the consumer's maximisation programme and respecting a constraint on the aggregation of household consumption (see Ramussen and Rutherford 2004).

The production function: Using the expression of marginal productivity of factors and the respective values of production and labour income for the base year, we can calibrate α, the share of capital income.[20]

The pension system: The equilibrium PAYG contribution rate is defined to ensure equality between pension system contributions and benefits in the base year. The replacement rate, μ, is chosen to reproduce the value of the benefits for the base year. The calibrated values are average values of the private (NSSF) and public (NPSIF) systems.

The demographic parameters: Some data on demographic variables and their rate of growth are taken from National Institute of Statistics (NSI) forecasts, others (for 2034–2040) are taken from United Nations forecasts,[21] and to complete missing information we made assumptions for long-term evolution.

3.2. Simulation Results for a complementary funded pillar

We suppose that funded contribution rate σ_t changes from the value of zero in the baseline scenario to a value of 1%. This is a low contribution level, but we must bear in mind that households continue to finance the PAYG scheme. Since our purpose is to illustrate the previous theoretical findings, we do not suppose any pension replacement decrease (see previous work on this scenario in Abdessalem and Chekki Cherni 2016 a). Three scenarios are simulated: r_t^c higher, lower, and equal to r_t.[22] Figure 1 illustrates the effects on capital accumulation,

20 Econometric estimates for Tunisia yielded a very close value.

21 http://esa.un.org/unpop/

22 We were interested in this figure mainly because of transitional dynamic effects (see more details in our previous work, Abdessalem and Chekki Cherni 2016 a).

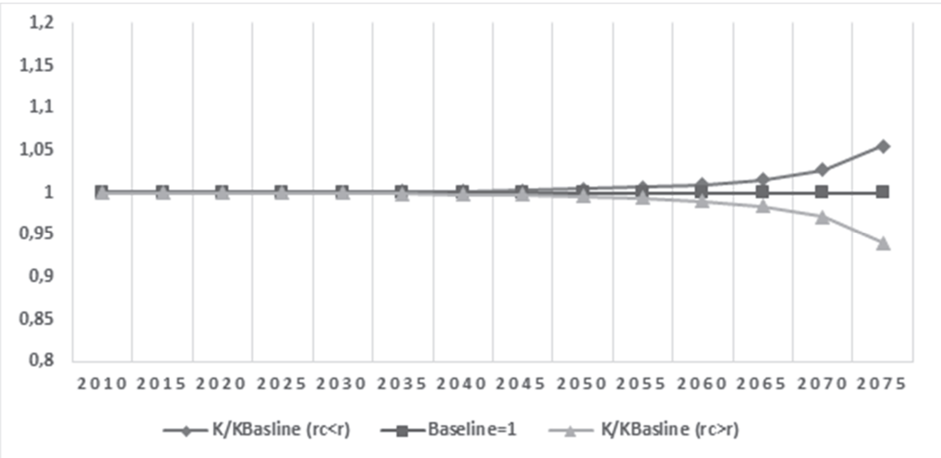
which depend on the difference between the returns of funded pensions and the interest rate of free savings:

Simulation results, in the case of equality between the two remunerations, show that capital stock is indifferent to the contribution rate of the funded pension scheme: we find that increased compulsory savings replace the same amount of decreased free savings, so there is no change in capital accumulation.

In the case where $r^c < r$, simulation results show that, compared to the baseline scenario, capital stock increases. Total saving increases since pension savings and free savings consolidate capital accumulation.

In the case where $r^c > r$, simulation results show that capital stock decreases compared to the baseline scenario. Funded saving increases at the expense of free savings, which deconsolidate capital accumulation via the crowding-out effect.

Figure 1: Effects of Complementary Funded Pension on Capital Accumulation, 2010–2075



Source: *Authors' calculations*

The implemented CGEM-OLG evaluates the effects of demographic transition in Tunisia and analyses policies for the reform of the Tunisian pension system, the policies' effects on the system's financial stability, and their socioeconomic impact. As the purpose of this paper concerns the effect of complementary pension funds on capital accumulation, we limited our results to this measure. Unlike in Abdessalem and Chekki Cherni 2010 and 2016, we proceeded to a sensitivity analysis in which we considered various values of the funded contribution rate σ_t. Other sensitivity analyses were conducted with respect to model key parameters and some functions, particularly the utility function, by changing the logarithmic form. Sensitivity analyses suggest that the results are remarkably stable.

4. CONCLUSION

The main aim of this paper is to conduct an analysis to guide effective pension reform, highlighting the effects of reform measures on capital accumulation and consequently economic growth.

Using a theoretical overlapping generations model, we found that under a pure pay-as-you-go system the equilibrium capital stock and the pension system's parameters (τ,μ) vary in opposite directions. Our second aim was to examine capital accumulation under a mixed pension system, PAYG and a complementary funded pillar, in which we differentiate between returns on free savings and returns on funded pension savings. This has not been much examined in the literature: usually the merits of the pure pay-as-you-go scheme and the pure funded pension scheme are compared. Our analysis allows us to compare the levels of per capita capital stock with and without pension funds (in a steady state) for three possible cases of pension savings return rate (compared to the free savings return rate). Our research shows that the funded scheme does not necessarily lead to an increase in capital stock. In the case of under-accumulation, under our analysis shows that such a measure is beneficial only when the rate of return is lower for pension savings than for free savings.

The theoretical assumptions were then empirically simulated based on replicable Tunisian data using a computable general equilibrium model with overlapping generations. The main conclusion is that it is possible to promote capital accumulation if the savings return rate for a funded pension is lower than that for free savings.

In a first scenario, we simulated the effects of introducing a complementary funded pension. The results show a crowding-out effect between free savings and pension savings (which are remunerated at the same rate). This finding confirms the classical result of economic theory in this context.

In a second scenario where the pension savings return rate is higher than the free savings return rate, the simulations reveal a decrease in free savings, total savings, and total stock of physical capital (compared to the baseline scenario). In this case, savings via the pension fund increased at the expense of free savings. The crowding-out effect was so great it caused a decline in total saving, and thus a decline in capital stock (in comparison to the baseline scenario).

In a third scenario, funded pension savings were assumed to be remunerated below the market rate. The simulation results showed that free savings decrease but total savings (free and pension savings) increase. The crowding-out effect is no longer strong so pension savings are added to free savings, total saving increases, and consequently the capital stock increases (always compared to the baseline scenario and under model assumptions).

The simulation results, using our computable general equilibrium model with overlapping generations, can be summarised as follows: economic activity (physical capital accumulation) can only be stimulated if compulsory pension savings are remunerated at a lower rate than free savings**.**

This paper contributes to the theoretical and empirical debate on pension reforms.

It shows that introducing funded plans is not synonymous with boosting economic growth. By generalising the theoretical modelling to several periods and 55 generations and using an inter-temporal computable general equilibrium model it provides a prospective analysis and shows that whether pension reform promotes capital accumulation and economic growth depends on the rate of return on funded pension savings relative to free savings.

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APPENDIX 1

Reaction of capital stock to the various parameters of the pension system

$$k=\frac{(1+\rho)(1-\alpha)}{(1+n)(1+\rho)}(k)^{\alpha}\left[\frac{(1-\tau)}{1+\rho}-\frac{1}{1+\alpha(k)^{\alpha-1}}\mu\right]=0$$

$$(k)^{1-\alpha}=\frac{(1+\rho)(1-\alpha)}{(1+n)(1+\rho)}\left[\frac{(1-\tau)}{1+\rho}-\frac{1}{1+\alpha(k)^{\alpha-1}}\mu\right]=0$$

let : $x=(k)^{1-\alpha}$ and $A=\frac{(1+\rho)(1-\alpha)}{(1+n)(1+\rho)}$ then $x=A\left[\frac{(1-\tau)}{1+\rho}-\frac{\mu x}{\alpha+x}\right]$

Pay-as-you-go contribution rate

If

$$\frac{\partial x}{\partial \tau}=-\frac{A}{1+\rho}\left(\frac{1}{1+\frac{A\mu\alpha}{(\alpha+x)^{2}}}\right) \qquad \text{then } \frac{\partial x}{\partial \tau}<0$$

$$\frac{\partial k}{\partial \tau}=k^{\alpha}\frac{1}{1-\alpha}\frac{\partial x}{\partial \tau}\text{ ; then }\frac{\partial k}{\partial \tau}<0$$

Replacement rate

If

$$\frac{\partial x}{\partial \mu}=-\frac{Ax}{\alpha+x}\left(\frac{1}{1+\frac{A\mu\alpha}{(\alpha+x)^{2}}}\right) \qquad \text{then } \frac{\partial x}{\partial \mu}<0$$

$$\frac{\partial k}{\partial \mu} = k^{\alpha} \frac{1}{1-\alpha} \frac{\partial x}{\partial \mu} \text{ ; then } \frac{\partial k}{\partial \mu} < 0$$

Funded scheme contribution rate

We use the same variable changes as before:

$$x = A\left[\frac{(1-\tau)}{1+\rho} - \frac{\mu x}{\alpha + x} + \sigma\left(1 - \frac{(1+i)x}{\alpha + x}\right)\right]$$

$$\frac{\partial x}{\partial \sigma} = A\frac{r-i}{1+r}\left(\frac{1}{1+\frac{A\alpha\left(\mu+\sigma(1+i)\right)}{(\alpha+x)^2}}\right)$$

$$\frac{\partial k}{\partial \sigma} = k^{\alpha} \frac{1}{1-\alpha} \frac{\partial x}{\partial \sigma} \text{ ; then } \frac{\partial k}{\partial \sigma} = k^{\alpha} \frac{A(r-i)}{(1-\alpha)(1+r)}\left(\frac{1}{1+\frac{A\alpha\left(\mu+\sigma(1+i)\right)}{(\alpha+x)^2}}\right)$$

APPENDIX 2

Transitional dynamic

Proposition 3 is also true for the transitional dynamic (Fig. 2 and Fig. 3). According to the equation of capital stock accumulation with a mixed system, we have:

$$\frac{\partial k_{t+1}}{\partial k_t} > 0$$

In the case of the pay-as-you-go pension system, we can then write:

$$k_{t+1}^{RP} = f^{RP}(k_t) \, and \, k_{t+1}^{SM} = f^{SM}(k_t).$$

If f is strictly increasing $\frac{\partial k_{t+1}}{\partial k_t} > 0$, the dynamic of *k* is monotonous.

* For i>r, we found that if

$$k_{t+1}^{RP} > k_{t+1}^{SM} \, then \, f^{RP}(k_t) > f^{SM}(k_t).$$

If we index T as the period when the funded pension scheme is introduced, then

$k_T^{RP} = k_T^{SM}$ and for all t >T we have $k_t^{RP} > k_t^{SM}$.

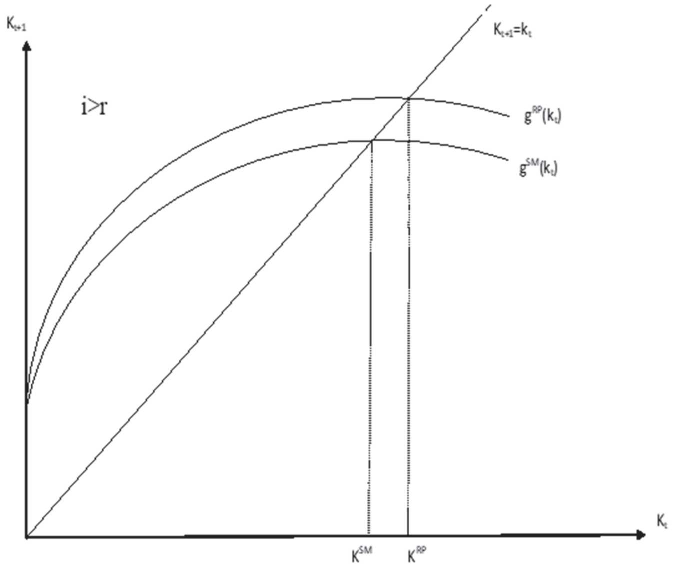
*In the same way, for i<r, if

$$k_{t+1}^{SM} > k_{t+1}^{RP} \, then \, f^{SM}(k_t) > f^{RP}(k_t)$$

and

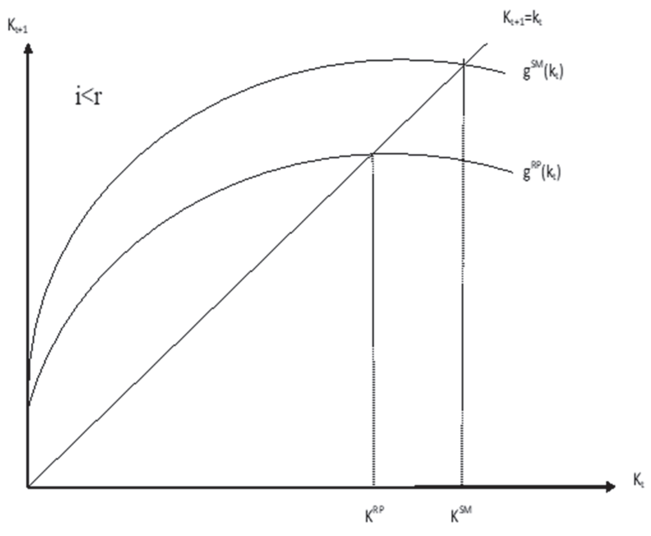
$k_T^{RP} = k_T^{SM}$, for all t >T we have $k_t^{SM} > k_t^{RP.}$

Figure 2: Capital stock accumulation for transitional dynamic (i>r).



Source: Authors' calculations

Figure 3: Capital stock accumulation for transitional dynamic (i<r)



Source: Authors' calculations

APPENDIX 3

Proof for Inter-temporal Budget Constraint

The successive budget constraints (through the life cycle) of an individual belonging to generation g are written :

Activity periods

$$\begin{cases} c_{g,g} + e_{g,g} = (1 - \tau_t - \sigma_t)W_t \\ c_{g,g+1} + e_{g,g+1} = (1 - \tau_{t+1} - \sigma_{t+1})W_{t+1} + e_{g,g}(1 + r_{t+1}) \\ c_{g,g+2} + e_{g,g+2} = (1 - \tau_{t+2} - \sigma_{t+2})W_{t+2} + e_{g,g+1}(1 + r_{t+2}) \\ c_{g,g+3} + e_{g,g+3} = (1 - \tau^R_{t+3} - \sigma_{t+3})W_{t+3} + e_{g,g+2}(1 + r_{t+3}) \\ \vdots \\ c_{g,g+7} + e_{g,g+7} = (1 - \tau_{t+7} - \sigma_{t+7})W_{t+7} + e_{g,g+6}(1 + r_{t+7}) \end{cases}$$

First retirement period

$$\left\{ c_{g,g+R} = e_{g,g+R-1}(1 + r_{t+R}) + Pen_{t+R} + Cap_{t+g+R} \right.$$

The last two retirement periods

$$\begin{cases} c_{g,g+R+1} = Pen_{t+R+1} \\ c_{g,g+R+2} = Pen_{t+R+2} \end{cases}$$

$$Cap_{t+g+R} = \sum_{t=g}^{g+R-1} (1 + r_{t+1}^{C})\sigma_t W_t$$

$$c_{g,g} + e_{g,g} = (1 - \tau_t - \sigma_t)W_t$$

$$(c_{g,g+1} + e_{g,g+1})\frac{1}{1+r_{t+1}} = [(1 - \tau_{t+1} - \sigma_{t+1})W_{t+1} + e_{g,g}(1 + r_{t+1})]\frac{1}{1+r_{t+1}}$$

$$(c_{g,g+2} + e_{g,g+2})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}} =$$

$$[(1 - \tau_{t+2} - \sigma_{t+1})W_{t+2} + e_{g,g+1}(1 + r_{t+2})]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}$$

$$(c_{g,g+3} + e_{g,g+3})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}} =$$

$$[(1 - \tau_{t+3} - \sigma_{t+3})W_{t+3} + e_{g,g+2}(1 + r_{t+3})]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}$$

.

.

