Advances in Manufacturing Technology XXX

The urgent need to keep pace with the accelerating globalization of manufacturing in the 21st century has produced rapid advancements in manufacturing technology, research and expertise.

This book presents the proceedings of the 14th International Conference on Manufacturing Research (ICMR 2016), entitled Advances in Manufacturing Technology XXX. The conference also incorporated the 31st National Conference on Manufacturing Research, and was held at Loughborough University, Loughborough, UK, in September 2016. The ICMR conference is renowned as a friendly and inclusive environment which brings together a broad community of researchers who share the common goal of developing and managing the technologies and operations key to sustaining the success of manufacturing businesses.

The proceedings is divided into 14 sections, including: Manufacturing Processes; Additive Manufacturing; Manufacturing Materials; Advanced Manufacturing Technology; Product Design and Development, as well as many other aspects of manufacturing management and innovation. It contains 92 papers, which represents an acceptance rate of 75%.

With its comprehensive overview of current developments, this book will be of interest to all those involved in manufacturing today.

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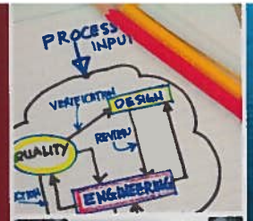

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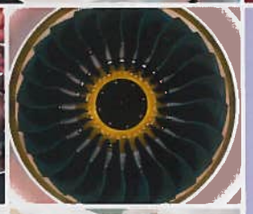

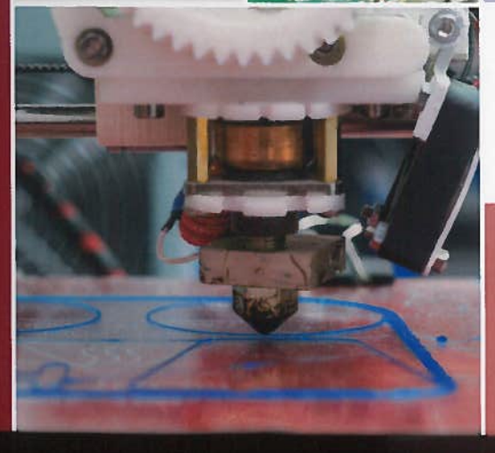

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EDITED BY
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Edited by

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and

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Part 1

Keynote

3. Summary and Outlook

Through utilization of a 3D PDF based planning tool, the efficient design of assembly connection, the quality of planning results and planning processes can be increased, while simultaneously time and cost reduction can be realized. With this approach working schedules as planning results are based on field-tested assembly processes and contain the implicit knowledge used in similar assembly planning processes. The automatic generation of an adapted assembly process enables the fast customization to the concrete setting at the shopfloor. The presented approach contributes an important added value to production design and planning through usage of knowledge in the existing systems. The exploitation of this approach under productive conditions has recently been started. Further development of tool sets and methods could help to reduce the high initial effort for adjustment of the data even more. Besides the evaluation of the results based on product data, it is important to investigate the behaviour and results of the methodology for new assembly technologies.

Subsequently, basic research was described and requirements for the appropriate use case were collected. Using that knowledge, it was possible to develop a concept that demonstrates how 3D PDF technologies can contribute to streamline the recycling process of end of life vehicles. The exact procedure, starting from the creation of the 3D data until the application of the document, was developed and described precisely.

The created 3D PDF template provides a basis for future realizations. In order to implement future developments efficiently, the template was designed as flexible as possible. The objective of this further development is the implementation of all of the derived requirements [10] [11].

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The Impacts of Ageing on Manufacturing Sectors

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Abstract. The progress in medical science and the decline of altruistic behavior of couples introduced to the world the ageing problem. The existence of ageing is more experienced by developed countries. Researchers and policy makers are constantly trying to find ways to study the impacts of ageing since the issue is unprecedented in our history. However, the majority of the literature focus more on immediate mechanisms such as public expenditures and somehow neglected the influence of ageing on manufacturing sector. Thus, through panel data, we studied the influence of ageing on manufacturing sectors. The empirical study was carried out on six developed countries namely Japan, Germany, Italy, Greece, Finland and Portugal that have high ageing population. Our results suggest that the growth of the old age group over 65 years old will have significantly negative influence on percentage contribution of manufacturing to the GDP of these countries. Moreover, the results also demonstrate that a country with a higher proportion of old age group over working group will face fall in the manufacturing.

