Institution: London School of Economics and Political Science

Unit of Assessment: **19 Business and Management Studies**

Title of case study: **Providing intellectual foundations for Quantitative Easing programmes**

1. Summary of the impact (indicative maximum 100 words)

LSE-led research developed formally, and tested empirically, a model of the term-structure of interest rates based on market segmentation. This research was developed prior to the Quantitative Easing (QE) programmes that central banks in the UK and the US have been undertaking since 2009. This research significantly influenced the design and execution of these QE programmes because it provided central banks with (i) a scientific underpinning for their actions, and (ii) precise quantitative guidance as to what the effects would be. QE, through its effects on interest rates, has inarguably played a pivotal role in recovery strategies from the recessions following the financial crisis.

2. Underpinning research (indicative maximum 500 words)

Research Insights and Outputs: The term-structure of interest rates (i.e. the curve that represents interest rates as a function of maturity) is of great interest to practitioners and policy makers. Early theories of the term-structure belong to two broad categories:

- According to Expectations Theory, long rates are driven by expectations of future short rates. For example, a downward-sloping term-structure signals that the market expects short rates to fall.

- According to Preferred-Habitat Theory, there are investor clienteles with preferences ("preferred habitats") for specific maturities, and the interest rate for a given maturity is driven by the demand and supply "local" to that maturity. For example, a downward-sloping term-structure signals that long-term bonds are in high demand by the corresponding clientele.

Although clientele effects are viewed as important by practitioners and policy makers, the Preferred-Habitat Theory has generally been neglected in recent academic research. Mainstream research based on Expectations Theory views the term-structure instead as determined by a representative household that participates in all markets costlessly. Although the representative-household model provides a basis for Expectations Theory, it cannot explain fundamental aspects of interest rate behaviour.

Clientele effects, in contrast, derive from market segmentation. Local demand and supply can affect prices only if segmentation limits the set of agents who can arbitrage away the effects of local shocks. Segmentation and limited arbitrage are studied formally in a recent and growing literature, a notable example of which is [1] and a survey is [4].

[2] is the first paper to study the term-structure of interest rates with a focus on segmentation and limited arbitrage, and to provide a formal model of Preferred-Habitat Theory. The term-structure in [2] results from the interaction between two types of agents: investor clienteles with preferences for specific maturities, and arbitrageurs. Arbitrageurs exploit price discrepancies arising from segmentation, buying bonds in maturity segments where interest rates are high and selling in segments where rates are low. Because arbitrageurs are risk-averse, shifts in investor demand and bond supply affect interest rates.

[5] develops the model in [2] further and tests it empirically using data on government bond supply. Consistent with the model, a decrease in supply is found to lower interest rates, with the effects being stronger for bonds with longer maturities and during periods when arbitrageur capital is low. This gives empirical support to the notion, taken up in the next section, that Quantitative Easing might have the desired effects.

Additional empirical support for the theory in [2] comes from [3], which presents two case studies. First, increased pension-fund demand for long-term bonds, following the UK 2004 Pensions Act, caused long rates to decrease dramatically but had only weak effects on short rates. Second, decreased supply for

long-term bonds following the US 2000-2002 Treasury buybacks caused a similar large decline in long rates with only weak effects on short rates.

[6] explores the implications of segmentation for the government's optimal debt issuance policy. It shows that an increase in the fraction of long-horizon investors lowers long rates and induces a welfare-maximizing government to tilt bond issuance towards long maturities. [6] confirms that such a tilt occurred in the UK following the 2004 Pensions Act and the subsequent decrease in long rates.

To note, the evidence in this research was established prior to the execution of Quantitative Easing programmes that were aimed at driving down long-term interest rates, but as we will explain below, was instrumental in informing their design and following the financial crisis.

Key Researchers: Dimitri Vayanos has been at LSE since 2004.

3. References to the research (indicative maximum of six references)

[1] Gromb, D. and Vayanos, D. (2002), "Equilibrium and welfare in markets with financially constrained arbitrageurs", *Journal of Financial Economics,* 66, 361-407. DOI: 10.1016/S0304-405X(02)00228-3

[2] Vayanos, D. and Vila, J.-L. (2009), "A preferred-habitat model of the term-structure of interest rates", *Working paper*, London School of Economics. LSE Research Online ID: 29308

[3] Greenwood, R. and Vayanos, D. (2010), "Price pressure in the government bond market", *American Economic Review, Papers and Proceedings,* 585-590. DOI: 10.1257/aer.100.2.585

[4] Gromb, D. and Vayanos, D. (2010), "Limits of arbitrage", *Annual Review of Financial Economics,* 2, 251-275. DOI: 10.1146/annurev-financial-073009-104107

[5] Greenwood, R. and Vayanos, D. (2013), "Bond supply and excess bond returns", *Review of Financial Studies*, accepted for publication. Available at http://personal.lse.ac.uk/vayanos/Papers/BSEBR_RFSf.pdf.

[6] Guibaud, S., Nosbusch, Y., and Vayanos, D. (2013), "Bond market clienteles, the yield curve, and the optimal maturity structure of government debt", *Review of Financial Studies,* 26, 1914-1961. DOI: 10.1093/rfs/hht013

Evidence of quality: publication in major peer-reviewed journals; citations.

4. Details of the impact (indicative maximum 750 words)

Nature of the Impact: The research described in Section 2 has had impacts on (a) thinking about Quantitative Easing, by providing a coherent theoretical foundation and (b) on policy, by providing empirical validation for the design and implementation of Quantitative Easing programmes.