.

$$(c_{g,g+7} + e_{g,g+7})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}} =$$

$$[(1 - \tau_{t+7} - \sigma_{t+7})W_{t+7} + e_{g,g+6}(1 + r_{t+7})]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}$$

$$(c_{g,g+R})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}} =$$

$$[e_{g,g+R-1}(1 + r_{t+R}) + Pen_{t+R} + Cap_{t+g+R}]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}$$

$$(c_{g,g+R+1})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}} =$$

$$(Pen_{t+R+1})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}}$$

$$(c_{g,g+R+2})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}}\frac{1}{1+r_{t+R+2}} =$$

$$(Pen_{t+R+2})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}}\frac{1}{1+r_{t+R+2}}$$

The summation of the terms on the left side of each equation equals the summation of the terms on the right side. After sipmlifying saving expressions we obtain:

$$
\begin{aligned}
&c_{g,g} + (c_{g,g+1})\frac{1}{1+r_{t+1}} + (c_{g,g+2})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}} + \dots\dots\dots\dots \\
&+(c_{g,g+7})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}} + \\
&(c_{g,g+R})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}} + \\
&(c_{g,g+R+1})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}} + \\
&(c_{g,g+R+2})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}}\frac{1}{1+r_{t+R+2}} = \\
&(1-\tau_t-\sigma_t)W_t + [(1-\tau_{t+1}-\sigma_{t+1})W_{t+1}]\frac{1}{1+r_{t+1}} + \\
&[(1-\tau_{t+2}-\sigma_{t+2})W_{t+2}]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}} + \dots\dots\dots + \\
&[(1-\tau_{t+7}-\sigma_{t+7})W_{t+7} + e_{g,g+6}(1+r_{t+7})]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}} + \\
&[Pen_{t+R} + Cap_{t+g+R}]\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}} + \\
&(Pen_{t+R+1})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}} + \\
&(Pen_{t+R+2})\frac{1}{1+r_{t+1}}\frac{1}{1+r_{t+2}}\frac{1}{1+r_{t+3}}\cdots\cdots\frac{1}{1+r_{t+7}}\frac{1}{1+r_{t+R}}\frac{1}{1+r_{t+R+1}}\frac{1}{1+r_{t+R+2}}
\end{aligned}
$$

Which leads to

$$
\begin{aligned}
&c_{g,g} + \sum_{t=g+1}^{g+N}\prod_{j=g+1}^{g+N}(1+r_{t+j})^{-1}c_{g,t} \le W_t(1-\tau_t-\sigma_t) + \\
&\sum_{t=g+1}^{g+R-1}\prod_{j=g+1}^{g+R-1}(1+r_{t+j})^{-1}W_t(1-\tau_t-\sigma_t) + \\
&\sum_{t=R+g}^{g+N}\prod_{j=g+1}^{g+N}(1+r_{t+j})^{-1}Pen_t + \prod_{j=1}^{R}(1+r_{t+j})^{-1}Cap_{t+g+R}
\end{aligned}
$$

With

N=10 (11 periods)

R=8 (beginning of the retirment period)

g= 0,1,2,3………10 (11 generations from generation 0)

APPENDIX 4

Table 1: Calibrated Parameters for CGEM-OLG (2010)

Parameters set	
n (baseline)	0.01
r (baseline)	0.05
R	8
σ (baseline)	0
calibrated parameter	
ρ	0.028
A	0.828
δ	0.07
α	0.4
τ (base year)	0.14
μ	0.67

Source: Authors' calculations

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A NEOCLASSICAL GROWTH MODEL WITH ENDOGENOUS BIRTH AND MORTALITY RATES

ABSTRACT: *This study examines dynamic interdependence between different socio-cultural groups' birth rates, mortality rates, populations, wealth accumulation, and the allocation of time between work, leisure, and childcare. It emphasises the role of changes in human capital, technology, and preferences on birth and mortality rates and time allocations. The economic mechanism of wealth and income distribution is based on the Walrasian general equilibrium theory, and wealth accumulation is based on the Solow growth model. The paper uses a utility function proposed by Zhang (2015) to describe the behaviour of households. It also models group and gender differences in human capital, the propensity to have children, the propensity to use leisure time, and the efficiency of childcare. The paper uses differential equations to describe the dynamics of group differences in wealth, income, birth rates, mortality rates, and populations. I simulate a model to show the motion of the system and identify the existence of an equilibrium point. I also examine the effects on the dynamics of the economic system of changes in the propensity to have children and the propensity to save, and in gender differences in the propensity to use leisure, in human capital, and in emotional involvement in childcare.*

KEY WORDS: *birth rate, mortality rate, population growth, childcare, time allocation, wealth accumulation.*

JEL CLASSIFICATION: J13, O41

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1. INTRODUCTION

Many modern economies consist of multiple socio-cultural groups. Different groups have different habits, customs, and attitudes to the family and having children. Even if we assume that a society is fair and there is no discrimination, it is reasonable to consider that cultural differences may result from differences in wealth, income, and population. In order to explain the consequences of differences in values and human capital between groups, this study deals with dynamic interdependence between different groups' birth rates, mortality rates, populations, wealth accumulation, and time distributions between work, leisure, and childcare. We emphasise the role of changes in human capital, technology, and preferences regarding birth and mortality rates and time allocation. The basic economic structure is based on Walrasian general equilibrium theory, and wealth accumulation is based the Solow growth model. We use an alternative utility function proposed by Zhang (2015) to describe the behaviour of households. In my approach, wealth and income inequality is due to heterogeneity in households' preferences and human capital levels, as well as in households' initial wealth. We also model gender differences in human capital, the propensity to use leisure time, and the efficiency of childcare. We model the dynamics of group differences in wealth, income, birth rates, mortality rates, and populations.

This study is based on some traditional economic theories. The economic aspects of this paper are strongly influenced by neoclassical growth theory. The seminal paper in the field is the Solow model. The theory is mainly concerned with endogenous physical capital or wealth accumulation (Solow, 1956; Burmeister and Dobell, 1970; Azariadis, 1993; Barro and Sala-i-Martin, 1995). The model of this study is built within the framework of neoclassical growth theory. We follow Solow in modelling economic production and wealth accumulation, but analyse household behaviour through the approach proposed by Zhang (1993). The model is also influenced by the Walrasian general equilibrium theory of pure exchange and production economies (Walras, 1874; Arrow and Debreu, 1954; Debreu, 1959; Arrow and Hahn, 1971; Arrow, 1974; and Mas-Colell et al., 1995). The model in this study is Walrasian in the sense that for given levels of wealth there are competitive market equilibria with heterogeneous industries and households. As the Walrasian general theory fails to be generalised and extended to the growth theory of heterogeneous households with endogenous wealth (e.g., Morishima, 1977; Diewert, 1977; Eatwell, 1987; Dana et al. 1989; Jensen and Larsen, 2005; Montesano, 2008; Impicciatore et al., 2012), we apply neoclassical growth theory to introduce the wealth accumulation of heterogeneous households.

Although endogenous population dynamics are mostly neglected in the main streams of economic growth theory, interaction between economic growth and population change has been a challenging question in economics even since Malthus published *An Essay on the Principle of Population* in 1798. This study examines dynamic interactions between wealth accumulation and population change with endogenous birth rates and mortality rates in a multi-group neoclassical growth framework. Many factors influence fertility, such as changes in the gender gap in wages (Galor and Weil, 1996), labour market frictions (Adsera, 2005), and age structure (Hock and Weil, 2012). Bosi and Seegmuller (2012) study the heterogeneity of households in terms of capital endowments, mortality, and costs per surviving child. Varvarigos and Zakaria (2013) examine interactions between fertility choice and expenditures on health in the traditional overlapping-generations framework. Another determinant of population change is the mortality rate (Robinson and Srinivasan, 1997; Lancia and Prarolo, 2012). There are many studies on the relation between economic growth and endogenous longevity (e.g., Blackburn and Cipriani, 2002; Chakraborty, 2004; Hazan and Zoabi, 2006; Balestra and Dottori, 2012 and many theoretical models of longevity (e.g., Boucekkine et al. 2002; Lee and Mason, 2010; and Ludwig et al., 2012).

This study is strongly influenced by the literature of neoclassical growth theory and the literature of population growth and economic development. A unique contribution of this paper is that it models the population growth of multiple groups in the framework of the Solow growth model with endogenous wealth accumulation and gendered time allocation between work, leisure, and childcare. The paper analyses the link between the growth of wealth, economic growth, the gender division of labour, and population growth. Physical capital accumulation is built on the Solow growth model. The birth rate and mortality rate dynamics are influenced by the Haavelmo population model and the Barro-Becker fertility choice model. These dynamic mechanisms are synthesised in a compact framework, applying an alternative utility function proposed by Zhang (1993, 2020). The model is a synthesis of two of my earlier models. The first of these (Zhang, 2012) developed a model of economic growth with a gender division of labour assuming a constant population, while the second (Zhang, 2015) developed a growth model with endogenous population with a homogenous household. Zhang (2013) developed a similar model with endogenous education. This paper is based on Zhang (2016), which deals with a multi-country economic system in which each national economy has a homogenous population. This paper is concerned with a case in which a single economy consists of multiple socio-cultural groups, a commonly observed feature of many national economies.

The paper is organised as follows. Section 2 introduces the basic model with wealth accumulation and population dynamics. Section 3 simulates the model. Section 4 carries out comparative dynamic analysis with regards to some parameters. Section 5 concludes the study.

2. THE BASIC MODEL

The model is a synthesis of my earlier models (Zhang, 2012, 2015, 2016). The production aspects are based on the Solow growth model (Solow, 1956). The economy has one sector, producing a single commodity for consumption and investment. Capital depreciates at a constant exponential rate, 0.03, which is independent of the manner of use. The technology of the production sector is characterised by constant returns to scale. All markets are perfectly competitive. Factors are inelastically supplied and the available factors are fully utilised at every moment. Saving is undertaken only by households. All earnings of firms are distributed in the form of payments to factors of production. Households own the assets of the economy and distribute their income between consumption, childcare, and wealth accumulation. The population of each gender is homogeneous. We assume that each family consists of husband, wife, and children. All the families are identical. We use subscripts $q = 1$ and $q = 2$ to stand for male and female respectively. The population is classified into J groups, each group with population $2N_j(t)$. We use $N_j(t)$ to stand for the population of each gender in group j. We use (j, q) to index a person of gender q in group j. Let $T_{jq}(t)$ and $\bar{T}_{jq}(t)$ stand for work time and time spent on childcare by (j, q), and $\bar{N}(t)$ for the flow of labour services used in time t for production. We have $\bar{N}(t)$ as follows:

$$\bar{N}(t) = \sum_{j=1}^{J} \left[h_{j1} \, T_{j1}(t) + h_{j2} \, T_{j2}(t) \right] N_j(t) \tag{1}$$

where h_{jq} is the level of human capital of person (j, q).

2.1 The production sector

The production sector uses capital and labour as inputs. Let $K(t)$ stand for the capital stock at time. The following form of the production function is:

$$F(t) = A\, K^{\alpha}(t)\, \bar{N}^{\beta}(t), \alpha, \beta > 0, \alpha + \beta = 1 \tag{2}$$

where $F(t)$ is the output level, and $A, \alpha,$ and β are parameters. Markets are competitive: thus labour and capital earn their marginal products. Profit is given by:

$$F(t) - (r(t) + \delta_k)K(t) - w(t)\bar{N}(t).$$

The marginal conditions are:

$$r(t) + \delta_k = \frac{\alpha\, F(t)}{K(t)}, w(t) = \frac{\beta\, F(t)}{\bar{N}(t)}, w_{jq}(t) = h_{jq}\, w(t) \tag{3}$$

2.2 Consumer behaviour

We use an alternative approach to the household proposed by Zhang (1993). Households decide on their time allocation, their consumption level, their number of children, and their amount of saving. To describe the behaviour of consumers, we denote wealth per family by $\bar{k}_j(t)$. Current income per family from interest payments and wage payments is:

$$y_j(t) = r(t)\bar{k}_j(t) + \left[h_{j1}T_{j1}(t) + h_{j2}T_{j2}(t)\right]w(t).$$

We call $y_j(t)$ the current income, in the sense that it comes from consumers' payment for effort and consumers' current earnings from the ownership of wealth. The total value of wealth that a family can sell to purchase goods and to save is equal to $\bar{k}_j(t)$. Here, we assume that selling and buying wealth can be conducted instantaneously without any transaction cost. The disposable income per family is given by

$$\hat{y}_j(t) = y_j(t) + \bar{k}_j(t) \tag{4}$$

Let $n_j(t)$ and $p_{bj}(t)$ stand for the birth rate and the cost of birth. Following Zhang (2015), we assume that children will have the same level of wealth as that of the parent. In addition to the time spent on children, the cost to the parent is given by:

$$p_{bj}(t) = n_j(t)\,\bar{k}_j(t) \tag{5}$$

Here, we neglect other costs such as the purchase of goods and services. In the fertility choice model by Barro and Becker (1989), the cost also includes consumption of goods. We now introduce time spent on children. Becker (1981) emphasises the cost of the mother's time spent on rearing children to adulthood. In most societies, women are the primary providers of childcare. We consider the following relation between fertility rate and the parent's time spent on raising children:

$$\bar{T}_{jq}(t) = \theta_{jq}\, n_j(t), \theta_{jq} \ge 0 \tag{6}$$

where θ_{jq} is the time required for a mother (father) to raise one child. The specified functional form implies that if the parents want more children, they spend more time on childcare. This requirement is strict, as childcare tends to exhibit increasing returns to scale. For instance, the time spent per child tends to fall as the family has more children. We require constant returns to scale because this assumption makes the analysis mathematically tractable.

The household distributes the total available budget between saving, $s_j(t)$, consumption of goods, $c_j(t)$, and childcare, $p_{bj}(t)$. The budget constraint is:

$$p_j(t)\,c_j(t) + s_j(t) + \bar{k}_j(t)\,n_j(t) = \hat{y}_j(t) \tag{7}$$

We consider that in addition to work and childcare, parents also allocate time to leisure. We denote the leisure time of person (j, q) by $\tilde{T}_{jq}(t)$. Each person faces the following time constraint:

$$T_{jq}(t) + \bar{T}_{jq}(t) + \tilde{T}_{jq}(t) = T_0 \tag{8}$$

where T_0 is the total available time for leisure, work, and childcare. Substituting (8) into (7) yields

$$p(t)\, c_j(t) + s_j(t) + \bar{k}_j(t)\, n_j(t) + \bar{T}_{j1}(t)\, w_{j1}(t) + \bar{T}_{j2}(t)\, w_{j2}(t) + \tilde{T}_{j1}(t)\, w_{j1}(t) + \tilde{T}_{j2}(t)\, w_{j2}(t) = \bar{y}_j(t) \quad (9)$$

where

$$\bar{y}_j(t) \equiv \left(1 + r(t)\right)\bar{k}_j(t) + \left(w_{j1}(t) + w_{j2}(t)\right) T_0.$$

The right-hand side is the 'potential' income that the family can obtain by spending all the available time on work. The left-hand side is the sum of consumption cost, saving, the opportunity cost of childcare, and the opportunity cost of leisure. Inserting (6) in (9) gives

$$c_j(t) + s_j(t) + \widetilde{w}_j(t)\, n_j(t) + \tilde{T}_{j1}(t)\, w_{j1}(t) + \tilde{T}_{j2}(t)\, w_{j2}(t) = \bar{y}_j(t) \quad (10)$$

where

$$\widetilde{w}_j(t) \equiv \bar{k}_j(t) + h_j\, w(t), h_j \equiv \theta_{j1}\, h_{j1} + \theta_{j2}\, h_{j2}$$

The variable $\widetilde{w}_j(t)$ is the opportunity cost of childcare. Like Barro and Becker (1989), we assume that the parents' utility is dependent on the number of children. We assume that the utility is dependent on $c_j(t)$, $s_j(t)$, $\tilde{T}_{jq}(t)$, and $n_j(t)$ as follows:

$$U_j(t) = c_j^{\xi_{j0}}(t)\, s_j^{\lambda_{j0}}(t)\, \tilde{T}_{j1}^{\sigma_{j01}}(t)\, \tilde{T}_{j2}^{\sigma_{j02}}(t)\, n_j^{\upsilon_{j0}}(t)$$

where ξ_{j0} is called the propensity to consume, λ_{j0} the propensity to own wealth, σ_{j0q} the gender $q's$ propensity to use leisure time, and υ_{j0} the propensity to have children. It should be noted that in this study we assume that the parents' utility is only dependent on their number of children. According to Soares (2005), parents' utility depends not only on their surviving offspring, but also on the length of each surviving child's lifespan. The first-order condition of maximising $U_j(t)$ subject to (10) yields:

$$c_j(t) = \xi_j\, \bar{y}_j(t), s_j(t) = \lambda_j\, \bar{y}_j(t), \tilde{T}_{jq}(t) = \frac{\sigma_{jq}\, \bar{y}_j(t)}{w_{jq}(t)}, n_j(t) = \frac{\upsilon_j\, \bar{y}_j(t)}{\widetilde{w}_j(t)} \quad (11)$$

where

$$\xi_j \equiv \rho_j \xi_{j0}, \lambda_j \equiv \rho_j \lambda_{j0}, \sigma_{jq} \equiv \rho_j \sigma_{jq0}, \upsilon_j \equiv \rho_j \upsilon_{j0}, \rho_j \equiv \frac{1}{\xi_{j0} + \lambda_{j0} + \sigma_{j10} + \sigma_{j20} + \upsilon_{j0}}.$$

2.3 Birth and mortality rates and population dynamics

My approach to population dynamics is influenced by the Haavelmo model (Haavelmo, 1954; and Stutzer, 1980) and the Ramsey model (Razin and Ben-Zion, 1975; Yip and Zhang, 1997; and Chu et al., 2013). According to the definitions, population change follows:

$$\dot{N}_j(t) = \left(n_j(t) - d_j(t)\right) N_j(t) \tag{12}$$

where $n_j(t)$ and $d_j(t)$ are respectively the birth rate and mortality rate. It should be noted that Tournemaine and Luangaram (2012) construct a model of population growth and economic development. They examine interactions between fertility, education, growth rates of technical progress, and income per capita growth. They use the following technology of production of children: $n(t) = bT_b^{\theta}(t)$, where $T_b(t)$ is the time needed to rear children and b and θ are parameters. In their model the mortality rate is assumed to be constant. My model introduces an endogenous mortality rate. In the Haavelmo model the mortality rate is negatively related to per capita income. In this study we assume that the mortality rate is negatively related to the disposable income in the following way:

$$d_j(t) = \frac{\bar{\upsilon}_j N_j^{b_j}(t)}{\bar{y}_j^{a_j}(t)} \tag{13}$$

where $\bar{\upsilon}_j \geq 0$, $a_j \geq 0$. We call $\bar{\upsilon}_j$ the mortality rate parameter. As in the Haavelmo model, an improvement in living conditions implies that people live longer. The term $N_j^{b_j}(t)$ takes account of possible influences of the population on mortality. For instance, when there is overpopulation, the environment deteriorates. We may take account of this kind of environmental effect by the term b_j. In this case, it is reasonable to require b_j to be positive. It should be noted that the sign of

b_j is generally ambiguous, in the sense that the population may also have a positive impact on mortality. Inserting (10) and (13) in (12) gives

$$\dot{N}_j(t) = \left(\frac{\upsilon_j \, \bar{y}_j(t)}{\widetilde{w}_j(t)} - \frac{\bar{\upsilon}_j \, N_j^{b_j}(t)}{\bar{y}_j^{a_j}(t)} \right) N_j(t) \tag{14}$$

This equation describes the population dynamics.

