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# Appendix to Staff Working Paper No. 835 Monetary policy and birth rates: the effect of mortgage rate pass-through on fertility

Fergus Cumming and Lisa Dettling

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## Monetary policy and birth rates: the effect of mortgage rate pass-through on fertility

Fergus Cumming<sup>(1)</sup> and Lisa Dettling<sup>(2)</sup>

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(1) Bank of England. Email: [fergus.cumming@bankofengland.co.uk](mailto:fergus.cumming@bankofengland.co.uk)

(2) Federal Reserve Board of Governors. Email: [lisa.dettling@frb.gov](mailto:lisa.dettling@frb.gov)

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Bank of England, Threadneedle Street, London, EC2R 8AH

Email [publications@bankofengland.co.uk](mailto:publications@bankofengland.co.uk)

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# Appendix (for online publication)

## 6.1 Data Appendix

### 6.1.1 PSD data

This section describes how we construct our measures of interest rate exposure based on the PSD mortgage origination data. The PSD is administrative data, reported by lenders to the Financial Conduct Authority for all but a few primary residential mortgages in the United Kingdom. To minimise measurement error we remove mortgages with a mortgage term of less than 5 years, a LTI ratio greater than 20 or a LTV ratio of greater than 200. This removes about 3.7 percent of the data. We also drop business mortgages (only 0.25 percent of mortgages), as well those held by a social buyer, not known, or other (another 4.8 percent of mortgages).

In order to estimate the stock of mortgages in the summer of 2008 we must remove superseded mortgages from the origination data to prevent double counting. Removing previous refinancing transactions requires matching birth dates and post codes and keeping the latest transaction before July 2008. Since postcodes typically cover around 15 households, this process rarely yields false matches (which arise in a small number of cases when the designated primary borrower changes between refinancing events). Removing loans that were paid off when a home owner moved houses is a little more involved. We do this using a three-way match on the (1) birth date, (2) transaction date and (3) post code following the steps outlined in Chakraborty et al. (2017).

Because the data relies on lender reporting, there will sometimes be gaps and errors in the data due to mis-reporting or fields that are optional. For example, some mortgages will not include the initial interest rate or the length of initial period governing the behavior of the interest rate. Note that very few mortgages are missing information about whether the interest rate is fixed or adjustable (less than 0.5 percent).

One important modification we must make is when the length of the initial period is missing. This is important in our model because we use it to determine when a fixed rate mortgage will reset to an adjustable rate. For a mortgage originally on an adjustable rate, the initial period will determine when the mortgage reverts to the Standard Variable Rate (also an adjustable rate, but usually with a higher level and slightly slower pass-through from policy rates). 52 percent of our final sample of fixed-rate mortgages are missing the initial period (this field was optional before 2015). When it is missing, in our main specifications we impute it using a model on the observed distribution depending on whether the mortgage was originally on a fixed or adjustable rate at origination. The models are an ordered probit model, where the initial period can be 1, 2, 3, 4, or 5+ years. Included in the model are lender fixed effects, borrower age fixed effects, borrowing income category, the property value category, and an LTV category. We then use the predicted probabilities arising from this model to assign borrowers' their most likely

initial period length (for all types of mortgage).

Alternatively, in our robustness checks, we simply drop the missing data and treat the sample of mortgages that have information on the missing period as though it were a random sample. There is good reason to think this is a fairly safe assumption. First, inspection indicates that the reporting of initial periods was a lender-specific decision. The structure, competitiveness and national reach of UK mortgage lenders during this time meant that the sample of mortgages with a known initial period has very similar characteristics to that of the full sample. Table A3 considers the full sample used in our main analysis in the first column. In the second column we construct the set of mortgages that have a known initial period. In order to match the proportion of fixed and adjustable-rate mortgages in the main sample as of July 2008 we take all of the known adjustable-rate mortgages and a random sample of the known FRMs. Almost all categories are similar across the samples. In particular, the two samples have a very similar initial-period, geographical and mortgage-purpose distribution. Table A4 shows that a more detailed breakdown of mortgage characteristics across samples shows considerable similarities. Together these tables suggest our initial-period modelling specification is unlikely to be important for our main results.

Once we have our estimated stock of mortgages and their initial periods, we proceed by simulating the loan-level evolution up until July 2008, and then quarter-by-quarter using the information we have regarding the mortgage characteristics at origination and the likely behavior of interest rates at each point in time. The primary variable of interest for each mortgage is whether the interest rate was fixed or adjustable in each quarter. A mortgage could be adjustable if it was specified at origination or the mortgage had run beyond the initial and therefore reverted to the *Standard Variable Rate*.