Impact on thinking. The policy impact concerns the design and execution of Quantitative Easing programmes by the Bank of England (BoE) and the US Federal Reserve (Fed). During the recent financial crisis, the BoE, the Fed, and other central banks around the world found themselves unable to stimulate the economy through reducing near-zero short-term interest rates, their traditional policy tool. The banks resorted instead to purchases of long-term bonds, a policy known as QE. The purchases were massive: about $1.8 trillion in the US and £375 billion in the UK.

The central banks anticipated that their purchases of long-term bonds would raise the prices of these bonds, hence lowering long-term interest rates. This would make borrowing cheaper for companies, and hence would stimulate investment. Making the intellectual case for the central banks' policy to reduce long-term interest rates in this way, however, was difficult based on Expectations Theory. Under Expectations Theory, one can only drive down long-term interest rates through reducing future short-term interest rates. However, Preferred-Habitat Theory allows for direct supply effects on the long-term

maturities, even in the presence of near-zero short-term interest rates. But this theory lacked a theoretical formalization before [2].

Vayanos and colleagues' research in [2] and [5] showed that Preferred-Habitat Theory can be rigorously modelled, and that within such a model or framework a decrease in bond supply lowers long-term interest rates. This research had been developed presciently, in a working paper at the time, prior to the QE, and found its natural application in QE. It thus gave central banks a basis for judging that their actions could have the desired effects and guided efforts by their research departments to develop quantitative estimates of the effects of the policies.

Senior officials in the central banks made extensive references to this research. For example, [2] and [5] are mentioned in 2011 speeches by the then Vice-Chair and now nominee-Chair of the Fed, Janet Yellen, and by the President of the San Francisco Fed, John Williams ([10] and [11], respectively). Moreover, Spencer Dale, the BoE's Chief Economist, sent the following quote in a letter to Vayanos:

"*When the Bank of England began its quantitative easing programme, there was very little recent academic work that articulated in a rigorous way how asset purchases might have effects on asset prices. The research by Dimitri Vayanos (in papers with Vila and Greenwood respectively) was particularly helpful and influential in this regard because it showed how a shock to the demand or supply of bonds -- and by implication central bank asset purchases -- could affect yields in an arbitrage-free model that incorporated preferred habitat investors and arbitrageurs. Although it is not the only model used at the Bank for thinking about how QE works, this research has provided an important framework for thinking about the issues and for framing research on the financial market effects of the policy*." [7]

Impact on policy design. The central banks required not only a theoretical justification for QE, but also precise quantitative guidance. For that purpose, they allocated teams of researchers to estimate the effects of the early stages of QE to inform the design and execution of subsequent stages. The research in [2] and [5] guided much of that effort. Papers by Fed researchers that estimate the effects of QE using [2] as a basis include [8], [12] and [15], and papers by BoE researchers include [9] and [14]. There are also extensive references to [2] and [5] in [11], which summarizes a 2011 conference on QE organized by the BoE.

The quantitative estimates of the impact of QE found in the above research by the central banks were large. For example, the 10-year rate for the first phase of QE was estimated to be 100 basis points lower than in the absence of QE, both in the UK and in the US. These findings, which provided "out-of-sample" validation for the supply effects predicted by our model, were fed into the design and execution of subsequent stages of QE.

Wider Implications. QE, through its effects on interest rates (and asset prices), has inarguably played a central role in government strategies to recover from the recessions following the financial crisis. Poorly designed QE programmes could have damaged economies further. LSE work has helped lay the foundations for well executed QE programmes and thus sustained economic recovery.

5. Sources to corroborate the impact (indicative maximum of 10 references)

All Sources listed below can also be seen at https://apps.lse.ac.uk/impact/case-study/view/32

[7] Testimonial from Bank of England's Chief Economist. This source is confidential.

[8] Doh, T. (2010), "The efficacy of large-scale asset purchases at the zero lower bound", *Federal Reserve of Kansas City Economic Review,* 2, 5-34. http://www.kc.frb.org/PUBLICAT/ECONREV/PDF/10q2Doh.pdf

[9] Joyce, M., Lasaosa, A., Stevens, I. and Tong, M. (2011), "The financial market impact of Quantitative Easing in the United Kingdom", *International Journal of Central Banking,* 7, 113-161. http://www.ijcb.org/journal/ijcb11q3a5.htm

[10] Yellen, J. (2011), "The Federal Reserve's Asset Purchase Program", Speech at the annual

meetings of the American Social Science Association, available at http://www.federalreserve.gov/newsevents/speech/yellen20110108a.htm

[11]. Williams, J. (2011), "Unconventional monetary policy: Lessons from the past three years", Presentation to the Swiss National Bank Research Conference, available at http://www.frbsf.org/news/speeches/2011/john-williams-0923.html.

[12] D'Amico, S. and King, T. (2012), "Flow and stock effect of large-scale treasury purchases: Evidence of the importance of local supply", *Discussion paper*, Federal Reserve Board of Governors. http://www.federalreserve.gov/pubs/feds/2012/201244/201244pap.pdf

[13] Joyce, M. (2012), "Quantitative easing and other unconventional monetary policies: Bank of England conference summary", *Bank of England Quarterly Bulletin,* 1, 48-56. http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb120104.pdf

[14] Joyce, M. and Tong, M. (2012), "QE and the gilt market: A disaggregated analysis", *Discussion paper*, Bank of England. http://www.bankofengland.co.uk/research/Documents/workingpapers/2012/wp466.pdf

[15] Li, C. and Wei, M. (2012), "Term-structure modelling with supply factors and applications to Federal Reserve's large-scale asset purchase programs evaluation", *Discussion paper*, Federal Reserve Board of Governors. http://www.federalreserve.gov/pubs/feds/2012/201237/201237pap.pdf