2.4 Wealth dynamics

We now find dynamics of wealth accumulation. According to the definition of $s_j(t)$, the change in a household's wealth is given by

$$\dot{\bar{k}}_j(t) = s_j(t) - \bar{k}_j(t) = \lambda_j \bar{y}_j(t) - \bar{k}_j(t) \tag{15}$$

2.5 The value of physical wealth and capital

The value of physical capital is equal to the value of physical wealth

$$\sum_{j=1}^{J} \bar{k}_j(t) N_j(t) = K(t) \tag{16}$$

2.6 Demand for and supply of goods

The national savings are the sum of households' savings. As the output of the capital goods sector is equal to net savings and the depreciation of capital stock, we have:

$$S(t) + C(t) - K(t) + \delta_k K(t) = F(t) \tag{17}$$

where $S(t) - K(t) + \delta_k K(t)$ is the sum of the net savings and depreciation and

$$S(t) = \sum_{j=1}^{J} s_j(t) \, N_j(t) \, , \text{and } C(t) = \sum_{j=1}^{J} c_j(t) \, N_j(t)$$

We have thus built the dynamic model. The model is structurally a unification of Walrasian general equilibrium and neoclassical growth theory with my earlier approach to household behaviour (Zhang, 1993, 2020). If we neglect wealth accumulation and capital depreciation (i.e., capital being constant), then the model with heterogeneous households and one sector belongs to Walrasian general equilibrium theory. The Solow model and the Haavelmo model can be considered as special cases of my model. Moreover, as my model is based on some well-known mathematical models and includes some features that no other single theoretical model explains, we should be able to explain some interactions which other formal models fail to explain. We now examine the dynamics of the model.

3. THE DYNAMICS AND ITS PROPERTIES

This section examines the dynamics of the model. First, we introduce the ratio of the interest rate and depreciation to the wage rate

$$z(t) \equiv \frac{r(t) + \delta_k}{w(t)}.$$

We show that the dynamics can be expressed by differential equations with $z(t)$, $\left(\bar{k}_j(t)\right)$, and $\left(N_j(t)\right)$ as the variables.

Lemma

The dynamics of the economic system is governed by

$$\dot{z}(t) = \Omega_1\left(z(t), \{\bar{k}_j(t)\}, \left(N_j(t)\right)\right)$$

$$\dot{\bar{k}}_j(t) = \Omega_j\left(z(t), \{\bar{k}_j(t)\}, \left(N_j(t)\right)\right), j = 2, \dots, J$$

$$\dot{N}_j(t) = \Lambda_j\left(z(t), \{\bar{k}_j(t)\}, \left(N_j(t)\right)\right), j = 1, \dots, J \quad (18)$$

where $\Omega_j(t)$ and $\Lambda_j(t)$ are functions of $z(t), \left(\bar{k}_j(t)\right)$, and $\left(N_j(t)\right)$ defined in the Appendix. Moreover, all the other variables are determined as functions of $z(t)$, $\left(\bar{k}_j(t)\right)$, and $\left(N_j(t)\right)$: $r(t)$ and $w_{jq}(t)$ by (A2) → $\bar{k}_1(t)$ by (A10) → $\bar{N}(t)$ by (A6) → $\bar{y}_j(t)$ by (A3) → $c_j(t)$, $s_j(t)$, $\tilde{T}_{jq}(t)$, and $n_j(t)$ by (11) → $\bar{T}_{jq}(t)$ by (6) → $T_{jq}(t)$ by (A5) → $K(t)$ by (A7) → $F(t)$ by (2).

The differential equations system (17) has $2J$ variables. As demonstrated in the Appendix, the expressions are complicated. It is difficult to explicitly interpret the economic implications of the equations. The model is simulated to illustrate the system's behaviour. The parameters are specified as follows:

$$\alpha = 0.25, A = 2, b_j = 1, T_0 = 24, \delta_k = 0.05,$$

$$\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} = \begin{pmatrix} 0.1 \\ 0.2 \\ 0.3 \end{pmatrix}, \begin{pmatrix} h_{11} \\ h_{21} \\ h_{31} \end{pmatrix} = \begin{pmatrix} 2 \\ 1.5 \\ 1 \end{pmatrix}, \begin{pmatrix} h_{12} \\ h_{22} \\ h_{32} \end{pmatrix} = \begin{pmatrix} 1.5 \\ 1 \\ 0.5 \end{pmatrix}, \begin{pmatrix} \xi_{10} \\ \xi_{20} \\ \xi_{30} \end{pmatrix} = \begin{pmatrix} 0.2 \\ 0.2 \\ 0.2 \end{pmatrix}, \begin{pmatrix} \lambda_{10} \\ \lambda_{20} \\ \lambda_{30} \end{pmatrix} = \begin{pmatrix} 0.6 \\ 0.55 \\ 0.5 \end{pmatrix},$$

$$\begin{pmatrix} v_{10} \\ v_{20} \\ v_{30} \end{pmatrix} = \begin{pmatrix} 1 \\ 1.2 \\ 1.5 \end{pmatrix}, \begin{pmatrix} \sigma_{110} \\ \sigma_{210} \\ \sigma_{310} \end{pmatrix} = \begin{pmatrix} 0.1 \\ 0.12 \\ 0.16 \end{pmatrix}, \begin{pmatrix} \sigma_{120} \\ \sigma_{220} \\ \sigma_{320} \end{pmatrix} = \begin{pmatrix} 0.13 \\ 0.14 \\ 0.8 \end{pmatrix}, \begin{pmatrix} \bar{v}_1 \\ \bar{v}_2 \\ \bar{v}_3 \end{pmatrix} = \begin{pmatrix} 0.02 \\ 0.03 \\ 0.035 \end{pmatrix},$$
$$\begin{pmatrix} \theta_{11} \\ \theta_{21} \\ \theta_{31} \end{pmatrix} = \begin{pmatrix} 0.1 \\ 0.2 \\ 0.1 \end{pmatrix}, \begin{pmatrix} \theta_{12} \\ \theta_{22} \\ \theta_{32} \end{pmatrix} = \begin{pmatrix} 0.5 \\ 0.3 \\ 0.2 \end{pmatrix}. \tag{19}$$

It is assumed that a mother spends more hours on childcare than a father. Person (1,2) spends a relatively long time on childcare per child and person (1,1) spends a relatively short time on childcare per child. Group 1's human capital is assumed to be higher than group 2's, and group 2's human capital is higher than group 3's. The relative propensities are listed as follows:

$$\begin{pmatrix} v_1 \\ \lambda_1 \\ \xi_1 \\ \sigma_{11} \\ \sigma_{12} \end{pmatrix} = \begin{pmatrix} 0.493 \\ 0.296 \\ 0.099 \\ 0.049 \\ 0.064 \end{pmatrix}, \begin{pmatrix} v_2 \\ \lambda_2 \\ \xi_2 \\ \sigma_{21} \\ \sigma_{22} \end{pmatrix} = \begin{pmatrix} 0.543 \\ 0.249 \\ 0.091 \\ 0.054 \\ 0.063 \end{pmatrix}, \begin{pmatrix} v_3 \\ \lambda_3 \\ \xi_3 \\ \sigma_{31} \\ \sigma_{31} \end{pmatrix} = \begin{pmatrix} 0.591 \\ 0.197 \\ 0.079 \\ 0.063 \\ 0.071 \end{pmatrix}.$$

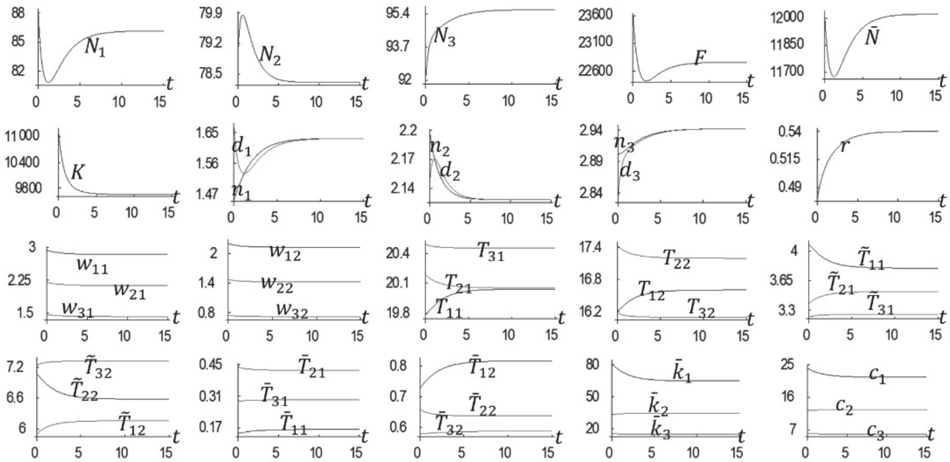
Group 1's propensity to have children is assumed to be lower than group 2's, and group 2's propensity to have children is assumed to be lower than group 3's. Both men and women in group 3 are assumed to have the highest propensities to stay at home. Group 1 is assumed to have the highest propensity to save. It is assumed that fathers have a lower propensity to pursue leisure than mothers. The total productivity factor is $A = 2$. Although the specified values are not based on empirical observations, the choice does not seem unrealistic. In many studies (for instance, Miles and Scott, 2005, Abel et al., 2007) the value of α in the Cobb-

Douglas production function is approximately 0.3. With regards to the preference parameters, what are important in my study are their relative values. To follow the motion of the system the initial conditions are specified:

$$z(0) = 0.36, \bar{k}_2(0) = 33, \bar{k}_3(0) = 15, N_1(0) = 88, N_2(0) = 79, N_3(0) = 92.$$

The simulation result is plotted in Figure 1. The population grows from its low initial condition. As the population rate rises, the mortality rate also increases. The labour force increases, and the wage rates decline. The falling wage rates reduce the opportunity cost of childcare, resulting in a rise in the birth rate. The rising birth rate is associated with an increase in both men's and women's time spent on childcare. As income falls, both men and women work longer hours. Their leisure hours are reduced. The national wealth and output increase in association with the rising labour force. Nevertheless, both consumption level and wealth per household decline. It should be mentioned that in a two-period overlapping-generations model, Strulik (2008) takes account of subsistence consumption and infant survival. The model predicts an inverted U-shape relationship between fertility and income. As the family's income increases it has more childcare resources. On the other hand, a higher income enables the parents to devote more resources to childcare. Some studies confirm that the fertility rate declines in the process of economic development (e.g., Kirk, 1996; Ehrlich and Lui 1997; Galor, 2012). From Figure 1 we can see that the relation between consumption and birth rate varies for different groups at different stages of economic growth.

Figure 1: The Motion of the Economic System



It is straightforward to confirm that all the variables become stationary in the long term. This implies the existence of an equilibrium point. The simulation confirms the existence of the following equilibrium point:

$N_1 = 86.2, N_2 = 78.3, N_3 = 95.6, K = 9644.7, \bar{N} = 12025.7, F = 22760.7,$
$n_1 = d_1 = 1.63, n_2 = d_2 = 2.13, n_3 = d_3 = 2.94, r = 0.54, w_{11} =$
$2.84, w_{12} = 2.13, \quad w_{21} = 2.13, w_{22} = 1.42, w_{31} = 1.42, w_{32} = 0.71, T_{11} =$
$20.03, \tilde{T}_{11} = 3.78, \bar{T}_{11} = 0.16, \quad T_{12} = 16.6, \tilde{T}_{12} = 6.58, \bar{T}_{12} = 0.62, T_{21} =$
$20.05, \tilde{T}_{21} = 3.52, \bar{T}_{21} = 0.43, T_{22} = 17.2, \quad \tilde{T}_{22} = 6.16, \bar{T}_{22} = 0.64, T_{31} =$
$20.45, \tilde{T}_{31} = 3.25, \bar{T}_{31} = 0.29, T_{32} = 16.09, \tilde{T}_{32} = 7.32, \quad \bar{T}_{32} = 0.59, \bar{k}_1 =$
$64.69, \bar{k}_2 = 34.67, \bar{k}_3 = 14.44, c_1 = 21.56, c_2 = 12.5, c_3 = 5.77.$

The populations of the three groups are respectively $N_1 = 86.2$, $N_2 = 78.3$, and $N_3 = 95.6$. These population differences are due to differences in human capital, the propensity to have children, and other factors. The following dynamic comparative statics demonstrate the effects of some parameters on the population dynamics. I calculate the six eigenvalues

$$-2.97, -2.13, -1.63, -0.68, -0.6, -0.54.$$

As the eigenvalues are negative, the unique equilibrium is locally stable. Hence, the system always approaches its equilibrium if it is not far from the equilibrium.

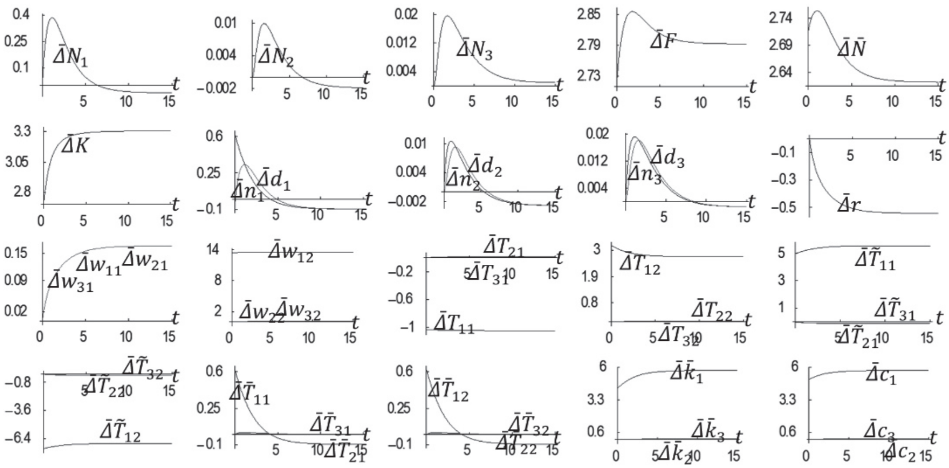
4. SIMULATION OF COMPARATIVE DYNAMIC ANALYSIS IN SOME PARAMETERS

The motion of the national economy is simulated in (18). We now examine how the economic system reacts to some exogenous change. As the lemma gives the computational procedure to calibrate the motion of all the variables, it is straightforward to examine the effects of change in any parameter on transitory processes as well as the stationary states of all the variables. We use a variable $\bar{\Delta}x_j(t)$ to stand for the change rate of the variable $x_j(t)$, as a percentage due to changes in the parameter value.

4.1 Improvements to female human capital in group 1

The traditional neoclassical approach holds that gender inequalities resulting from disparities in human capital will wither away as an economy experiences high growth (e.g., Beneria and Feldman, 1992, Forsythe, et al. 2000). According to Stotsky (2006: 18), "the neoclassical approach examines the simultaneous interaction of economic development and the reduction of gender inequalities. It sees the process of economic development leading to the reduction of these inequalities and also inequalities hindering economic development." As my model is a general equilibrium model with heterogeneous households and endogenous population, we can deal with complicated relations between different variables. We now examine the following rise in female human capital in group 1: $h_2: 1.5 \Rightarrow 1.7.$ The result is plotted in Figure 2. The national labour force, national output, and national capital are enhanced. The interest rate falls. The female wage rate in group 1 increases and the wage rates of other groups are slightly affected. Group 1's population rises initially and falls slightly in the long term. The other two groups' populations are slightly affected. Group 2's population rises initially and falls in the long term. Group 3's population expands. For group 1, the opportunity cost of childcare increases in association with the mother's wage rising. At the same time, the wage rate increases. The net result on the group's birth rate is that it rises initially and falls in the long term. The time that group 1's parents spend caring for children changes correspondingly. The mother from group 1 works more and the father works less. The father has more leisure time and the mother has less. The family consumes more and has more wealth. The mortality rate falls in association with improved living conditions. With regard to the effects on the other two groups, we find that the change in group 1's human capital has little impact on its consumption and wealth levels, even though the birth and death rates are affected. It should be remarked that many studies demonstrate that life expectancy increases with the aggregate level of human capital (e.g., Blackburn and Cipriani, 2002; Boucekkine et al., 2002). The results also demonstrate the same trend if we consider the mortality rate as negatively related to life expectancy.

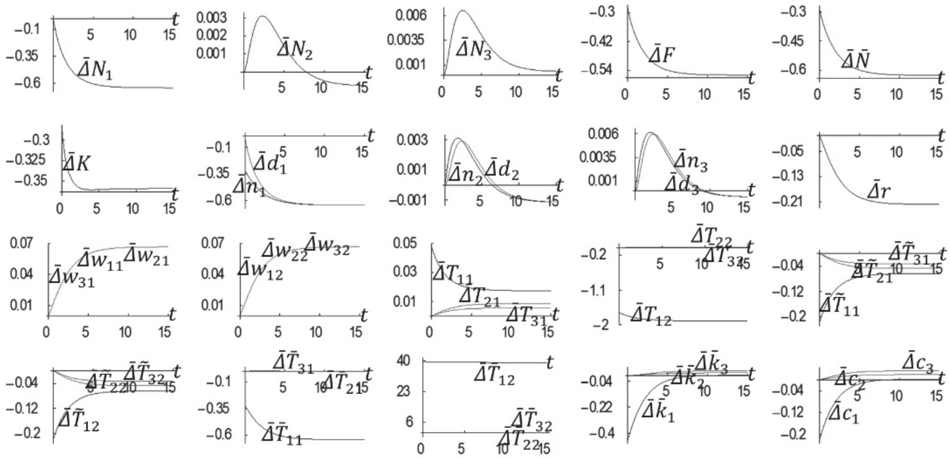
Figure 2: Human Capital of Group 1 Women Improves



4.2 Group 1 mothers spend more time on childcare

There is a vast amount of empirical and theoretical literature on economic growth and time allocation. We now theoretically examine another factor that may affect economic growth and the gender division of labour. We consider that the mother spends more time on childcare per child. We increase the parameter θ_{12} as follows: $\theta_{12}: 0.5 \Rightarrow 0.7$. The result is plotted in Figure 3. Group 1's mother spends more time on childcare and the father spends less time on childcare. Both the father and the mother spend less time on leisure. The mother works less hours and the father works more hours. The other two groups' time distributions are slightly affected. The national wealth, capital, and output decrease. Group 1's population is reduced. Group 2's population rises initially and falls in the long term. Group 3's population expands.