Keywords. Manufacturing, ageing, panel data models, GDP

1. Introduction

Continuous development in the medical science and less altruistic behaviour of couples have increased the life expectancy and decreased the fertility rate of most countries. This demographic transition process has introduced to the world the new era of ageing. The constant success in the technological infrastructure has transformed the majority of the developed counties into ageing countries [1]. Lately researchers and policy makers are concerned with the issue of population ageing as its presence is expected to influence the economic development of the countries.

Since most of the developed countries are facing the issue of ageing without precedent, there is numerous literature that examines its influence on countries' growth [2–5]. In fact, this literature has clearly proved a negative relationship between population ageing and economic growth. The presence of ageing is likely to influence the economics of a country for a simple reason, when considering the physical capability, preferences and needs are expected to change along with age [6].

To some extent, literature has identified the mechanisms (public expenditure, human capital, consumption and saving patterns) through which ageing influences the economic progress [7]. However, research work on ageing has given emphasis only to

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immediate mechanisms such as public expenditures and policies. To an extent, we find that the influence of ageing on human capital and labour market were also less focused [7]. Yet, examining the influence of ageing on human capital and labour market participation is considered important as the productivity of a country depends on these mechanisms. Furthermore, the existence of an ageing problem will have higher impact when the country's economy relies highly on exports [2].

Since ageing is considered as an important problem to be handled in modern economics, in this paper we intend to uncover the influence of ageing on manufacturing sectors. The main aim of this research work is to identify the influence of ageing on the contribution of manufacturing towards the gross domestic product (GDP).

2. Methodology

We chose panel data estimation to study the impact of ageing and speed of ageing on the contribution of manufacturing to the GDP of six developed countries. Along with ageing and speed of ageing other relevant variables such as labour, human capital, physical capital, institutions, public expenditures and population growth were also considered.

The analysis was carried out considering the following panel data model

$$y_{it} = \alpha_i + X'_{it-j}\beta + \varepsilon_{it}, \qquad i = 1,\ldots,N; \quad t = 1,\ldots,T \tag{1}$$

where the subscripts i and t denote respectively the countries and the years; the subscript j represents 0, 5 and 10 to define the current ($j = 0$) and lagged value (with $j = 5$ representing a 5-years' lag and $j = 10$ representing a 10 years' lag); Y_{it} stands for net manufacturing in percentage of GDP; X_{it} are the regressors including labour, human capital, physical capital, institutions, public expenditures, population growth, ageing and speed of ageing; β are the regression parameters to estimate; α_i represents the individual-specific effects; and ε_{it} is the idiosyncratic error. The α_i may be correlated with one or more explanatory variables.

We assumed fixed estimated effects[2] and therefore the composite error term u_{it} for these specifications will be decomposed into the time-invariant unobserved effect α_i and the idiosyncratic error term ε_{it} [8]

$$u_{it} = \alpha_i + \varepsilon_{it} \tag{2}$$

[2] To identify the efficiency and consistency of the fixed effects model, a Hausman test was carried out. For the Hausman test, the null hypothesis is that the unobserved effect α_i is uncorrelated with each explanatory variable i.e. $H_0 : \mathrm{cov}(X_{it}, \alpha_i) = 0, \quad t = 1,\ldots,T$ where $X_{it} = (X_{it1},\ldots,X_{itk})$ and the alternate hypothesis is $H_1 : \mathrm{cov}(X_{it}, \alpha_i) \neq 0$. Under the null hypothesis the random effects estimator is consistent and efficient, whereas, under the alternate hypothesis, the fixed effects estimator is considered consistent and efficient.

