REM Research in Economics and Mathematics

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Editors: António Afonso, Filipe Oliveira, Joana Pais
https://rem.rc.iseg.ulisboa.pt/
Contacts: Phone: +351 213 925 912. e-mail: rem@iseg.ulisboa.pt

The Latest REM Working Papers

The center of **Research in Economics and Mathematics** (REM) circulates research, notably by its affiliated members, as working papers intended for professional and public discussion and comment. The papers have not been peer reviewed.

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Events

For your 2021 calendar:

9th UECE Conference on Economic and Financial Adjustments, ISEG/UL – Lisbon School of Economics and Management/University of Lisbon, **July 30, 2021**. Submissions until **15 June 2021**, to rem@iseg.ulisboa.pt

INFER 2021, 23rd Annual Conference, ISEG/UL – Lisbon School of Economics and Management/University of Lisbon, **September 8-10, 2021.** Submissions until **14 June 2021**, via Conference Maker: https://editorialexpress.com/conference/INFER2021.

Announcements

Call for applications for PhD Research Grants 2021

Closing date: 31/05/2021

REM Working Papers

Panel Granger causality between financial development and economic growth, Cândida Ferreira, *Working Paper 0179-2021*

This paper uses panel Granger causality estimations with the approaches developed by Nair-Reichert and Weinhold (2001), and Bangake and Eggoh (2011) as well as the Dumitrescu and Hurlin (2012) test, with the algorithm developed by Lopez and Weber (2017), to analyse the causality relations between all the nine IMF financial development indices, and the real GDP growth considering a sample of 46 countries spread by all continents over the interval 1990- 2017. The results obtained reveal the dynamic character of these causality relations and overall, no significant differences were found when comparing the results obtained for the financial institutions indices with those regarding the financial markets indices. The results confirm the existence of bidirectional causality, although not with the same statistical robustness for all the IMF indices, addressing relevant aspects of the financial development: access, depth and efficiency of the financial institutions and markets.

Population density and economic development, José Pedro Pontes, *Working Paper 0178-2021*

We describe formally the relationship between population density and per capita income along the two growth regimes put forward by KUZNETS (1960), BOSERUP (1965) and TAMURA (2002). We consider a spatial economy where an undifferentiated consumer good is produced by a continuum of competitive agents. Each agent requires one unit of a capital good to produce the final good and the two goods are assumed to be perfect substitutes in production. Under the first growth regime (called “classical” or “Malthusian”), each agent self-produces the capital good by shifting resources that would otherwise produce one unit of the final good. This economy shows marginal decreasing returns of labour. Population growth brings about congestion and the elasticity of output per worker (and income per capita) is negative. A structural change takes place following a sufficient increase in population density and decrease in transport costs. Then, the supply of capital goods is outsourced to a specialized industry, operating in spatial monopolistic competition in line with SALOP (1979). Under this “modern” growth regime, the specialization of the capital goods production is a source of increasing returns in the aggregate economy. The elasticity of per capita income with respect to population density becomes positive just after the structural transition, but this effect may not persist in the long run. If the outsourcing of capital goods is matched by a rising importance in final production of activities which are not land-based, then aggregate increasing returns can be sustained in the long run. Otherwise, the positive sign of elasticity will be transitory and a further increase in population density will revert the economy to a situation where the use of increasing amounts of labour with non-reproducible resources determines mainly a congestion effect.

Financial deepening, Stock market, Inequality and Poverty: Some African Evidence, Jelson Serafim, *Working Paper 0177-2021*

This study provides evidence for the relationship between private credit, stock market indicators, income inequality, and poverty. Using the annual data that ranges from 1992 to 2018 on 9 African economies. We had applied the estimation method of the Autoregressive Distributed Lag Model (ARDL) to model the long-run effect. Besides, we use Dumitrescu and Hurlin Panel causality to test for checking the direction of causality. The results of long-run estimates indicate that the stock market indicators have a significant positive impact on income inequalities, but have a negative and significant impact on poverty. Further, our findings show that private credit adversely reduces income inequalities. Our results also establish significant short-run causalities among stock market indicators, private credit, income inequalities, and Poverty.

Least squares Monte Carlo methods in stochastic Volterra rough volatility models, Henrique Guerreiro, João Guerra, *Working Paper 0176-2021*

In stochastic Volterra rough volatility models, the volatility follows a truncated Brownian semi-stationary process with stochastic vol-of-vol. Recently, e-cient VIX pricing Monte Carlo methods have been proposed for the case where the vol-of-vol is Markovian and independent of the volatility. Following recent empirical data, we discuss the VIX option pricing problem for a generalized framework of these models, where the vol-of-vol may depend on the volatility and/or not be Markovian. In such a setting, the aforementioned Monte Carlo methods are not valid. Moreover, the classical least squares Monte Carlo faces exponentially increasing complexity with the number of grid time steps, whilst the nested Monte Carlo method requires a prohibitive number of simulations. By exploring the infinite dimensional Markovian representation of these models, we device a scalable least squares Monte Carlo for VIX option pricing. We apply our method rstly under the independence assumption for benchmarks, and then to the generalized framework. We also discuss the rough vol-of-vol setting, where Markovianity of the vol-of-vol is not present. We present simulations and benchmarks to establish the e-ciency of our method.

Relativistically into Finance, Vitor H. Carvalho, Raquel M. Gaspar, *Working Paper 0175-2021*

The change of information near the light speed, advances in high-speed trading, spatial arbitrage strategies and foreseen space exploration, suggest the need to consider the effects of the theory of relativity into finance models. Time and space, under certain circumstances, are not dissociated and no longer can be interpreted as Euclidean. This paper provides an overview of research made on this field, while formally defining the key notions of spacetime and proper time. Further progression in this field does require a common ground of concepts and an understanding of how time dilation impacts financial models. For illustration purposes, we compute relativistic effects for option prices when viewed from the viewpoint of two distinct reference frames, based upon the classical Balck-Scholes model. We show relativistic effects are non-negligible and illustrate how they depend on option characteristics such as maturity of the contract and volatility of the underlying.

Motorways, urban growth, and suburbanisation: evidence from three decades of motorway construction in Portugal, Bruno T. Rocha, Patrícia C. Melo, Nuno Afonso, João de Abreu e Silva, *Working Paper 0174-2021*

Portugal moved from having less than 200 km of motorways before joining the European Union in 1986 to having the fifth highest motorway density relative to population in the Union in 2017. This paper studies the relationship between the expansion of the Portuguese motorway network between 1981 and 2011 and the growth of population and employment in the 275 mainland municipalities of the country. We address the endogeneity of the geography of motorways using instrumental variables based on historical transport networks from 1800 and 1945. Our findings suggest that, on average, new motorways caused large increases in both population and employment. In line with existing evidence for other countries, we find that motorways contributed to suburbanisation, as the impact of motorways on population growth (but not on employment growth) is particularly strong in suburban municipalities. In addition, motorways also appear to have influenced urban agglomeration dynamics, as their effect on population growth depends positively on the municipality's population size in 1970.