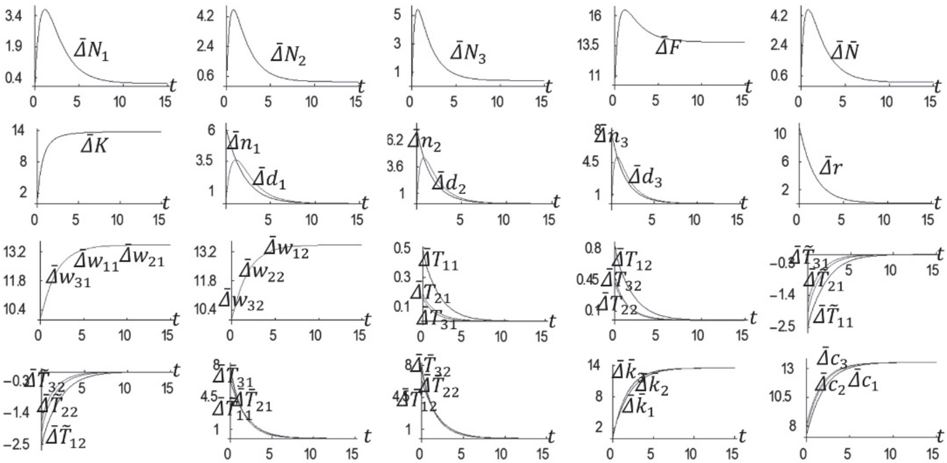
Figure 3: Mothers in Group 1 Spend More Time on Childcare



4.3 A rise in total factor productivity

The next concern is how the total factor productivity affects economic growth and population change. Technological change in the traditional Solow model has positive effects on long-term economic growth. As the Solow model assumes a constant growth rate and constant returns to scale, technological change has no impact on labour inputs and time allocation even in the short term. We now increase total factor productivity as follows: $A: 2 \Rightarrow 2.2$. The simulation results are plotted in Figure 4. As productivity is enhanced, the output level and wage rates increase. The total capital and labour force are enhanced. The interest rate increases initially but is not affected in the long term. Each group's population increases. Birth and mortality rates increase initially but are not affected in the long term. Technological change results in increased levels of consumption and wealth per household, and of the opportunity cost of childcare. It has no long-run impact on time allocations.

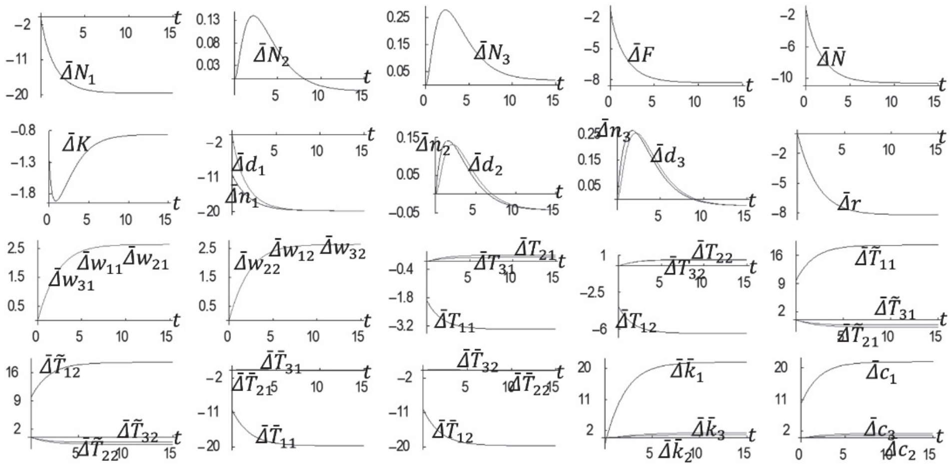
Figure 4: A Rise in the Total Factor Productivity



4.4 A decline in the propensity to have children

According to Tournemaine and Luangaram (2012: 925), “depending on the country, population growth may contribute, deter, or even have no impact on economic development. This ambiguous result is explained by the fact that the effects of population growth change over time. For example, a higher fertility rate can have a short-term negative effect caused by the cost of expenditures on children whereas it has a long-run positive effect through the larger labour force it generates.” But, according to Malthusian population theory for instance, it is argued that if a national economy has no economic activity characterised by increasing returns to scale, a rise in the population tends to reduce individual living conditions. We now examine the effects of the following decline in group 1’s propensity to have children: $\upsilon_{10}: 1 \Rightarrow 0.8$. The simulation results are plotted in Figure 5. As group 1’s interest in having children decreases, the group’s birth rate falls. Group 1 spends less time on childcare, more time on leisure activities, and less time on working. The group’s mortality rate also falls. Group 1’s population falls. Group 2’s population rises initially and falls in the long term. Group 3’s population increases. We see that when the other conditions are kept constant, a rise in the propensity to have children has a great impact on the population growth. The levels of capital and total labour input and output fall. Wage rates increase and the interest rate falls. Wealth and consumption levels increase.

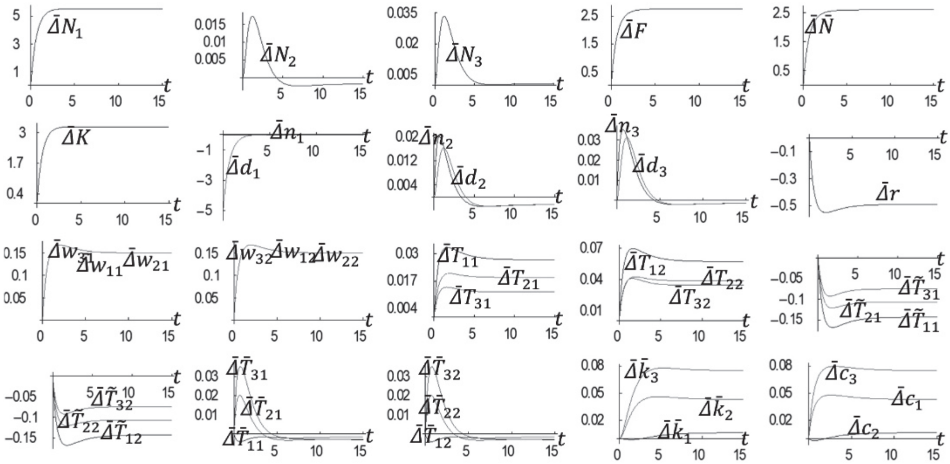
Figure 5: A Decline in Group 1's Propensity to Have Children



4.5 Group 1's income having a stronger impact on the mortality rate

We now examine what will happen to the economy when group 1's mortality rate is more negatively related to disposable income: $a_1: 0.01 \Rightarrow 0.02$. The result is plotted in Figure 6. Group 1's population increases. Group 2's population rises initially and falls in the long term. Group 3's population increases initially and is not affected in the long term. The national labour force and capital and output increase. Group 1's birth and mortality rates are not affected in the long term. The other two groups' birth and mortality rates fall slightly in the long term. The wage rates increase and the interest rate falls. The wealth and consumption levels increase. There are also slight changes in the time allocations.

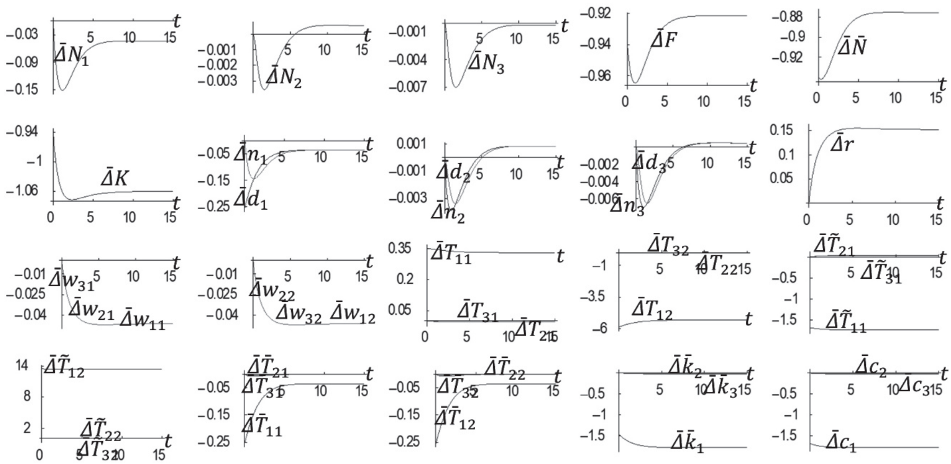
Figure 6: Group 1's Disposable Income Having a Stronger Impact on the Mortality Rate



4.6 A rise in the female propensity to pursue leisure activities

It is important to examine the economic consequences of an increase in female preferences for pursuing leisure activities. As the economy and other conditions in society change, people may change their preferences. For instance, women and men in developed societies may change their education and work preferences, resulting in changes to the economic system. To illustrate this we consider the effects following an increase in the female propensity to pursue leisure in Group 1: $\sigma_{102}: 0.13 \Rightarrow 0.15$. An immediate consequence of the preference change is that a wife from group 1 spends more time on leisure and the husband has less leisure hours. The husband works more hours and the wife works less. Both husband and wife reduce their time spent on childcare. Group 1's birth and mortality rates fall. Group 1's population falls. The other two groups' birth and mortality rates and populations are only slightly affected. The national output, national labour force, and national capital all decrease. The wage rates fall and the interest rate increases. Group 1's representative household consumes less and has less wealth. The representative households of the other two groups are only slightly affected.

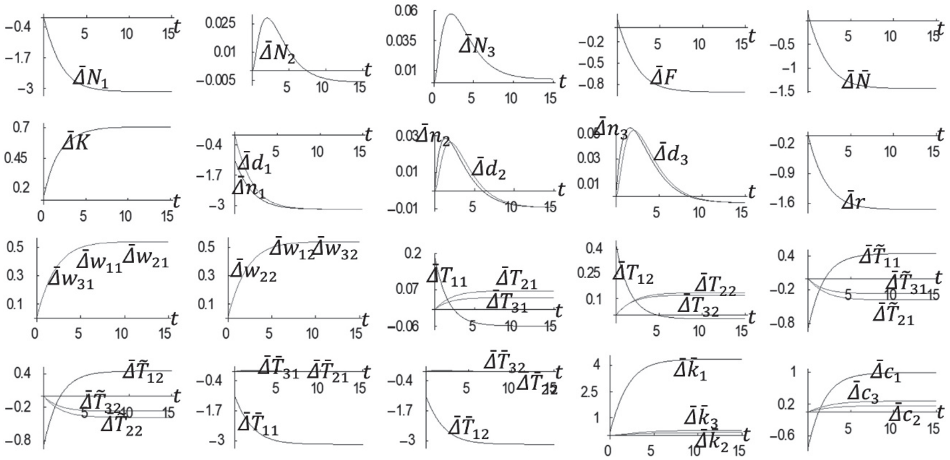
Figure 7: An Increase in Woman's Propensity to Pursue Leisure Activities



4.7 The impact of an increase in group 1's propensity to save

According to the Solow model, a rise the propensity to save will increase per capita wealth but reduce the per capita consumption level. I will show that the impact in my model is different from the result in the Solow model in the long term. The (exogenous) population growth rate is not affected by economic conditions in the traditional one-sector growth model. I now examine what will happen in an economy with endogenous birth and mortality rates when group 1's propensity to save is increased as follows: $\lambda_{10}: 0.6 \Rightarrow 0.62.$ Group 1's per household consumption level falls initially and rises in the long term. Group 1's per household wealth increases. Both men and women from group 1 work more hours initially and work less hours in the long term, they spend less hours on leisure initially and more hours in the long term, and they spend less hours on childcare. Group 1's population falls. Group 2's population rises initially and falls in the long term. Group 3's population increases. The national labour supply and national output fall, while the national capital increases. The wage rates increase and the interest rate falls. Groups 2 and 3 consume more and own more wealth. Groups 2 and 3 do not change the time allocated to childcare; they increase work hours and reduce leisure hours. We see that group 1's change in the propensity to save not only affects the group's time allocation but also the other groups' allocation of time between leisure and work. Changes in the national capital stock affect the marginal returns of work (i.e., wage rate). As the wage rates are affected, the other groups' time allocations are also affected.

Figure 8: The Impact of an Increase in Group 1's Propensity to Save



5. CONCLUDING REMARKS

This paper introduces endogenous population into a generalised Solow one-sector growth model with multiple types of households. The paper is a synthesis of my earlier models of endogenous population (Zhang, 2015) and of general equilibrium dynamics with heterogeneous households (Zhang, 2012). The study analyses the dynamic interdependence between different socio-cultural groups' birth rates, mortality rates, population, wealth accumulation, and time distribution between work, leisure, and childcare. The emphasis is on the role of changes in human capital, technology, and preferences on birth and mortality rates and the allocation of time between work, childcare, and leisure. The basic economic structure is based on the Walrasian general equilibrium theory and wealth accumulation is based the Solow growth model. An alternative utility function proposed by Zhang (2020) is used to describe the behaviour of households. In my approach, wealth and income inequality is due to heterogeneity in households' preferences and human capital levels as well as in households' initial wealth. Also modelled are gender differences in human capital, the propensity to use leisure time, and the efficiency of childcare, and the dynamics of group differences in wealth, income, birth rate, mortality rate, and population. The model simulates the movement of the economy and population change and identifies the existence of an equilibrium point. Also examined are the effects of changes in the propensity to have children, the propensity to save, the female propensity to use leisure, female human capital, and female involvement in childcare. As this model is built on economic theory, it can be generalised and extended. In my approach, the childcare function exhibits constant returns to scale in the parent's time allocated to childcare. It is possible to generalise the model by applying more general production or utility functions. Future studies could take account of scale effects in childcare.

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APPENDIX

Proving the lemma

The dynamics can be expressed by a differential equations system. From (3), we obtain:

$$z \equiv \frac{r+\delta_k}{w} = \frac{\tilde{\alpha}\bar{N}}{K} \tag{A1}$$

where $\tilde{\alpha} \equiv \alpha/\beta$. From (2) and (3), we have:

$$r = \alpha\, A\left(\frac{z}{\tilde{\alpha}_i}\right)^{\beta} - \delta_k, w = \beta\, A\left(\frac{\tilde{\alpha}}{z}\right)^{\alpha}, w_{jq} = h_{jq}\, w. \tag{A2}$$

Hence, we determine r, w, and w_{jq} as functions of z. From the definition of $\bar{y}$ and (3) we have:

$$\bar{y}_j = (1+r)\bar{k}_j + h_{j0}\, w \tag{A3}$$

where $h_{j0} \equiv \left(h_{j1} + h_{j2}\right)T_0$. By (8) and (11), we have:

$$T_{jq} = T_0 - \bar{T}_{jq} - \tilde{T}_{jq} = T_0 - \left(\frac{\theta_{jq}\, v_j}{\tilde{w}_j} + \frac{\sigma_{jq}}{h_{jq}\, w}\right)\bar{y}_j. \tag{A4}$$

Insert (A3) in (A4)

$$T_{jq} = \chi_{jq} - \frac{\tilde{r}_{jq}\, \bar{k}_j + \bar{r}_q}{\tilde{w}_j} - r_{jq}\, \bar{k}_j \tag{A5}$$

where

$$\chi_{jq} = \left(1 - \frac{\left(h_{j1} + h_{j2}\right)\sigma_{jq}}{h_{jq}}\right)T_0, \tilde{r}_{jq} \equiv \theta_{jq}\, v_j(1+r), \bar{r}_{jq} \equiv h_{j0}\, \theta_{jq}\, v_j\, w, r_{jq} \equiv \frac{(1+r)\sigma_{jq}}{h_{jq}\, w}.$$

Insert (A5) in (1)

$$\bar{N} = \sum_{j=1}^{J}\left(\chi_j - \frac{\tilde{r}_j\,\bar{k}_j + \tilde{h}_{3j}}{\widetilde{w}_j} - \tilde{r}_{0j}\,\bar{k}_j\right)N_j \tag{A6}$$

where

$$\chi_j \equiv h_{j1}\,\chi_{j1} + h_{j2}\,\chi_{j2}, \tilde{r}_j \equiv h_{j1}\,\tilde{r}_{j1} + h_{j2}\,\tilde{r}_{j2}, \tilde{h}_{3j} \equiv h_{j1}\,\bar{r}_{j1} + h_{j2}\,\bar{r}_{j2}, \tilde{r}_{0j} \equiv h_{j1}\,r_{j1} + h_{j2}\,r_{j2}.$$

By the definition of z, we have:

$$K = \frac{\tilde{\alpha}\bar{N}}{z}. \tag{A7}$$

Insert (A6) and (16) in (A7)

$$\left(z_1 + \frac{\tilde{r}_1}{\widetilde{w}_1}\right)\quad \bar{k}_1 + \frac{\tilde{h}_{31}}{\widetilde{w}_1} = \phi_0\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv \chi_1 + \frac{1}{N_1}\sum_{j=2}^{J}\left(\chi_j - \frac{\tilde{r}_j\,\bar{k}_j + \tilde{h}_{3j}}{\widetilde{w}_j} - z_j\,\bar{k}_j\right)N_j, \tag{A8}$$

where

$$z_j \equiv \tilde{r}_{0j} + \frac{z}{\tilde{\alpha}}.$$

Insert $\widetilde{w}_1 = \bar{k}_1 + h_1\,w$ in (A8):

$$\bar{k}_1^2 + m_1\,\bar{k}_1 + m_2 = 0, \tag{A9}$$

where

$$m_1\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv h_1\,w + \frac{\tilde{r}_1 - \phi_0}{z_1}, m_2\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv \frac{\tilde{h}_{31} - h_1\,w\,\phi_0}{z_1}.$$