2.1. The relevant proxies and description of data

For the empirical study we considered six developed countries that have high ageing populations namely Japan, Germany, Italy, Greece, Finland and Portugal. The analysis was carried out for the time span of 25 years (from 1990 till 2015). For this empirical study, we gathered data from World Bank and Freedom House database[3]. The net manufacturing in percentage of GDP was considered as a proxy for the dependent variable. Meanwhile, the variables ageing index[4] and old age dependency ratio[5] were also considered as proxies for ageing. Precisely, we incurred ageing index, old age dependency ration, ageing index with five years lag and ageing index with ten years lag as proxies for ageing. The annual growth rate of the 65 year old[6] age group and above was used as a proxy to determine the influence on the speed of ageing. In the estimation we also included a number of proxies for control variables. The variables student enrolment in primary school and student enrolment in secondary school were used as proxies for the human capital. Meanwhile, the variable gross capital formation as percentage of GDP and the five years lagged value of foreign direct investment were used as proxies for physical capital investment. The five years lagged value of government consumption as a percentage of GDP was incurred in the analysis to identify the effectiveness of public expenditure on manufacturing. For the institutional variables we considered civil liberties index and political right index from "Freedom House". These indexes are measured using a scale from 1 to 7 (1 is the highest freedom level and 7 is the lowest freedom level). Therefore, the hypothesis will be the freer and fairer a country is the higher is the net manufacturing. Apart from that, the labor force and the population growth were also included in the study to determine the influence of population and labor on manufacturing.

3. Empirical study

3.1. Empirical models

For the empirical analyses we examined the impact of ageing and the speed of ageing on the manufacturing considering four distinct models:

- (A) the impact of ageing on manufacturing by considering old age dependency ratio as a proxy;
- (B) the impact of ageing on manufacturing by considering ageing index as a proxy;
- (C) the impact of ageing on manufacturing by considering the 5 years lagged value of ageing index as a proxy;

[3] https://freedomhouse.org/report-types/freedom-world

[4] Ageing index is: $\frac{\sum \text{Old population}_t \text{ (60 years old or more)}}{\sum \text{Individuals aged under 15}_t} \times 100$

[5] Old age dependency ratio is: $\frac{\sum \text{Old population}_t \text{ (65 years old or more)}}{\sum \text{Working individuals (aged under 15}_t - 64)} \times 100$

[6] Growth of 65 years old and above is: $\frac{\sum 65 \text{ years old and above}_{t+j}}{\sum 65 \text{ years old and above}_{t+i}} - 1$

- (D) the impact of ageing on manufacturing by considering the 10 years lagged value of ageing index as a proxy.

3.2. Results

As mentioned in the previous section, the Hausman test was computed to identify the consistency of the model to choose between fixed effects and random effects. Overall, the test result shows a *p*-value of 0.000 for the four models, hence we reject the null hypothesis with significance level of 1% that the random effects provide a consistent estimator.

Table 1 presents the coefficients estimated for each variable considered in the models. In general, by looking into the *F* statistics and the respective *p*-values for all the estimated specifications, we may conclude that our results are globally statistically significant.

Table 1. Estimation of the impact of ageing and the speed of ageing on manufacturing (dependent variable: Net manufacturing in percentage of GDP).

Variable	Proxy	Model A	Model B	Model C	Model D
Ageing	Old age dependency ratio$_{(t)}$	-0.393858***			
	Ageing index$_{(t)}$		-0.071575***		
	Ageing Index$_{(t-5)}$			-0.085548***	
	Ageing Index$_{(t-10)}$				-0.085990***
Speed of ageing	Annual growth rate of 65 years old age group and above	-0.7922117***	-0.9783469***	-1.2918610***	-1.1868840***
Human capital	Primary student enrolment (in ratio)	-1.39e-06	-1.97e-06*	-8.25e-07	5.39e-07
	Secondary student enrolment (in ratio)	-4.02e-08	2.49e-07	-5.26e-07	-7.22e-07
Labor	Labor force participation (% of total population, ages 15-64)	-7.52e-07***	-6.58e-07***	-5.46e-07***	-5.58e-07***
Physical capital	Capital formation on GDP (in proportion)	5.16e-14	7.36e-14	8.16e-14*	5.40e-14
	Foreign direct investment$_{(t-5)}$	0.0245954	0.0051096	0.0700490	0.0625494
Institution	Political rights (1: the highest level…, 7: the lowest level)	0.7444426	0.5177850	0.6848750	0.9549853
	Civil liberties (1: the highest level…, 7: the lowest level)	-0.8051723**	-0.6829427**	-0.7450140**	-0.7006230**
Public expenditure	Government consumption on GDP (in proportion)$_{(t-5)}$	-0.1138347	-0.1072725	0.0171633	0.1021063
Population growth	Population growth	-0.4668155	-0.4799655	-0.3232425	0.2626655
Constant		54.11741***	50.01953***	45.65770***	40.31758
Observations (no. of countries*years)		6*26=156			
R^2		0.6130	0.6096	0.6613	0.6618
F statistics		20.01 (0.0000)	19.73 (0.0000)	24.67 (0.0000)	24.73 (0.0000)
Hausman test		578.81 (0.0000)	223.15 (0.0000)	317.21 (0.0000)	494.62 (0.0000)

Notes: The regressions were carried out for the period 1990–2015 for Germany, Greece, Japan, Italy, Portugal and Finland. Estimated coefficients and *p*-values are calculated using robust standard error and the significance levels are: *** (**)[*] 1%(5%)[10%].