For context, it is also useful to measure in money terms how mortgage payments changed over time. Quarterly mortgage payments are a function of the mortgage balance outstanding, the interest rate and the mortgage term and can be estimated using standard annuity calculations. Where we know the mortgage was a so-called interest only mortgage, the payment reduces to the balance outstanding multiplied by the quarterly interest rate. For some mortgages the initial interest rate is missing (about 37 percent). Though we do not use this in our main analysis, we must use it to simulate the payment changes in Table 1. Because the UK mortgage market was very competitive during the mid-2000's, we can run a simple model based on the date of origination and LTV to predict the interest rate using observed data.

### 6.1.2 Car-buying among new parents in the LCFS

The Living Costs and Food (LCFS) is an annual survey carried out by the ONS to gather information about the expenditure on goods and services. The LCFS uses multi-stage stratified random sampling but does not involve re-sampling so we cannot track households across time. Respondents keep a detailed diary of spending for two weeks but in Table A2 we use the

questions that ask families about the past twelve months. We use the surveys from 2006 to 2017.

Table A2 reports OLS regressions where the dependent variable is a categorical variable based on whether or not the households bought a new or used car in the last year. The sample consists of mortgaged and all-tenure households with one child under 2 or no children under 18 at all. We drop all households that do not have an adult of child-bearing age (defined here as under 45) and households with more than one child.

## 6.2 Additional Tables and Figures

**Table A1:** Coefficients on Control Variables

	(1)	(2)	(3)	(4)
	Birth rate	Birth rate	Birth rate	Birth rate
Age 25-34	0.4284*** (0.0962)	0.0000 (.)	0.4420*** (0.1169)	0.3850*** (0.0968)
Age 35-44	-0.2243 (0.1430)	0.0000 (.)	-0.2154 (0.1729)	-0.3044* (0.1423)
2008Q4		0.0072 (0.0049)	0.0033	0.0069 (0.0052)
2009Q1	-0.0408*** (0.0080)	-0.0479*** (0.0070)		-0.0403*** (0.0089)
2009Q2	-0.0681*** (0.0091)	-0.0764*** (0.0080)		-0.0678*** (0.0111)
2009Q3	-0.0692*** (0.0092)	-0.0763*** (0.0086)		-0.0699*** (0.0126)
2009Q4	-0.0424*** (0.0089)	-0.0475*** (0.0086)		-0.0424** (0.0135)
2010Q1	-0.0548*** (0.0092)	-0.0596*** (0.0090)		
2010Q2	-0.1012*** (0.0090)	-0.1055*** (0.0089)		
2010Q3	-0.0828*** (0.0099)	-0.0860*** (0.0099)		
2010Q4	-0.0609*** (0.0097)	-0.0640*** (0.0097)		
2011Q1	-0.0899*** (0.0104)	-0.0947*** (0.0103)		
2011Q2	-0.1066*** (0.0104)	-0.1116*** (0.0103)		
Female degree <sub>it</sub>	-0.0019 (0.0026)		-0.0020 (0.0032)	-0.0020 (0.0027)
Ownership rate <sub>la</sub>	3.1718 (2.5907)		2.8724 (3.1258)	2.2525 (2.7246)
ARM at origination <sub>la</sub>	0.0397*** (0.0075)		0.0395*** (0.0091)	0.0397*** (0.0077)
First time buyer <sub>la</sub>	-0.7614 (0.6816)		-0.7326 (0.8262)	-0.8265 (0.6977)

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Table A1 – *Continued from previous page*

	(1)	(2)	(3)	(4)
	Birth rate	Birth rate	Birth rate	Birth rate
Remortgager <sub>la</sub>	0.1122 (0.6890)		0.0775 (0.8341)	-0.0474 (0.7126)
1-2y seasoned	-4.1315*** (0.9516)		-4.0871*** (1.1479)	-3.9013*** (0.9714)
2-3y seasoned	-3.4107** (1.0458)		-3.3937** (1.2658)	-3.3574** (1.0717)
>3y seasoned	-1.6250 (2.1533)		-1.5998 (2.5942)	-2.2317 (2.2368)
LTI <2	1.6535 (1.2352)		1.9264 (1.5130)	1.4557 (1.2946)
LTI 2-2.5	5.0150*** (1.2944)		5.2751*** (1.5833)	4.6932*** (1.3438)
LTI 2.5-3	3.4415* (1.3914)		3.6629* (1.6938)	3.0754* (1.4596)
LTI 3-3.5	5.1673*** (1.3596)		5.2862** (1.6338)	5.1211*** (1.4313)
LTI 3.5-4	4.1125** (1.4097)		4.1797* (1.6955)	4.1888** (1.4535)
LTV <60%	-1.3076 (2.3870)		-1.4125 (2.8846)	-0.1451 (2.4730)
LTV 60-65%	0.9056 (2.8322)		1.0082 (3.4232)	1.7436 (2.9022)
LTV 65-70%	-0.1095 (2.8268)		-0.0557 (3.4079)	1.1507 (2.9070)
LTV 70-75%	-3.9152 (2.7308)		-3.8846 (3.2843)	-2.4613 (2.8479)
LTV 75-80%	-2.2619 (2.8071)		-2.2832 (3.3854)	-1.3858 (2.9011)
LTV 80-85%	-3.9062 (2.6605)		-3.8431 (3.2070)	-3.3280 (2.7754)
LTV 85-90%	-2.3429 (2.4987)		-2.2864 (3.0056)	-1.4096 (2.5774)
LTV 90-95%	-3.6044 (2.5727)		-3.5846 (3.1010)	-2.3963 (2.6612)
LTV 95-100%	-1.0038 (2.6239)		-0.9937 (3.1588)	0.1054 (2.7322)
5th percentile income	-0.0481		-0.0631	-0.1242

