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A heterogeneous-agent Model of Growth and Inequality for the UK- Do Planning and Infrastructure matter? A Supplementary note

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Abstract
This paper builds on Yang et al. (Open Econ Rev 32(1):37–69, 2021) which analysed the effect of wealth inequality on UK economic growth in recent decades with a heterogeneous-agent growth model where agents can enhance individual productivity growth by undertaking entrepreneurship. In this supplementary note we examine whether ease of planning and infrastructure spending also contribute to productivity growth, as argued by some policymakers. The model is estimated and tested by indirect inference. The original model was not rejected in its match to the data behaviour. We find the enhanced model contributes no improvement of the match. The model with only planning and infrastructure is strongly rejected.

Keywords Heterogeneous-agent model · Entrepreneurship · Growth · Inequality · Indirect inference · Planning · Infrastructure

JEL Codes E10 · O30 · O40

1 Introduction

Theories of growth focus on a wide range of factors, as is apparent in the huge literature on factors causing or preventing growth. In this paper we build on Yang et al. (2021) who develop a theory of growth and inequality for the UK and test it on a long

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episode of UK history when policies towards the economy changed radically, with strong effects on economic growth and general macroeconomic behaviour. They used Indirect Inference to test the match between the facts of inequality and growth and the predictions of their DSGE model of growth and inequality in the UK economy. Here we extend the model to include other factors that have been argued to contribute to growth- including public spending on infrastructure and housing planning permission, both of which have been hindered in the UK by government policies that have given power to special interest groups opposing development on environmental grounds- see Zenghelis et al. (2024). These factors have also been stressed by the current Labour government, which in its first budget raised tax rates sharply but has since emphasised the need to reduce obstacles to infrastructure and housing investment.

For the UK Yang et al. found that the DSGE model was not rejected. Their model emphasises the key role of tax and regulation in driving growth via entrepreneurial action. Inequality both results from growth and reinforces growth via a link between wealth and lower exposure to the costs of taking entrepreneurial risks-the wealthy are both less risk-averse and have a lower marginal disutility of costs. Our aim in this paper is to extend the model to include the potential effects of infrastructure and housing investment, and to test this extended model against the same data behaviour as the original model. What we find in this paper's extension of the model to planning and infrastructure is that these do not improve the model's explanatory power; and that if they alone are included as explanations of growth, the model is strongly rejected. Thus we find that these are not factors that explain growth (Fig. 1).

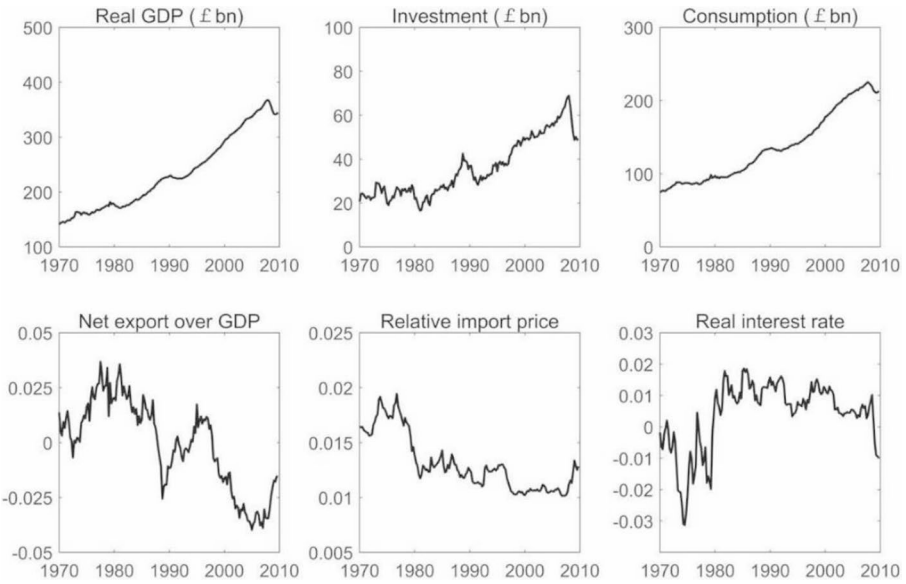

Fig. 1 Facts of the post-war economy in the UK

In the rest of this paper we explain our new data and results. The reader is referred to Yang et al. for our review of the literature on growth and inequality, and on heterogeneous agent models of the type used here.

In the remainder of this paper, the first section reviews the data we use in the various models we test. The second sets out our empirical results. The last concludes. There are two appendices. The Appendix A describes the model. The Appendix B explains our methodology of model testing and parameter estimation.