3.3. Discussion of the results

The proxies of ageing and speed of ageing for the four models reveal a significant and negative relation (with the *p*-values being 0.0000 for all the models). Hence, regardless

of how we proxy the ageing and speed of ageing, our results confirm that ageing has a significant and negative influence in the net manufacturing of the six developed countries selected. The estimates for these selected developed countries show a significantly negative relationship when considering old age dependency ratio as a proxy to test the impact of ageing on manufacturing. The empirical results indicate that for an additional increase of one per cent in the old age dependency ratio, there will be a decline of 0.34% in the contribution of net manufacturing to the GDP. This is mainly due to the fall in the proportion of the active working age group over the old age group. Hence, aligned with the arguments of Lam [2] and Bierwisch *et al.* [9] our results demonstrate that the rise in the old age group and fall in the working age group will have a profound impact in the countries especially if manufacturing is considered to be their main source of revenue. Besides old age dependency ratio, the empirical analysis also shows a statistically negative relationship between the ageing index and manufacturing. In addition, our findings also show that the present ageing index will experience decline in the contribution of manufacturing to the GDP in the future (in five and ten years' time). The current fall in the proportion of the young age group will affect the future manufacturing since the current young age group will be the successor of the future working age group. Therefore, unlike the argument of Xu *et al.* [10] our results demonstrate that even though manufacturing industry has a high proportion of machine-based activities, the participation of physically fit workers is needed to increase the productivity level of this industry. Likewise ageing, speed of ageing also evidences statistically significant influence to the net manufacturing. Our results confirm that the growth of the population aged 65 and above will decrease manufacturing. The participation of the old age group in the labour market to overcome the shortage in the labour supply is expected to subsequently decrease net manufacturing value. Thus, contradicting the arguments of Bloom *et al.* [3], our results show that even though there is a rise in the life expectancy due to better health, the participation of the old age working group still decreases net manufacturing. Meanwhile authors like Thun *et al.* [11] and Gaigné and Thisse [12] stressed that, other than the physical fitness, the unwillingness to be immobile and adapting to new technologies will be the common reasons for the decline in the output of old age workers in the manufacturing sectors.

Regarding the control variables, we find that the variable labor force participation shows a significantly negative relationship with net manufacturing for the four models. In brief the result shows that a country with high level of labor participation in manufacturing will experience a decline in net manufacturing. Apart from labor force participation, the variable civil liberties also exhibits a significant negative relationship for the four models. The negative value of civil liberties indicates that the countries with greater expression of individual freedom, will experience an increasing trend in net manufacturing. Meanwhile, the remaining control variables (primary student enrolment, secondary student enrolment, capital formation, foreign direct investment, government consumption and population growth) used in the analysis failed to prove any significant relation to net manufacturing.

4. Conclusions

Focusing on the influence of ageing and speed of ageing on manufacturing we carried out empirical studies for six high ageing countries namely Germany, Greece, Italy,

Portugal, Finland and Japan for the period between 1990 and 2015. The results confirm that the issue of ageing and its influence to the manufacturing sectors is no longer in denial. From our analysis we conclude that the selected developed countries will face continuous decline in net manufacturing unless appropriate measures are considered to overcome the existence of the ageing problem. The impact of ageing on manufacturing in countries like Japan and Germany will be profound since their main source of revenue depends deeply on this sector.

Researchers and policy makers argue that the rise in retirement age and the increase of immigrant workers will help to overcome the shortage of labour supply. However, some literature [11, 12] claims that the existence of old age labour may affect the manufacturing output considering their immobile capability, physical fitness and the unwillingness to learn new technologies. Hence for the future work, it will be appropriate to study the efficiency of old age workers' participation in the manufacturing sectors.

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Part 7

Product Design and Development