Solve (A9)

$$\bar{k}_1 = \phi\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv \frac{-m_1 \pm \sqrt{m_1^2 - 4\,m_2}}{2}. \tag{A10}$$

In the simulation, (A10) has a meaningful solution:

$$\bar{k}_1 = \frac{-m_1 + \sqrt{m_1^2 - 4\, m_2}}{2}.$$

The following procedure shows how to express the variables as functions z, $\{\bar{k}_j\}$, and (N_j): r and w_{jq} by (A2) → $\bar{k}_1$ by (A10) → $\bar{N}$ by (A6) → $\bar{y}_j$ by (A3) → c_j, s_j, $\tilde{T}_{jq}$, and n_j by (11) → $\bar{T}_{jq}$ by (6) → T_{jq} by (A5) → K by (A7) → F by (2). From this procedure (15) and (14), we have:

$$\dot{\bar{k}}_1 = \Omega_0\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv s_1 - \bar{k}_1, \tag{A11}$$

$$\dot{\bar{k}}_j = \Omega_j\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv s_j - \bar{k}_j, j = 2, \ldots, J,$$

$$\dot{N}_j = \Lambda_j\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv \left(\frac{\upsilon_j \bar{y}_j}{\tilde{w}_j} - \frac{\bar{\upsilon}_j N_j^{b_j}}{\bar{y}_j^{a_j}}\right) N_j, j = 1, \ldots, J. \tag{A12}$$

Take derivatives of (A10) with respect to t:

$$\dot{\bar{k}}_1 = \frac{\partial \phi}{\partial z}\dot{z} + \sum_{j=2}^{J} \frac{\partial \phi}{\partial \bar{k}_j}\dot{\bar{k}}_j + \sum_{j=1}^{J} \frac{\partial \phi}{\partial N_j}\dot{N}_j. \tag{A13}$$

Insert (A12) in (A13):

$$\dot{\bar{k}}_1 = \frac{\partial \phi}{\partial z}\dot{z} + \sum_{j=2}^{J} \Omega_j \frac{\partial \phi}{\partial \bar{k}_j} + \sum_{j=1}^{J} \Lambda_j \frac{\partial \phi}{\partial N_j}. \tag{A14}$$

Equalise the right-hand sides of (A11) and (A14):

$$\dot{z} = \Omega_1\left(z, \{\bar{k}_j\}, (N_j)\right) \equiv \left(\Omega_0 - \sum_{j=2}^{J} \Omega_j \frac{\partial \phi}{\partial \bar{k}_j} - \sum_{j=1}^{J} \Lambda_j \frac{\partial \phi}{\partial N_j}\right)\left(\frac{\partial \phi}{\partial z}\right)^{-1}. \tag{A15}$$

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REVISITING THE ROLE OF EXCHANGE RATE VOLATILITY IN TURKEY'S EXPORTS: EVIDENCE FROM THE STRUCTURAL VAR APPROACH

ABSTRACT: *The exchange rate is both an important economic variable when determining a country's export volume and an indicator of its international competitiveness. This paper re-investigates the impact of real exchange rate volatility on Turkey's exports using the structural vector autoregression method and monthly data from 2003:01 to 2019:12. Empirical evidence shows that real exchange rate and exchange rate volatility do not affect exports in Turkey. On the other hand, external income has had a slight effect on Turkey's exports in the post-global-crisis period. The findings show that other factors which effect macroeconomic indicators in the Turkish economy should also be considered.*

KEY WORDS: *exchange rate volatility, exports, SVAR, structural breaks, Turkey.*

JEL CLASSIFICATION: C32, F31, F4.

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1. INTRODUCTION

Producers are assumed to have full knowledge of the markets. In other words, it is assumed that producers know the prices of all inputs and outputs and know the production function precisely under perfect competition conditions. In addition, consumers have information about their income, utility functions, and the prices of all goods and services. However, in the real world, certainty in economic activity is an exception because the results of economic activity depend not only on individuals' decisions but also on factors that individuals do not control. Thus, the reality is that uncertainty prevails and therefore the rational decisions of economic units may produce biased results. The uncertainty arising from an increase in exchange rate volatility creates risk. Thus, it is thought that exchange rate volatility negatively affects international trade (Doğanlar, 2002: 859). The exchange rate is an important economic variable, both as a determinant of a country's export volume and as an indicator of its international competitiveness. At the same time, in developing countries such as Turkey the exchange rate also plays an important role in production costs due to the total value of imported intermediate and capital goods. High fluctuations in the exchange rate create uncertainty regarding profits and thus reduce the gains of international trade and hinder trade volumes (Yüksel et al., 2012; Ozcelebi and Yildirim, 2011).

The Bretton Woods System, which was based on a fixed exchange rate regime, collapsed in 1973, and from that date most countries let their currencies float free. Since then, the question of whether volatility in the exchange rate within the flexible exchange rate system affects international trade flows has been a matter of intense debate. Exchange rate volatility is defined as the risk associated with unexpected movements in the exchange rate. It is widely believed that high exchange rate volatility increases uncertainty and hinders the growth of foreign trade. This belief is accepted not only by politicians and financial market participants but also by commercial economists (Cushman, 1983:45; Arize, 1997, p.95).

In the literature the results of studies on the relationship between exchange rate volatility and trade flows are contradictory. Most studies argue that volatility reduces foreign trade (Doğanlar, 2002; Al-Rashidi and Lahiri, 2013; Serenis, 2013; Barseghyan and Hambardzumyan, 2017), while some find that the former stimulates the latter (Serenis and Tsounis, 2014; Uslu, 2018). The existence of a negative relationship between these variables is due to risk-averse firms. Accordingly, high exchange rate volatility reduces the expected profitability from exports and therefore reduces the trade volume (Altintaş et al., 2011). The positive or negative effect of exchange rate volatility on exports is also analysed within the framework of income and substitution effects. Given the effects of increased risk on both income and substitution, the impact of volatility on exports will vary depending on the degree of risk aversion. When risk increases, individuals prefer to export more to avoid the possibility of a serious reduction in their income (income effect). However, if firms are less risk-averse, they find the return on exports less attractive and decide to export less (substitution effect). Consequently, higher volatility leads to more exports if the income effect dominates the substitution effect (Grauwe, 1988: 67). However, some studies find no significant relationship between exchange rate volatility and exports (Bahmani-Oskooee and Harvey, 2011; Bahmani-Oskooee et al., 2015).

After the 1929 Great Depression the Law on the Protection of the Turkish Currency came into force in 1930 and foreign exchange markets began to be audited. The central bank was established in 1930 and the Law on Lending Affairs came into effect in 1933, implementing a fixed exchange rate regime in Turkey. After Turkey became a member of the IMF and the World Bank in 1947 an adjustable fixed exchange rate policy was implemented (Dilbaz Alacahan and Akarsu, 2017: 332). Since 1980, Turkey has implemented liberal economic policies. A floating exchange rate regime was adopted after the 2001 economic crisis, to be determined according to supply and demand in the market. Hence, exchange rate volatility and uncertainty increased (Erdal et al., 2012). The current account deficit problem in Turkey's economy has been called the 'learned helplessness' phenomenon, and the relationship between exchange rate and foreign trade has been intensively analysed in the economics literature of Turkey. Table 1 shows that the findings of these studies on exchange rate volatility in the Turkish economy are as diverse as they are in the international literature.

Table 1: Summary of previous studies on exchange rate volatility in Turkey

Author	Period	Method	Impact of Volatility
Özbay (1999)	1998Q2–1997Q2	OLS	Negative
Acaravci and Ozturk (2002)	1989:01–2002:08	Johansen Cointegration Test	Negative
Kasman and Kasman (2005)	1982Q1–2001Q4	Johansen Cointegration Test	Positive
Guloglu (2008)	1982:01–2006:12	Markow Switching ARCH	Negative
Köse et al. (2008)	1995:01–2008:06	Johansen Cointegration Test	Negative
Tarı and Yıldırım (2009)	1989Q1–2007Q3	Johansen Cointegration Test	Negative
Altintaş et al. (2011)	1993Q3–2009Q4	ARDL	Positive
Yüksel et al. (2012)	2003:02–2010:12	OLS	No Impact
Erdal et al. (2012)	1995:01–2007:11	Johansen Cointegration Test	Negative
Çiftçi (2014)	2003:01–2013:11	ARDL	Negative
Balcılar et al. (2014)	1995Q1–2012Q4	ARDL	No Impact
Sevim and Doğan (2016)	2002:01–2014:11	ARDL	No Impact
Çelik (2018)	1995:01–2017:01	ARDL	Negative
Ayhan (2019)	2005:01–2014:02	ARDL	Negative
Köse and Aslan (2020)	2002:01–2017:12	Structural VAR	No Impact

Note: OLS = Ordinary least squares, ARCH = Autoregressive conditional heteroskedasticity, ARDL = Autoregressive distributed lag model, VAR = Vector autoregression.

The present study uses monthly data for the period 2003–2019 to investigate the relationship between exports and exchange rate. Two important break points were taken into consideration for the selection of the dataset period. The first is the financial measures taken in 2003 after the 2001 crisis. The second is the global Covid-19 pandemic. Therefore, the years before 2003 and the year 2020 have been excluded. The study uses the most up-to-date dataset and simultaneously analyses the effects of both exchange rate and volatility on exports. Most previous studies use vector autoregression (VAR) analysis, but this study's application of the structural VAR (hereafter SVAR) model reinforces its novelty. The SVAR model estimates impulse-response functions by imposing short- and long-term constraints on the model's calculation process. The study's analyses also consider structural breaks.

The remainder of the article is organised as follows. Chapter 2 introduces the data set and the econometric methodology, section 3 reports the findings, and the final section presents the concluding remarks.

2. DATASET AND ECONOMETRIC METHODOLOGY

This section first introduces the variables in the study and then explains the SVAR model that is used to examine the relationship between the relevant variables.

2.1. Dataset

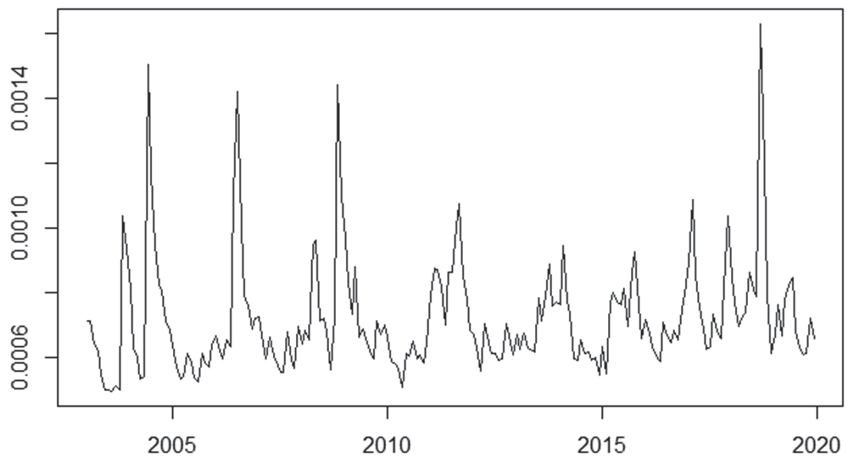
The relationship between exchange rate volatility and exports is examined using monthly data for the period January 2003 – December 2019. The CPI-based real effective exchange rate (2003=100) is from the Central Bank of the Republic of Turkey and imports and exports are from the Turkish Statistical Institute (in thousand US$). The industrial production index (2015=100) for the EU (27) countries is from the OECD. The industrial production index is added to the model as a proxy for external income. The income of EU countries is used because they are important trading partners for Turkey. The industrial production index and foreign trade data are seasonally adjusted and therefore without calendar effects. The Exponential Generalised Autoregressive Conditional Heteroskedasticity (EGARCH) process is used to capture exchange rate volatility (Nelson, 1991). The logarithmic transformation is applied to all variables.

The ARCH LM test is used to examine the existence of heteroskedasticity in the real exchange rate series (see Table 2) and the null hypothesis claiming that there is no ARCH effect is rejected at the 1% significance level. This shows that there is a heteroskedasticity problem in the residuals of the real exchange rate series. After detecting the existence of the ARCH effect, the appropriate GARCH model is used to estimate the exchange rate volatility. Before moving on to the GARCH models, the quantile-quantile graph and the Shapiro-Wilk (1965) normality test are used to examine whether the real exchange rate shows a significant difference from the normal distribution, and it is observed that the distribution of the relevant series is not normal. In the light of these results, GARCH models are analysed considering the student-t distribution. In order to determine the most suitable model the Akaike and Schwarz values should be the smallest, the ARCH effect should be eliminated, and there should be no autocorrelation problem.

Considering all these factors, it is determined that EGARCH(1,1) is the most suitable model for estimating exchange rate volatility. The gamma coefficient in the EGARCH model examines the leverage effect. A negative gamma coefficient indicates the presence of a leverage effect. As shown in Table 3, the alpha+beta<1 condition is met. According to the results of the EGARCH (1,1) model, the gamma coefficient is positive and statistically insignificant. Accordingly, it is observed that there is no leverage effect. The Ljung Box Q and Q2 and ARCH-LM tests are used to examine the autocorrelation problem in the residuals obtained from the appropriate EGARCH (1,1) model and whether the ARCH effect disappears (see Table 4 in the Appendix).

Table 4 shows that the ARMA (2,0) – EGARCH (1,1) model, found to be the most suitable model for estimating the volatility of the real exchange rate variable, is eliminated and there is no autocorrelation problem. Accordingly, all the conditions are met for the EGARCH (1,1) model, which is determined as the appropriate model to estimate exchange rate volatility. The conditional variance given by the EGARCH (1,1) model is used as the real exchange rate variable. The volatility series obtained for this paper is as in Figure 1.

Figure 1: Real exchange rate volatility



2.2. The SVAR Model

Sims (1980) developed the VAR model as an alternative approach to simultaneous equation systems. Simultaneous equation systems do not consider the dynamic structure in time series, and these models also take some variables as exogenous. According to Sims this is questionable, since this supposition of the exogeneity of variables reflects the preferences and prejudices of the modelmakers and is not fully supported by theoretical evaluations. Unlike the simultaneous equation models, the VAR models consider all variables to be a priori endogenous and imposed by statistical tools rather than controversial theories (Lütkpohl, 2005, p.1).

Using the VAR models makes it possible to observe the relative importance of various shocks on macroeconomic variables and to address their dynamic impact. The VAR analysis gives policymakers a deeper understanding of how economic variables are affected by demand or supply shocks so that in an everchanging environment they can respond with more effective policy decisions (Sarte, 1997, p.45). However, changes in policy implementation, economic crises, and shocks that occur for similar reasons cannot be defined perfectly with a specific variable. Therefore, the VAR models cannot determine the influence of shocks, and the SVAR approach was developed for this reason. The SVAR technique provides the determination of sufficient constraints to define underlying shocks in the form of either repetitive structures using economic information, coefficient restrictions, and variance or covariance restrictions, or constraints on the short- or long-term multipliers. The SVAR model offers the opportunity to determine constraints consistent with economic theory and current conditions, and so helps to achieve more robust and logical findings (Köse and Aslan, 2020, p.6). Also, contrary to the VAR models, the SVAR models consider structural changes, and both short- and long-term constraints can be imposed (Narayan et al. 2008, p.2765).

The VAR model with a lag p (VAR (p)) can be written as follow (Narayan et al., 2008, p.2766):

$$X_t = A_1 X_{t-1} + \cdots + A_p X_{t-p} + \Psi D_t + u_t \qquad (1)$$

In Equation 1, the A_i (i=1,...,p) are (KxK) parameter matrices, p shows the lag of the VAR model, X is an $nx1$ vector of dependent variables, and u_t is an $nx1$ vector of reduced form residuals. According to Narayan et al. (2008), the deterministic component can be safely ignored because it is not affected by shocks to the system. In this case, the SVAR model can be written as:

$$AX_t = A_1^* X_{t-1} + \cdots + A_p^* X_{t-p} + B\varepsilon_t \quad (2)$$

where matrix B contains the structural form parameters of the model, while matrix A is used to connect instant models. The ε_t is an $nx1$ vector of structural disturbances shown as $\text{var}(\varepsilon_t) = \Lambda$, where Λ is a diagonal matrix with variance of structural defects forming diagonal elements. Shocks cannot be observed directly, so some restrictions are needed. The common practice for the constraint is to multiply Equation 2 by A^{-1}. This leads to the following relationship between reduced-form disturbances and structural disturbances (Narayan et al., 2008, p.2766):

$$u_t = A^{-1} B\varepsilon_t \quad (3)$$

Equation 3 for the AB model can be written as:

$$Au_t = B\varepsilon_t \quad (4)$$

In this study the SVAR model includes income, real exchange rate volatility, and import and export variables. Köse and Aslan's (2020) study is based on creating constraints for the SVAR model under which external income is not contemporaneously affected by shocks in other variables in the system but external income affects export shocks simultaneously. While real exchange rate volatility is not affected contemporaneously by shocks of the other variables, it has an impact on the import and export shocks. While the real exchange rate is not affected by the variables, it affects all variables except income. Imports only have an impact on exports. On the other hand, exports do not affect any variables, yet they are simultaneously affected by all variables. The impacts of external income and exchange rate volatility on exports are determined considering the economic theory. However, the influence of import restrictions is determined considering the economic structure of Turkey. Turkey has external dependence on energy, which is an essential item in production; therefore it is expected that imports have an impact on exports (Köse and Aslan, 2020, p.8). Under these constraints, the SVAR model is as below:

$$\begin{bmatrix} \varepsilon_t^{\ln EXR} \\ \varepsilon_t^{\ln Y} \\ \varepsilon_t^{VOL} \\ \varepsilon_t^{\ln M} \\ \varepsilon_t^{\ln X} \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & 0 & 0 & 0 \\ a_{21} & 1 & a_{23} & a_{24} & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^{\ln EXR} \\ u_t^{\ln Y} \\ u_t^{VOL} \\ u_t^{\ln M} \\ u_t^{\ln X} \end{bmatrix}$$

where $\varepsilon_t^{\ln X}$, ε_t^{VOL}, $\varepsilon_t^{\ln EXR}$, $\varepsilon_t^{\ln Y}$, and $\varepsilon_t^{\ln M}$ are structural disturbances; that is, exports, real exchange rate, exchange rate volatility, income, and import shocks, respectively. $u_t^{\ln X}$, u_t^{VOL}, $u_t^{\ln EXR}$, $u_t^{\ln Y}$, and $u_t^{\ln M}$ are residuals in the reduced-form equations and represent unexpected disturbances.