2 UK Data Used in this Study

The facts of inequality also show substantial movement during this period, as indicated in the charts following for the shares of the top 10% of the population in income, wealth and consumption (Fig. 2). For example, the income share of the top 10% rose from 1980 to the mid-1990s before levelling off, while their wealth share rose to a peak at the end of the 1990 s before falling back almost to its starting point. Their consumption share fluctuated around a slightly rising trend. Notice how income and consumption inequality rise much less than capital inequality, due to the operation of the benefits system which was boosted during this period.

In this paper, we extend Yang et al. (2021) to include data on planning restrictions for housing and the stock of government capital spending on infrastructure (Fig. 3).

Here, we proxy infrastructure investment using gross fixed capital formation (GFCF) for general government, which reflects public spending on long-term assets. To obtain the public capital stock k_t we accumulate the GFCF and apply an annual depreciation rate δ of 2.5% by the perpetual inventory method as follows:

$$k_t = (1 - \delta)\, k_{t-1} + I_t \tag{1}$$

In relation to planning constraints in the housing sector, we use quarterly data on permanent dwellings started in the UK which serves as a practical proxy.

It can be seen that the public stock of infrastructure grew more rapidly in the 2010 decade, otherwise accumulating at a quite steady rate. Planning constraints tightened in that same decade, as evidenced by the fall-off in housing starts.

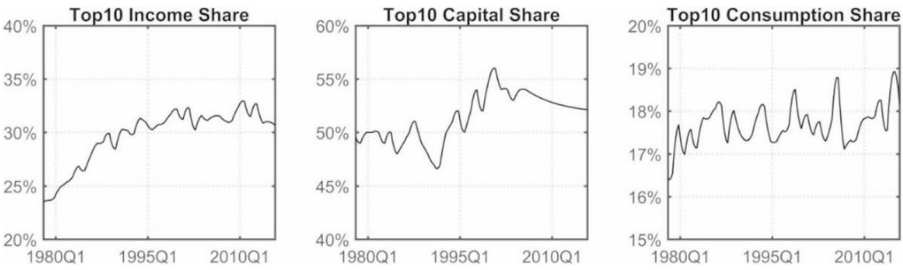

Fig. 2 Inequality Indicators

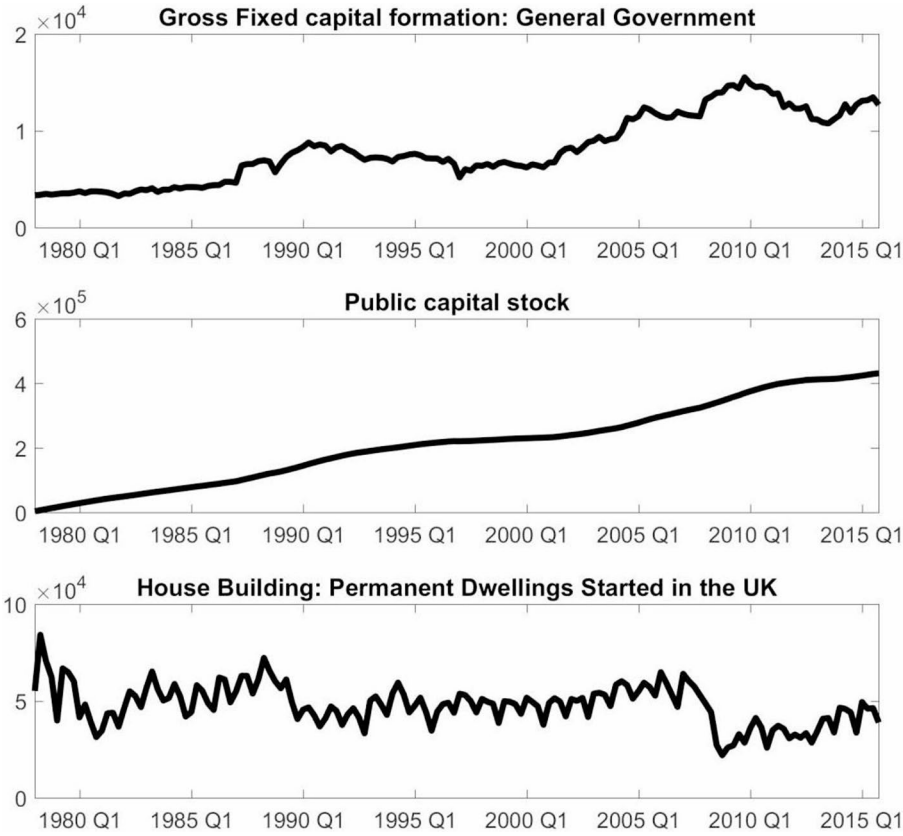

Fig. 3 Data for the stock of government capital spending on infrastructure and housing

3 Empirical Results: Testing the Model for the Role of Planning and Infrastructure

We follow Yang et al. (2021) in their test of the model on UK data from 1978. Our aim is to see whether adding planning and infrastructure to the productivity equation improves the model's fit to the data behaviour.