3. FINDINGS

This section presents the findings and interpretations of the econometric analyses. In the VAR models the variables must meet the stationarity condition, which is essential for robust results. Hence, unit root tests are carried out before employing the SVAR analysis: both classical unit root tests with a single structural break such as Phillips-Perron (1988), Ng-Perron (2001), and Zivot-Andrews (1992), and Lee and Strazicich (2003) LM tests with two structural breaks (See Tables 5, 6, and 7 in the Appendix). When these unit root tests are evaluated together it is determined that the integration degree of the volatility series is I (0), and the real exchange rate, exports, and imports are I (1). Finally, although the Phillips-Perron (1988) and Lee and Strazicich (2003) tests show that the income variable is stationary at the first difference, according to the Ng-Perron (2001) and Zivot-Andrews (1992) tests it is stationary at level. The graph of the series shows that there is only one structural break, so the result of the Zivot-Andrews (1992) test with one structural break is considered. Therefore, the income variable is I (0).

Both domestic and global economic crises and the policies implemented because of those crises may cause structural breaks in the macroeconomic dataset. Therefore, considering structural breaks in the analyses of macroeconomic data ensures that the results are more consistent. The SVAR models assume that structural parameters remain constant throughout volatility regimes. Bacchiocchi and Fanelli (2012, 2015) state that this assumption might be valid to some extent, but this situation is controversial for macroeconomic data since there is parameter instability. Hence, structural breaks may have noticeable consequences for both the transmission and propagation shock mechanisms (Bacchiocchi and Fanelli, 2015, p.2).

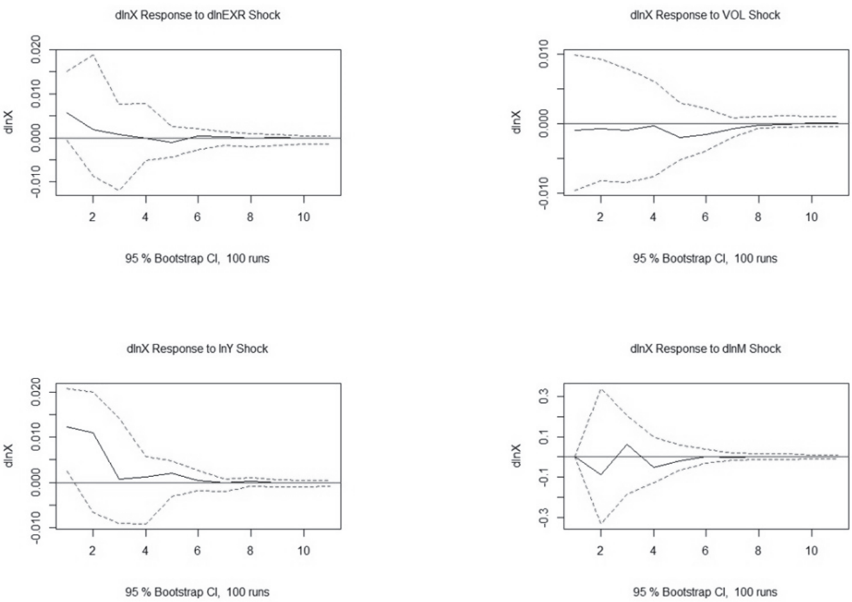
In this context, in this study both structural break unit root tests and Bai and Perron's (2003) multiple structural break tests are used to investigate the presence of a structural break (see Table 8 in the Appendix). Structural break unit root tests mostly reveal that there is a break in 2008. According to the Bai and Perron (2003) test, the break dates are 2008M11 and 2012M02. The mortgage crisis that emerged in the US real estate market in mid-2007 caused a global economic crisis towards the end of 2008. Therefore, it is thought that the 2008 global crisis led to the structural break in Turkey's economy. Since the variables used in the study are directly affected by global market conditions, 2008M11 is considered as a break date. The data set is divided into two regimes starting from the period after the break date and the impulse-response functions between the variables are examined.

The confidence intervals required for impulse response functions are obtained using Monte Carlo simulations. In order to get reliable results, both of the dashed lines must be on either the positive or the negative side (Yamak and Korkmaz, 2005:26). In addition, Abrigo and Love (2016) state that the effect is insignificant if the confidence intervals include the zero line (Abrigo and Love, 2016: 795). This study considers these two facts regarding the results of the impulse-response analysis. Impulse-response analysis can examine the effect of a shock in one variable on other variables. The impulse-response functions of the shocks on exports are presented in Figure 2. Ninety-five per cent confidence intervals, that are shown with the dashed lines, are established to show the parameter uncertainty, the future 10-month responses are considered, and the 500 bootstrapped iterations are used. The Akaike Information Criteria (AIC) is chosen for the lag length selection of the VAR model, which is determined to be 2.

This paper uses real effective exchange rate. In this case, increasing the real exchange rate, which is an indication of revaluing the Turkish Lira, and the expectation of a rising exchange rate level are supposed to hinder the export level. Therefore, a negative relationship is expected between exchange rate and exports.

In Figure 2, it seems that the increase in the real exchange rate has a positive impact on exports for 4 months. This effect is negative in the 5th and 6th months and balances in the following months. However, the impact is statistically insignificant. This insignificant relationship between real exchange rate and exports is consistent with Aktaş's (2010) findings. Contrary to the real exchange rate, the effect of shocks in exchange rate volatility on exports is negative, but this effect is also insignificant. It is observed that the external revenue affects Turkey's exports positively, and this effect is statistically significant for the first two months. Increasing foreign demand is an important driving factor for exports. Therefore, the positive effect of external income on exports is in accordance with the economic theory. Finally, imports do not affect exports. This result contradicts the results of Köse and Aslan (2020), who find that exports respond increasingly to shocks in imports.

Figure 2: The variables' impulse-response functions (2003–2019)



The stationarity degrees of the variables for the sub-periods are examined with the Phillips-Perron unit root test. Except for the real exchange rate, all variables are found to be stationary at the first difference in both the first and second sub-periods. While the real exchange rate variable is stationary at its level in the first sub-period, it meets the stationarity condition after taking the first difference in the second sub-period examined (see Table 9 in the Appendix).

Figures 3 and 4 show the impact of real exchange rate, exchange rate volatility, income, and import shocks on exports for the pre-global-crisis and post-global-crisis periods. The appropriate lag length is 2 for both sub-periods according to AIC.

In the pre-global-crisis period (see Figure 3) the response of exports to shocks in exchange rates is positive, and insignificant. This result contradicts the hypothesis which suggests that exports will become more expensive as a result of the appreciation of a country's real effective exchange rate, and thus exports will suffer. However, Saatcioğlu and Karaca (2004) also find similar results for the Turkish economy. On the other hand, in the post-crisis period (see Figure 4) the impact of the exchange rate on exports fluctuates and becomes zero as of the 6th month, but this effect is not statistically significant. The latter can be explained by considering global markets in the global crisis. A similar relationship is observed in the response of exports to external income. However, although foreign income has a significant positive effect in the first months of the pre-crisis period, there is no significant influence in the post-crisis period. The response of exports to shocks in exchange volatility is negative in the pre-crisis period. In other words, exchange rate uncertainty reduces exports in Turkey. However, this impact is not statistically significant. In the post-crisis period, exports respond to shocks by first decreasing, then increasing and decreasing again. The response is statistically significant for the first period. Finally, imports are ineffective in both periods.

Figure 3: The variables' impulse-response functions pre-global financial crisis (2003:01–2008:11)

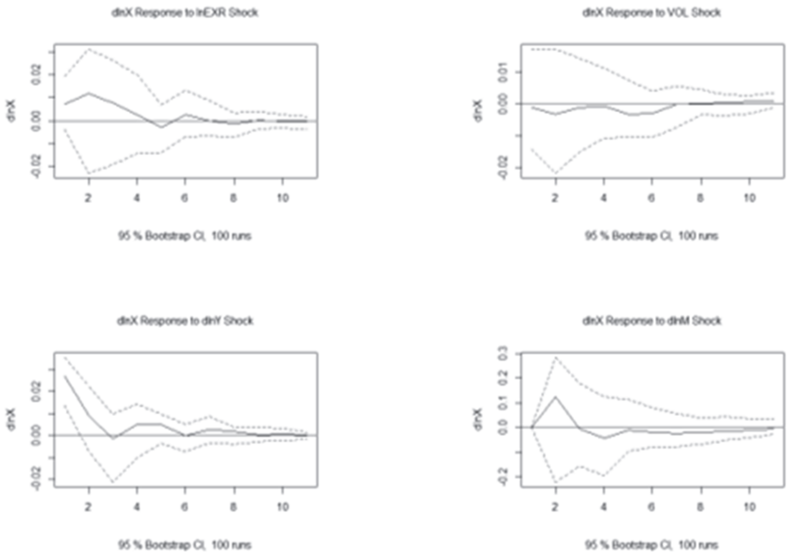
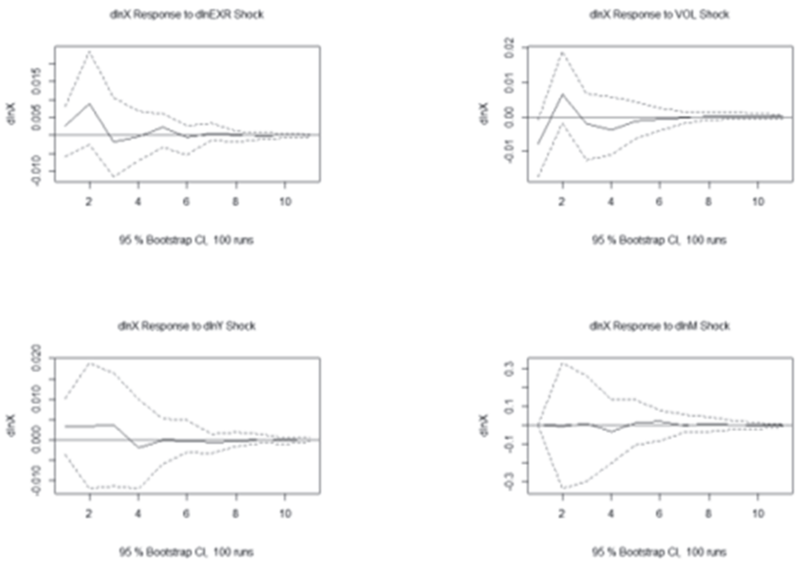


Figure 4: The variables' impulse-response functions pre-global financial crisis (2008:12–2019:12)



The most recent study investigating the relationship between real exchange rate and exports for Turkey's economy is by Köse and Aslan (2020). The findings of this paper differ from Köse and Aslan (2020) in terms of the impact of imports on exports. The study finds that, contrary to expectations, imports do not have a significant effect on exports. The most recent figure showing the share of imports in exports is from 2016 and is 16.5% (OECD, 2021). This shows that Turkish exports are not highly dependent on imported inputs. Examining the relationship between variables on a sector basis rather than at the macro level would provide more reliable results and show the effects of imports on exports more clearly.

4. CONCLUSION

Exports are a component of aggregate demand, which is why most researchers agree that an increase in exports contributes positively to economic growth through increasing aggregate demand. In addition, increased exports eliminate foreign exchange shortages, reduce production costs, increase employment, allow the appropriate allocation of the division of labour and resources, and can encourage the implementation of new technologies. Therefore, appropriate ways of achieving a sustainable export volume as an essential step for increasing welfare are extensively researched in the economics literature. With the liberalisation of international trade and capital markets and the transition to a floating exchange rate regime, the effects of exchange rate and/or exchange rate volatility on foreign trade have been the subject of considerable debate. Turkey's economy is based on a dual currency system as a result of high levels of dollarisation and has struggled constantly with a current account deficit problem. Therefore, it is important to define the relationship between exchange rate and foreign trade correctly.

The connection between real exchange rate and foreign trade data for the period 2003:01–2019:12 was analysed using SVAR. Since the dataset includes the 2008 global crisis the analyses took structural breaks into account. When structural breaks are neglected, it appears that the impact of real exchange rate, volatility, and imports on exports is not statistically significant. On the other hand, shocks in external income have a positive and significant impact on exports in the first two months. These results suggest that Turkey's exports are mostly affected by external demand. Regarding the structural breaks, the response of exports to the shocks is an increase in the real exchange rate and this effect reaches equilibrium after the 6th and 7th months. Again, this response is not significant. The impact of exchange rate volatility on exports is negative in the first period but the direction of the response changes in the second period. However, these effects are found to be statistically insignificant.

This study shows that exchange rate volatility has no effect on exports. Therefore, the hedging practices of exporting companies (such as forward, option, and swap contracts) should be examined. In addition, because the Turkish economy has an increasingly important current account deficit problem and an increasing exchange rate, it should not be deduced from the results that the risks brought by volatility, and the negative effects of these risks on foreign trade, can be ignored. This situation justifies the concerns in the literature that volatility will adversely affect foreign trade. While the depreciation of the Turkish lira is expected to increase exports economically, both the increasing uncertainty and the cost of importing intermediate goods, especially in the manufacturing sector, may pose a significant problem for manufacturers.

Examining the relationship between volatility and foreign trade based on sectors would provide more consistent results. Using aggregated export data may cause aggregation biases, so working with sector-based data to eliminate possible biases might be more effective. The consequences of national and international and positive and negative externalities are different for each sector. Thus, further studies could produce more reliable evidence by paying attention to sector-based export data and structural breaks.

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APPENDIXES

Table 2: ARCH LM Test

χ^2 statistics	180.99
p value	0.0000

Table 3: GARCH model statistics

Variable	**EGARCH(1,1)**
mu	4.51*** (255.3)
AR(1)	1.145*** (26.27)
AR(2)	–0.148*** (–3.33)
Omega	–2.153 (–1.126)
Alpha1	–0.143 (–1.483)
Beta1	0.704** (2.657)
Gamma1	0.066 (0.370)
Akaike Information Criteria	–4.51
Schwarz Information Criteria	–4.38

Note: Values in parentheses are t statistics. *, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

Table 4: Heteroskedasticity and autocorrelation test results

Model: ARMA (2,0) – EGARCH (1,1)					
ARCH Test [3]	0.249 (0.62)	**Q [1]**	0.317 (0.57)	**Q^2 [1]**	0.083 (0.77)
ARCH Test [5]	0.290 (0.94)	**Q [5]**	3. 655 (0.14)	**Q^2 [5]**	1.387 (0.76)
ARCH Test [7]	2.667 (0.58)	**Q [9]**	5.877 (0.28)	**Q^2 [9]**	3.555 (0.66)

Note: The values in square brackets show the lag lengths, and the values in parentheses show the probability values of the relevant statistics.

Table 5: Ng-Perron and Phillips-Perron unit root test results

Variable	Ng-Perron				Phillips-Perron
	MZ_a	MZ_t	MSB	MPT	t-statistics
lnX	−2.246	−0.928	0.413	34.48	−2.613
ΔlnX	−95.61***	−6.912***	0.072***	0.959***	−19.77***
lnEXR	−4.756	−1.442	0.303	18.56	−3.638**
ΔlnEXR	−88.14***	−6.638***	0.075***	1.034***	–
lnM	−1.331	−0.643	0.483	48.01	−2.587
ΔlnM	−16.08*	−2.813*	0.175*	5.809*	−14.62***
lnY	−17.68**	−2.972**	0.168*	5.161**	−2.368
ΔlnY	–	–	–	–	−15.69***
VOL	−66.97***	−5.785***	0.087***	0.371***	−7.075***

Note: ln denotes logarithmic transformation, Δ denotes the difference operator. ***, **, and * indicate that the null hypothesis is rejected at 1%, 5%, and 10% significance levels, respectively. A constant-trend model is considered for all variables except for the VOL variable, and a constant model for the VOL variable. The appropriate lag length in the Ng-Perron test is determined according to the Schwarz Information Criteria, and the lag length in the Phillips-Perron test is determined according to Newey-West.

Table 6: Zivot-Andrews unit root test results

Variable	Test statistic	T_B	λ
lnX	−4.345	2008M10	0.34
ΔlnX	−19.88***	2009M06	0.38
lnEXR	−4.766	2016M10	0.81
ΔlnEXR	−10.80***	2006M07	0.21
lnM	−4.005	2010M07	0.45
ΔlnM	−6.720***	2009M03	0.36
lnY	−6.374***	2008M10	0.34
VOL	−7.662***	2009M05	0.37

Note: ln denotes logarithmic transformation, Δ denotes the difference operator, T_B denotes the break date and λ denotes the break point (TB/T). The calculated t-statistics values are compared with the table critical values of Zivot and Andrews (1992). The mentioned table critical values are 1%: −5.57, 5%: −5.08 for the C model. *** indicates that the null hypothesis is rejected at the 1% significance level.

Table 7: Lee and Strazicich (2003, 2004) two break points LM unit root test results

Variable	Test statistic	T_B	λ
lnX	−5.164	2008M08, 2011M03	0.33, 0.48
ΔlnX	−13.45***	2007M05, 2009M03	0.26, 0.36
lnEXR	−5.199	2011M07, 2017M02	0.50, 0.83
ΔlnEXR	−11.001***	2004M08, 2008M10	0.10, 0.34
lnM	−4.990	2008M09, 2011M01	0.33, 0.47
ΔlnM	−7.281***	2007M12, 2010M12	0.29, 0.47
lnY	−5.152	2008M08, 2010M01	0.33, 0.42
ΔlnY	−9.283***	2008M02, 2009M01	0.30, 0.36
VOL	−7.428***	2008M03, 2009M12	0.31, 0.41

Note: ln denotes logarithmic transformation, Δ denotes the difference operator, T_B denotes the break date, and λ denotes the break point (TB/T). C model is estimated for unit root test. *** Indicates that the null hypothesis is rejected at the 1% significance level.

Table 8: Bai-Perron multiple structural break test results

Specification					
$y_t = \{\text{lnX}_t\}$ $z_t = \{1, \text{VOL}_t, lnEXR_t, \text{lnY}_t, \text{lnM}_t\}$ q = 5 p = 0 h = 30 M = 2 ε = 0.15					
Break Number	**F-statistic**	**Scaled F-statistic**	**Weighted F-statistic**	**UD max statistic**	**WD max statistic**
1	54.582**	272.911**	272.911**	308.654**	360.228**
2	61.731**	308.654**	360.228**		
Break Numbers (Selected according to the Information Criteria)					
Sequential 2					
BIC 2					
LWZ 2					
Break Dates					
2008M11 2012M02					

Note: y_t denotes dependent variable, z_t denotes independent variables changing on the basis of regimes, q denotes the number of independent variables changing on the basis of regimes, p denotes the number of unchanging independent variables on the basis of regimes, h denotes the minimum number of observations in any regime, M denotes the number of max breaks, and ε denotes trimming percentage. ** indicates the rejection of the main hypothesis at the 5% significance level.

Table 9: Phillips-Perron unit root test results/sub periods

Variable	Phillips-Perron test statistics	
	First Sub-Period (2003:01–2008:11)	Second Sub-Period (2008:12–2019:12)
lnX	−1.575	−2.286
ΔlnX	−10.088***	−19.614***
lnEXR	−3.489**	−0.934
ΔlnEXR	–	−9.690***
lnM	−2.212	−2.404
ΔlnM	−5.639***	−13.657***
lnY	−1.367	−1.181
ΔlnY	−9.136***	−14.546***
VOL	−3.745	−5.936***

Note: ln denotes logarithmic transformation and Δ denotes the difference operator. ***, **, and * indicate that the null hypothesis is rejected at 1%, 5%, and 10% significance levels, respectively. The lag length is determined according to Newey-West.

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REVISITING THE DEBT–GROWTH NEXUS: EVIDENCE FROM INDIA

ABSTRACT: *The main purpose of this study is to examine the debt–growth nexus in India over the period 1984–2019 using Bayer-Hanck and Autoregressive Distributed Lag (ARDL) cointegration techniques. The findings of both techniques suggest the existence of a negative relationship between public debt and economic growth in the long run. The results also confirm the significant negative relationship between foreign exchange reserves and economic growth. Interestingly, the test results confirm the unidirectional causality running from public debt to economic growth in the case of India. From a policy perspective, reducing public debt is imperative to achieve long-term sustainable growth. Efforts should be made to circumvent the burden of burgeoning interest liabilities by generating a primary surplus, which will facilitate debt servicing and timely repayment of debt.*

KEY WORDS: *economic growth, public debt, foreign exchange reserve, Bayer-Hanck, ARDL, India*

JEL CLASSIFICATION: H63; E6; C32

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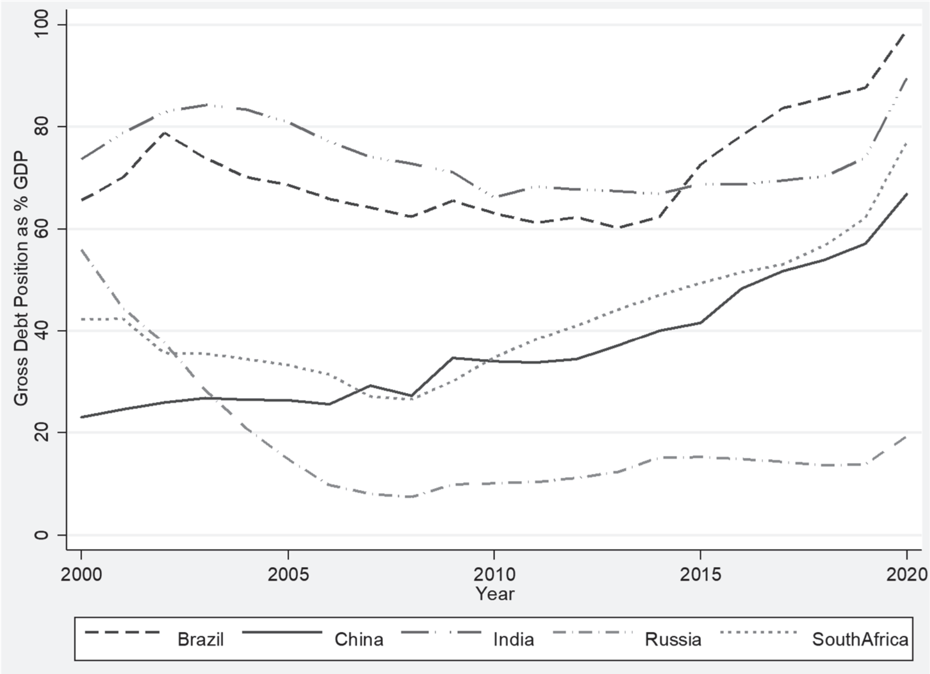
1. INTRODUCTION

There has been a substantial increase in the public debt of many emerging economies, such as India, China, and Brazil. In addition to the global financial crisis of 2008 and frequent downturns in business activities, the COVID-19 pandemic has created an unprecedented setback for several economies, particularly emerging economies, in their efforts to mitigate the economic damage of mounting public debt. Figure 1 plots the ratio of gross debt to gross domestic product (GDP) in Brazil, Russia, India, China, and South Africa (popularly termed the 'BRICS' countries). This shows that Brazil's gross debt as a percentage of GDP increased from 60% in 2013 to a historic 99% in 2020. Considering the sheer size of China's economy, it is not surprising that public debt as a percentage of GDP in China has almost doubled in the last 10 years. Similarly, public debt in India as a percentage of GDP increased by 23 points between 2014 and 2020. Since the onset of the global financial crisis in 2008, public debt in South Africa has increased from 27% in 2007 to 77% in 2020. For many emerging economies, crossing the desired level of public debt is a major cause for concern. As mentioned earlier, the COVID-19 pandemic and subsequent fiscal constraints are likely to make these emerging economies more fragile and less resilient to macroeconomic instability.

Most economists consider public borrowing necessary for emerging economies to enhance their economic stability and sustainable growth, as such economies are often constrained by financial resources, particularly in the initial phases of development. However, as noted by Krugman (1988), beyond a desired level, public debt, which differs across countries, often poses a major threat to achieving potential growth because it involves an enormous repayment cost in the future. As a result, a substantially high public debt is likely to put the nation in a perpetual debt trap, leading to a state of unproductive utilisation of funds and increased service costs (Pegkas, 2018; Mhlab & Phiri, 2019). In the aftermath of the 2008 global financial crisis it is increasingly being recognised that the sluggish growth of business, coupled with the crippling level of public debt, tends to stifle not only the ability of a country to honour the obligation of debt repayment but also its fiscal policies (Alper & Forni, 2011). In sum, an excessive level of public debt has the potential to affect the stability of an economy, capital formation, and consumption expenditure (Pegkas, 2018).

Figure 1: Gross Public-Debt-to-GDP ratio in BRICS from 2000 to 2020.

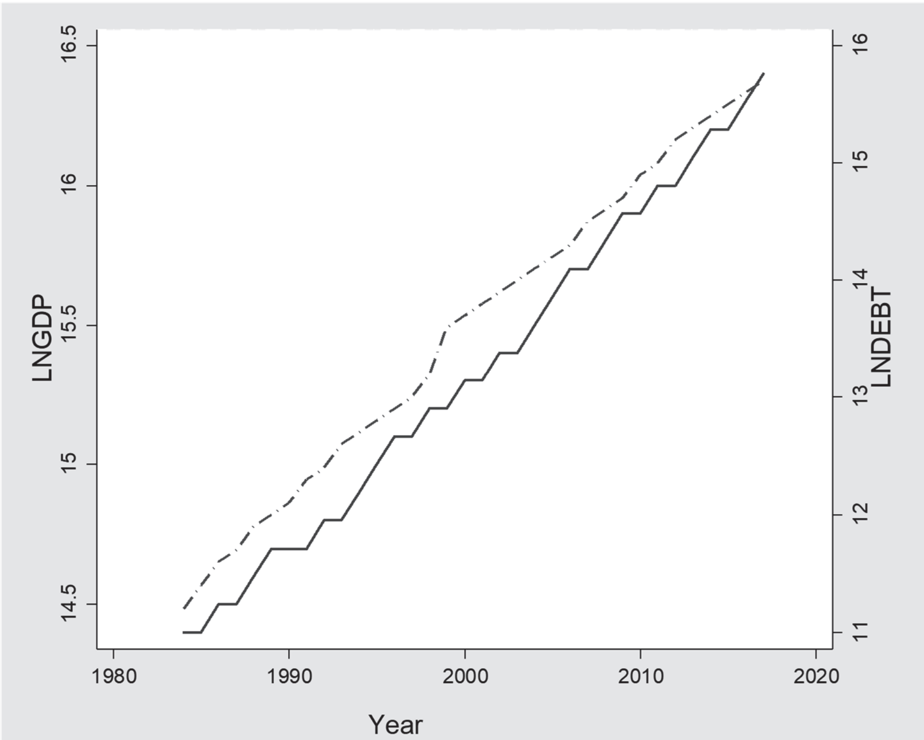


Source: *Fiscal Monitor, IMF 2020*

1.1 AN OVERVIEW OF THE DEBT–GROWTH NEXUS IN INDIA

The increasing public debt in many emerging economies has spurred a renewed interest in investigating the relationship between public debt and economic growth (Bilan & Ihnatov, 2016; Chudik et al., 2018). In this paper we explore the relationship between India's economic growth and its public debt (Figure 2). According to a status report by the Reserve Bank of India, the government's public borrowing stood at 68.2% of GDP in 2017–2018. As a result of increasing external debt, India has begun to substitute domestic debt for external debt (Hanson, 2007; Panizza, 2008). An examination of the composition of internal and external public debt shows that India's internal debt as a percentage of its GDP has increased consistently, while a declining trend has been observed in the government's external borrowing during the period 2011 to 2017. Since 2017 the country's external debt has begun to rise. It is to be noted that India's outstanding external debt has surpassed its foreign exchange reserves. While foreign exchange reserves reached US $440 billion, the outstanding external debt increased from US $471 billion in March 2017 to US $544 billion in March 2019, at a compound annual growth rate of 7.47%. However, in the midst of the COVID-19 pandemic and increasing global uncertainty the Union government's efforts to reduce the debt to 40% of GDP by 2025 appear to be a difficult task.

Figure 2: Log of real GDP and log of public debt



Against this backdrop, the purpose of this paper is to examine whether there is any causal relationship between public debt and economic growth in India. Our study is distinct from the previous literature in three ways. First, the study employs the Bayer and Hanck (2013) technique to examine the co-integrating relationship between the chosen variables. The Bayer and Hanck cointegration test is a recent technique that is more robust and reliable as it integrates four distinct cointegration methods. Second, we employ the autoregressive distributed lag (ARDL) bounds test of cointegration and checked the robustness of the results by comparing the results obtained using the Bayer and Hanck method. The ARDL bounds test also facilitates the estimation of long-run and short-run coefficients. Third, this study adds to previous literature by examining the role of foreign exchange reserves in influencing the relationship between debt and economic growth in the Indian context.

The rest of the paper is composed of five sections. The second section focuses on the review of previous studies in the published literature, followed by the data sources and econometric methods in the third section. The fourth section presents the empirical results obtained and discussions derived from econometric analysis. The last section lays out the conclusion and discusses policy implications.

2. LITERATURE REVIEW

The relationship between public debt and economic growth has been studied extensively in economics literature (Barro, 2002; Panizza, 2008; Reinhart & Rogoff, 2010). Broadly speaking, numerous studies have focused on the adverse impact of debt on economic growth in the long run by suggesting changes to the tax structure to finance interest liabilities (Diamond, 1965; Drine & Nabi, 2009; Kumar & Woo, 2010; Checherita-Westphal & Rother, 2012; Swamy, 2015). The more recent studies suggest that public debt is likely to reduce consumers' income, consumption, and savings and the country's capital stock formation, which in turn will affect economic growth (Pattillo et al., 2004; Cochrane, 2011; Pegkas, 2018). In the following paragraphs we provide a detailed analysis of various empirical studies.

An empirical study of the debt–growth nexus in 38 developed and emerging economies over the period 1970 to 2008 by Woo and Kumar (2015) indicates that debt and growth are negatively related, conforming to theoretical literature. More specifically, a 10% rise in a country's public debt is likely to reduce its growth by 0.2%, mainly due to the decline in labour productivity and investment. In an analysis of 12 European countries during the period 1970 to 2008, Checherita-Westphal and Rother (2012) show that private investment, public investment, and total factor productivity are three channels through which debt retards economic growth. Panizza and Presbitero (2014), in their analysis of 17 countries in the Organization for Economic Co-operation and Development (OECD), support the general argument that a prospective decline in economic prosperity could lead to a rising public-debt-to-GDP ratio. Swamy (2015) also shows that economic growth uniformly causes debt.

Conversely, Elmendorf and Mankiw (1999) point out that public debt facilitates the formation of gross fixed capital and the overall production level, augmenting the disposable income of the nation in the short run. However, the outcome of public debt is different in the long run. High public debt might affect the effective utilisation of public expenditure due to increased uncertainty from a possible hike in future interest rates and a contraction in private investment (Cochrane, 2011; Teles & Cesar Mussolini, 2014).

It should be noted that trade openness and institutional quality can to some extent leverage the effect of public debt on economic growth (Kourtellos et al., 2013). Drine and Nabi (2009), in their analysis of 27 developing countries over the period 1970 to 2005, show that a rise in external debt leads to a decline in production efficiency. Similarly, in an examination of 61 developing nations for the period 1996 to 1998, Pattillo et al. (2004) report that the adverse effect of high debt on economic growth works through a substantial change in capital formation. It is worth noting that Schclarek's (2005) analysis of panel data on 24 developed and 59 developing nations over the period 1970 to 2002 shows that there is a reverse relationship between debt and economic growth in the case of developing economies, unlike in developed nations. Moreover, the export of goods and investment positively contribute to GDP growth. In a study of the linkages between growth, productivity, and government debt involving a panel of 155 nations, Afonso and Tovar (2013) note that the public debt is negatively associated with economic growth. More importantly, while fiscal consolidation stimulates growth, financial crisis acts as an impediment to economic recovery.

While Ogunmuyiwa (2011) notes a fragile and weak association between debt and growth, Égert (2015) argues that the relationship between debt and growth could weaken when economies move towards high indebtedness. As shown by Abbas and Christensen (2010), a medium level of domestic debt contributes positively to growth in low-income and emerging countries. On the contrary, high domestic debt is likely to impede better economic performance.

A few scholars are of the view that foreign exchange reserves are a relevant macroeconomic variable, implying that currency misbalance and dependency on external funding will have an adverse impact on the performance of economic growth during economic crises (Llaudes et al., 2010; Calvo et al., 2013; Feldkircher, 2014). However, evidence suggests that the relationship between growth and foreign exchange reserves is statistically insignificant in economies with higher foreign reserves (Berkmen et al., 2012). Similarly, Llaudes et al. (2010) observe that holding a higher level of foreign exchange reserves paves the way for diminishing returns.

An empirical study in India suggests that debt affects economic growth through interest liability in the future (Rangarajan & Srivastava, 2005). As shown by Kannan and Singh (2007), a crippling level of public debt has an adverse effect on interest rates, output, and trade balance in the long run, gradually negatively affecting economic growth. Moreover, an increase in public debt is likely to reduce public expenditure, which further aggravates economic growth (Pradhan, 2016). In brief, most studies determine the relationship between debt and economic growth by focusing on the change in debt servicing, exports, and total factor production (Bal & Rath, 2014).

Our review of existing studies identifies two key issues for further investigation. First, although the relationship between public debt and economic growth is widely examined, the long-run relationship between these two variables is often inconclusive. Similarly, the direction of causality is ambiguous in the case of developing economies. Second, the limited literature on the debt–growth nexus in India seldom considers the role of other macroeconomic variables in determining the causal relationship between public debt and economic growth.

3. DATA SOURCES

This study uses annual time series data for the Indian economy between 1984 and 2019. Data for GDP, gross final consumption expenditure (GFCE), gross fixed capital formation (GFCF), imports–exports, and inflation (INF) rate are sourced from the World Development Indicators (World Development Indicators, 2019). The remaining data, namely foreign exchange reserves (FXR) and debt, are taken from the Handbook of Indian Statistics released on the Reserve Bank of India database. For the analysis, trade openness (TRADE) is taken as the proportion of the sum of exports and imports to GDP. Similarly, public debt ratio is computed by dividing by GDP.

4. ESTIMATION PROCEDURE

As mentioned earlier, we employ one of the most recent techniques, proposed by Bayer and Hanck (2013), to examine cointegration between the variables of interest. The Bayer-Hanck approach is more reliable and robust, as it integrates four individual cointegration techniques. Taking a cue from Umar et al. (2020), we formulate Fisher's equation in the following manner:

$$EG - JOH \;=\; -2[ln(P_{EG}) + ln(P_{JOH})] \tag{1}$$

$$EG - JOH - BO - BDM \;=\; -2[ln(P_{EG}) + ln(P_{JOH}) + ln(P_{BO}) + ln(P_{BDM})] \tag{2}$$

where *EG, JOH, BO* and *BDM* represent the different tests formulated by Engle and Granger (1987), Johansen (1991), Boswijk (1994) and Banerjee et al. (1998), respectively. *P* stands for the probability value of each individual test of cointegration.