We first report here the results for testing our basic model of endogenous growth, featuring the tax on entrepreneurs and inequality. For this model the p-value was 0.054, above the 5% confidence threshold. Next we add the two variables suggested in the LSE work: planning permissions (proxied by house starts) and infrastructure (proxied by the publicly created capital stock). These when added leave the p-value essentially unchanged at 0.057, indicating that they add no explanatory value. If we include them but exclude the tax and inequality terms (model 2) the model is strongly rejected with a p-value of zero. A general model (model 3) of exogenous productivity with no identified causal theory, is also strongly rejected with a p-value of zero. What this all means is that planning and infrastructure do not explain growth or even

Table 1 Fixed parameters

Fixed parameters		Value
No Share of capital in Cobb-Douglas production	α	0.3000
Utility discount rate	β	0.9975
Capital depreciation rate	δ	0.0034
Share of consumption preference in CRRA utility	ϕ	0.5000
Elasticity of consumption in CRRA utility	ψ_1	1.0000
Elasticity of labour in CRRA utility	ψ_2	1.0000
Drift in individual entrepreneurship penalty equations	ρ_0^{π}	0.3690
Steady-state consumption share by top 10% income decile	$\varpi_{C,1}$	0.2000
Steady-state aggregate output/consumption ratio	$_{Y/C}$	1.7100
Steady-state aggregate capital/consumption ratio	$_{K/C}$	33.535

contribute to its explanation. What explains growth is the entrepreneurial tax and the extent of inequality in capital ownership (Table 1 and 2).

4 Conclusion

We have followed Yang et al. (2021) in setting out a model of endogenous growth by entrepreneurial innovation in which the major influences are the tax/costs levied on firms' innovation and the extent of inequality (indicating the proportion of entrepreneurs who are rich). These last two factors stimulate innovation; this in turn creates growth which increases inequality as much of it accrues to rich entrepreneurs. We tested this model by indirect inference and found that it passed our test at 5% confidence.

Our aim in this paper was to add to this model an explanatory role for planning permission and infrastructure in the promotion of productivity growth, as argued by Zenghelis et al. (2024). What we found was that these extra factors made no difference to the model's explanatory power. When put into the model as the sole explanatory factors (i.e. without the tax and inequality terms), the model was strongly rejected. Hence we find these factors make no explanatory contribution, either alone or in tandem with the tax and inequality factors.

We conclude that the UK data support the original model of Yang et al. based on entrepreneurs' incentives to innovate.

Table 2 Estimated parameters

Estimated parameters		Yang et al.	Model1*	Model2**	Model3***
Entrepreneurship time effect on individual productivity growth	θ_2	0.5100	0.4879	0.4354	0.4763
Capital on individual entrepreneurship penalty rate	ρ_2^{π}	−0.0012	−0.0016	−0.0010	−0.0014
Penalty rate on productivity growth for the rich	$\phi_{1,2}$	−0.5479	−0.6513		
Penalty rate on productivity growth for the poor	$\phi_{2,2}$	−0.2195	−0.3214		
Infrastructure investment on productivity growth for the rich	$\kappa_{1,1}$		0.5123	0.6783	
Infrastructure investment on productivity growth for the poor	$\kappa_{1,2}$		0.2231	0.4144	
House planning on productivity growth for the rich	$\kappa_{2,1}$		0.4867	0.5412	
house planning on productivity growth for the poor	$\kappa_{2,2}$		0.1931	0.3212	
T-stats		1.608	1.584	6.612	7.581
P-value		5.4%	5.7%	0.0%	0.0%

*Model 1 includes infrastructure investment and house planning effects in the productivity

**Model 2 excludes entrepreneurship tax effects on productivity

**Model 3 excludes entrepreneurship tax, infrastructure investment and house planning effects on productivity

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11079-025-09843-3.

Declarations

The authors declare no competing interests.

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