Further, in order to check the robustness of results obtained using the Bayer-Hanck method (2013) we use the ARDL bounds test, which has two important features. First, it can be applied where variables are integrated of equal order or a mixture of both. Second, the estimated coefficients using ARDL are more robust than the Johansen approach when the sample size is small (Pesaran and Shin, 1995). Therefore, using the following equation, we examine the long-run coefficients of public debt, economic growth, and other variables in the model:

$$\text{lnY}_t \;=\; \alpha_0 + \beta_0 \text{ln}Y_{t-1} + \beta_1 \text{lnDEBT}_{t-1} + \beta_2 \text{lnGFCF}_{t-1} + \beta_3 \text{lnGFCE}_{t-1} +$$

$$+ \beta_4 \text{lnTRADE}_{t-1} + \beta_5 ln\text{INF}_{t-1} + \beta_6 ln\text{FXR}_{t-1} + \omega_t \tag{3}$$

where ln refers to the natural log of the variables, *Y* is the GDP, DEBT is the ratio of public debt to GDP, GFCF is the gross fixed capital formation, GFCE is the government final consumption expenditure, TRADE is the trade openness, INF is the inflation, and FXR is the foreign exchange reserves. While ω_t in the model represents the error term with constant mean and variance, t is the time. As usual, α is the constant term, and β denotes the coefficients of the variables.

Similarly, Equation (4) shows the short-run co-integrating relationship with a set of variables, and δ represents the coefficients of the variables. The optimal lagged values of each variable based on Schwarz criteria are explained by *a, b, c, d, e, f,* and *g*.

$$\Delta \ln Yt = \alpha_0 + \sum_{j=1}^{a} \delta_j \Delta \ln Y_{t-j} + \sum_{k=0}^{b} \delta_k \Delta \ln DEBT_{t-k} + \sum_{l=0}^{c} \delta_l \Delta \ln GFCF_{t-l} + \sum_{m=0}^{d} \delta_m \Delta \ln GFCE_{t-m} + \sum_{n=0}^{e} \delta_n \Delta \ln TRADE_{t-n} + \sum_{o=0}^{f} \delta_o \Delta \ln INF_{t-o} + \sum_{p=0}^{g} \delta_p \Delta \ln FXR_{t-p} + \varphi ECT_{t-1} \quad (4)$$

The error correction term (ECT) measures the pace of the model's adjustment back towards equilibrium in the face of any shock in the economy. Significant negative ECT indicates long-run causality among the variables. Lastly, we test the direction of the causality between public debt and economic growth by applying the Granger causality test. The null hypothesis of the test assumes that there is no Granger causality. It should be noted that the optimal lag length and the maximum integrated order required for the causality test are estimated through the vector autoregression (VAR) approach and Augmented Dickey-Fuller (ADF) and Phillips-Perron tests, respectively.

5. EMPIRICAL RESULTS

5.1 Descriptive statistics

Table 1, which presents the descriptive statistics of the variables under study, shows that the distribution of each variable is nearly symmetrical over the chosen period. Interestingly, the mean and median estimates for most of the variables are very close to each other. The skewness estimates indicate that all the variables are positively skewed except TRADE, INF, and FXR. The findings of the Jarque-Bera test point to the non-rejection of the null hypothesis even at a 10% significance level, and hence confirm that all the variables are normally distributed.

Table 1: Descriptive statistics of the variables

	lnGDP	lnDEBT	lnGFCF	lnGFCE	lnTRADE	lnINF	lnFXR
Mean	31.520	4.248	30.148	29.293	–1.323	1.941	28.412
Median	31.464	4.244	30.119	29.267	–1.342	2.003	28.759
Maximum	32.612	4.422	31.429	30.436	–0.578	2.630	31.215
Minimum	30.515	4.024	28.858	28.266	–2.120	0.913	24.859
Std. Dev.	0.641	0.081	0.829	0.613	0.542	0.421	2.133
Skewness	0.118	0.101	0.062	0.145	–0.158	–0.399	–0.409
Kurtosis	1.788	4.006	1.607	1.869	1.512	2.361	1.780
Jarque-Bera	2.288	1.580	2.933	2.044	3.472	1.569	3.236
Probability	0.318	0.454	0.231	0.360	0.176	0.456	0.198

Source: *Authors' calculations*

5.2 Unit root test

The purpose of the unit root is to examine the stationarity of the series and order of integration of each variable; i.e., GDP, DEBT, GFCF, GFCE, TRADE, FXR, and INF. For the analysis we conducted two different unit root tests in the paper: ADF and PP. The null hypothesis of the test assumes the presence of the unit root against the alternative hypothesis that the time series is stationary. The Akaike criterion is used to estimate the optimal lag length for all the macroeconomic variables. The results obtained from the ADF and PP tests indicate that the null hypothesis is not rejected at level for any of the series. However, each series becomes stationary after taking the first difference (Table 2).

Table 2: Results of the unit root test

Variable	Level Data		First Difference		**Inference**
	ADF	PP	ADF	PP	
lnGDP	–2.172	–1.837	–4.406***	–8.591***	I[1]
lnDEBT	–2.657	–2.751	–3.250*	–3.892**	I[1]
lnGFCF	–2.101	–2.042	–7.333***	–7.317***	I[1]
lnGFCE	0.747	–1.664	–5.392***	–3.479**	I[1]
lnTRADE	–0.045	–0.528	–4.699***	–4.718***	I[1]
lnFXR	–1.044	–1.306	–3.565**	–3.888**	I[1]
lnINF	–3.089	–2.858	–4.699***	–6.836***	I[1]

I[1] shows the integration order of one.

****, **, * Significant at 1%, 5%, and 10%, respectively.*

Source: *Authors' calculations*

5.3 Bayer and Hanck cointegration Test

The Bayer-Hanck cointegration approach provides a combined test decision of multiple cointegration methodologies. The basic assumption of the approach is that the null hypothesis of no cointegration is rejected if the F-statistic exceeds the critical values. Table 3 shows that the F-statistic is higher than the critical value in both cases. Therefore, we cannot accept the null hypothesis. The results suggest the existence of cointegration among the selected variables in the long run.

Table 3: Bayer-Hanck cointegration test

	F-Statistic		**Decision**
Model	**EG-J**	**EG-J-Ba-Bo**	
lnGDP = f(lnDEBT, lnGFCF, lnGFCE, lnTRADE, lnINF, lnFXR)	55.876***	55.931***	Cointegration
Critical Values at 5% level of significance	10.352	19.761	

****, **, * Significant at 1%, 5%, and 10 %, respectively.*

Source: *Authors' calculations*

5.4 ARDL bounds test for cointegration

Following the Bayer-Hanck cointegration test, we conducted the ARDL bounds test proposed by Pesaran et al. (2001) to test the long-run relationship between debt and growth. The suitability of this model is validated by conducting normality (Table 1), autocorrelation (Appendix B), and heteroscedasticity (Appendix A) tests. The model clears all the standard diagnostic tests. The null hypothesis of the bounds test assumes that there is no level of relationship between the variables. It is evident from Table 4 that the null hypothesis is rejected at a 1% significance level as the F-statistic is higher than the lower and upper bounds.

Table 4: Bounds test for cointegration

F-statistic	Level of significance	Lower critical value	Upper critical value
5.296121	10%	2.53	3.59
	5%	2.87	4.00
	2.50%	3.19	4.38
	1%	3.6	4.9

Source: *Authors' calculations*

5.4.1 Long-run and short-run estimates

Table 5 reports the results of the long-run estimates of the ARDL model. The negative coefficient of the debt-to-GDP ratio implies that a 1 unit increase in debt causes a 0.23 unit decrease in economic growth in the long run. The findings are consistent with the extant literature (Sen et al., 2007; Drine & Nabi, 2009; Kumar & Woo, 2010; Ogunmuyiwa, 2011). However, capital formation has a significant positive effect on economic growth in the long run and expenditure affects economic growth negatively, as demonstrated by Adhikary (2011) and Aigheyisi (2013). As expected, both trade openness and inflation have a negative impact on economic growth in the long run (Hodge, 2006; Were, 2015). The country's holding of foreign exchange reserves has a significant adverse effect on growth. A change of 1 unit of foreign exchange reserves leads to a negative change of 0.03 units in GDP growth. The findings are in line with some of the previous empirical investigations (Ben-Bassat & Gottlieb, 1992; Aizenman & Marion 2003; Nathaniel & Oladiran 2018). The foreign exchange reserves of India have been rising continuously and the literature suggests that a when a developing country has a consistent and huge rise in foreign exchange reserves it can result in problems such as soaring inflation and fiscal costs, high interest rates, and the promotion of imports, which could affect growth negatively (Mohanty & Turner 2006; Prasad et al. 2007; Park & Estrada 2009)

Table 5: Long-run estimates of the ARDL model

Variables	Coeff.	Std. Err.	t-Stat.	Prob.
lnDEBT(−1)	−0.234	0.040	−5.863	0.000
lnGFCF(−1)	0.205	0.045	4.592	0.000
lnGFCE(−1)	−0.044	0.051	−0.863	0.397
lnTRADE(−1)	−0.048	0.024	−2.014	0.056
lnINF(−1)	−0.040	0.008	−5.157	0.000
lnFXR(−1)	−0.031	0.010	−3.152	0.005

Source: *Authors' calculations*

Similarly, Table 6, which presents the short-run estimates of the ARDL model, shows that debt also affects growth negatively by 0.426 units in the short run. Trade openness, inflation, and foreign exchange reserves also have a significant adverse effect on growth. The financial markets of emerging economies are not well established and their absorptive capacity for foreign exchange reserves is limited (Gould, 2003; Polterovich & Popov, 2004). Hence, enlarged FXR affect economic growth through rising inflation and high imports (Prasad et al. 2007) . However, expenditure and capital formation positively respond to growth in the short run at the 10% and 1% levels of significance, respectively. The existence of a long-run relationship is confirmed by the error correction term (Banerjee et al., 1998). The ECT measures the speed of adjustment, and it should be negative in a range between 0 and 1. The findings suggest that the coefficient of ECT is negative and significant, implying that the dependent variable adjusts to changes in the independent variables at a speed of almost 88% to converge towards long-run equilibrium within a year.

Table 6: Short-run estimates of ARDL model

Variables	Coeff.	Std. Err.	t-Stat.	Prob.
C	24.315	4.343	5.599	0.000
TREND	0.049	0.009	5.47	0.000
D(lnDEBT)	–0.426	0.074	–5.749	0.000
D(lnGFCE)	0.100	0.055	1.809	0.084
D(lnGFCF)	0.119	0.04	2.957	0.007
D(lnTRADE)	–0.042	0.024	–1.778	0.089
D(lnFXR)	–0.028	0.009	–3.141	0.005
D(lnINF)	–0.024	0.006	–4.045	0.001
ECT(–1)	–0.882	0.128	-6.869	0.000

Source: *Authors' calculations*

5.4.2 Stability test

As explained by Brown et al. (1975), the cumulative sum of recursive residuals (CUSUM) test and the CUSUM of the square (CUSUMQ) test are used to check a model's robustness and stability. Interestingly, the cumulative sum of the estimated parameters should not move beyond the critical area at a 5% level of significance. Figure 3 and Figure 4, which present the fall of the regression coefficients within the boundaries of critical values at a 5% significance level, indicate that the model is stable.

Figure 3: CUSUM Test

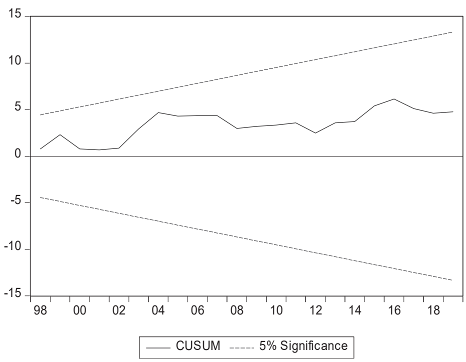
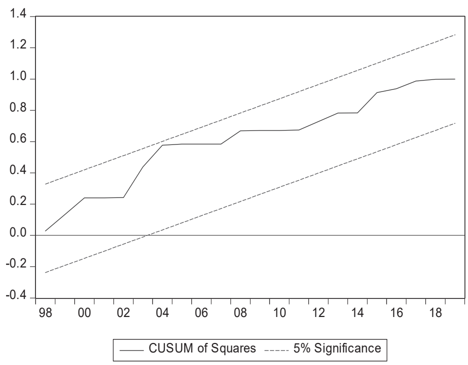


Figure 4: CUSUM Square Test



5.5 Granger causality test results

The cointegration tests do not shed light on the direction of causality. Therefore, in this study the direction of the causality is confirmed using the Granger causality test. The empirical results presented in Table 7 show that the first null hypothesis, which states that debt does not cause GDP, can be rejected as its p-value is significant at a 5% level. However, the second null hypothesis that GDP Granger-causes debt cannot be rejected due to an insignificant p-value. Hence, the results confirm that unidirectional causality runs from debt to economic growth in both the short run and the long run. The rest of the results of the Granger causality test of all variables with GDP are given in Appendix C. We found a unidirectional causality moving from GDP to GFCF and GFCE, and also from TO and FXR to GDP. Similar to the findings of Riyath and Ismail (2018), the results of our study also suggest bidirectional causality between INF and GDP.

Table 7: Granger causality test

Null Hypothesis:	F-Statistic	Prob.
lnDEBT does not Granger-Cause lnGDP	16.16439	0.059665
lnGDP does not Granger-Cause lnDEBT	6.372647	0.143348

Source: *Authors' calculations*

6. CONCLUSION AND POLICY IMPLICATIONS

This study examines how debt and other key macroeconomic variables such as public expenditure, capital formation, inflation, trade openness, and foreign exchange reserves affect economic growth using the Bayer-Hanck cointegration test. To check the robustness of the model, we compare the results with ARDL bounds test results. The results of both analyses suggest that the variables are co-integrated in the long run. Regarding the impact of explanatory variables on economic growth, we found that debt and inflation have a negative effect on economic growth. This is mainly due to the unproductive utilisation of funds raised through debt and delay in repayment of the debt liability resulting from high interest payments. As expected, trade openness, expenditure, and foreign exchange reserves have a significant negative effect on the growth of the Indian economy. Taking a cue from Aigheyisi (2013), irrational spending and unproductive utilisation could be among the reasons why public expenditure has a negative effect on growth. Presumably, rising imports are a major reason for the negative impact of trade openness on economic growth in the long run. Not surprisingly, capital formation has a significant positive effect on growth. As explained by Gould (2003) and Prasad et al. (2007), with the enlargement of FXR the low absorption capacity of financial markets in emerging economies leads to rising inflation, fiscal costs, and imports, and later affects economic growth negatively. Moreover, India's foreign exchange reserve has been continuously rising over the past decade, pushing it to rank fourth in the list of countries with the highest foreign exchange reserve holdings.

The findings of our study have significant policy implications for the Indian economy, particularly in the context of the COVID-19 pandemic, which has resulted in a steep decline in economic growth and a subsequent rise in public debt. The empirical results of the Granger causality test indicate the presence of unidirectional causality running from debt to economic growth in the long run. Policymakers can take a more cautious approach by halting the rising debt and keeping to a sustainable growth path. Although for India the risk is not extremely severe, the unprecedented increase in public debt is a major cause for concern and poses a severe threat to achieving sustainable growth. We believe that timely implementation of policies to improve fiscal sustainability could help increase the country's liquidity position. In addition, to have a positive impact on economic growth it is essential to utilise public debt productively. This study highlights the need for considering a threshold level of public debt beyond which the economy cannot acquire funds on credit. It is acknowledged that after a certain limit the increased debt could lead to a negative impact on economic growth. The government should focus on increasing its primary surplus so that debt servicing can be improved, and timely debt repayments can be made to avoid the burden of increased interest liabilities. Balanced policy changes can make achievable the government's goal of reducing public debt to 40% by 2025. As our study is limited to India, future research could extend it to investigate the relationship between public debt and economic growth in the context of other developing economies.

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APPENDIX A

Heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.499764	Prob. F(12,22)	0.8928
Obs*R-squared	7.497216	Prob. Chi-Square(12)	0.8231
Scaled explained SS	1.598005	Prob. Chi-Square(12)	0.9998

APPENDIX B

Autocorrelation test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.121603	Prob. F(1,21)	0.16
Obs*R-squared	3.211547	Prob. Chi-Square(1)	0.0731

APPENDIX C

Granger Causality test

Null Hypothesis:	F-Statistic	Prob.
LNGFCF does not Granger-Cause LNGDP	1.01081	0.4038
LNGDP does not Granger-Cause LNGFCF	2.79738	0.0600
LNGFCE does not Granger-Cause LNGDP	0.41547	0.6639
LNGDP does not Granger-Cause LNGFCE	8.63400	0.0011
LNFER does not Granger-Cause LNGDP	4.38345	0.0217
LNGDP does not Granger-Cause LNFER	0.68322	0.5129
LNINF does not Granger-Cause LNGDP	9.27089	0.0097
LNGDP does not Granger-Cause LNINF	4.98649	0.0826
LNTO does not Granger-Cause LNGDP	3.15244	0.0321
LNGDP does not Granger-Cause LNTO	0.53593	0.7937

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When there are multiple authors, list them all, with the addition of ampersand (&) before the last surname. If there are more than seven authors, list the first six, then write three full stops (…), and at the end write the last author.

Acemoglu, D., & Robinson, J.A. (2006). *Economic Origins of Dictatorship and Democracy.* Cambridge: Cambridge University Press.

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