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Table A1 – *Continued from previous page*

	(1)	(2)	(3)	(4)
	Birth rate	Birth rate	Birth rate	Birth rate
	(0.2047)		(0.2482)	(0.2085)
25th percentile income	0.1000		0.0778	0.1205
	(0.2192)		(0.2705)	(0.2182)
50th percentile income	0.1724		0.1725	0.2136
	(0.1399)		(0.1698)	(0.1429)
75th percentile income	-0.0439		-0.0454	-0.0522
	(0.0497)		(0.0610)	(0.0528)
Share <15 year term	-7.1893***		-7.0992***	-6.9395***
	(0.9551)		(1.1541)	(0.9873)
Share 15-20 year term	-7.0150***		-6.9305***	-7.0424***
	(0.9773)		(1.1820)	(1.0069)
Share 20-25 year term	-3.8872***		-3.9123***	-3.6939***
	(0.4971)		(0.6021)	(0.5050)
House price <sub>lt</sub> x Own rate <sub>la</sub>	0.0576***	0.0266***	0.0636***	0.0577***
	(0.0113)	(0.0040)	(0.0154)	(0.0131)
House price <sub>lt</sub>	-0.0262***	-0.0126***	0.0000	-0.0254***
	(0.0054)	(0.0025)	(.)	(0.0064)
Unemployment rate <sub>lt</sub>	0.0014	0.0021	0.0000	0.0046
	(0.0021)	(0.0021)	(.)	(0.0031)
Constant	2.4872***	2.8823***	2.0200***	2.4240***
	(0.2719)	(0.0266)	(0.2615)	(0.2942)
N	12,348	12,348	12,348	6,174

Estimated according to Equation 2. Data Sources are ONS, PSD and 2001 Census. Standards errors adjusted for clustering at LAU level. Regressions are weighted by the number of births in each cell. \* p<0.05 \*\* p<0.01 \*\*\* p<0.001.



**Table A2:** Microdata Evidence on Car Spending

	Total Cars	Used Cars	New Cars
<i>All Households</i>			
Has Children Under 2	0.033** (0.012)	0.037*** (0.011)	-0.004 (0.005)
N	15,355	15,355	15,355
<i>Mortgaged Households</i>			
Has Children Under 2	0.041* (0.018)	0.048** (0.017)	-0.008 (0.009)
N	6,915	6,915	6,915
Income Controls	x	x	x
Income Sq. Controls	x	x	x
Age Dummies	x	x	x
HH Size Dummies	x	x	x
Year Dummies	x	x	x

Sample includes households with at most one child under 2, no other children and at least one adult under 45. Age dummies represent the same age categories as our main analysis and household size is split between 1 or more than one adults aged between 18-45 in the household. Source: ONS Living Costs and Food Survey (LCFS). \*  $p < 0.05$  \*\*  $p < 0.01$  \*\*\*  $p < 0.001$ .

**Table A3:** Mortgage Characteristics Across Samples

Variable	Full Sample	Known-Initial-Period Sample
<i>Region</i>		
East Anglia (%)	4.5	4.3
East Midlands (%)	6.3	6.0
London (%)	14.5	15.0
North (%)	5.7	5.9
North West (%)	12.6	12.7
South East (%)	22.7	23.2
South West (%)	9.0	9.1
Wales (%)	5.2	5.3
West Midlands (%)	8.9	8.4
Yorkshire (%)	10.6	10.1
<i>Employment status</i>		
Employed (%)	79.1	76.9
Self-employed (%)	17.7	19.5
Other (%)	3.2	3.6
<i>Rate type at 2008Q3</i>		
On SVR (%)	19.8	25.8
<i>Mortgage type</i>		
First time buyer (%)	16.4	17.9
Home mover (%)	29.3	29.0
Remortgage (%)	51.1	50.4
Other (%)	3.2	2.7
<i>Initial period</i>		
1 year or less (%)	3.0	8.5
2 years (%)	48.2	48.1
3 years (%)	20.7	18.4
4 years or more (%)	28.1	25.0
N	4.58m	1.27m

Data Source is PSD. There are 4.58m mortgages in the full sample, of which 58.6% are on a fixed rate in July 2008. The Known-period sample is made up of all mortgages on an adjustable rate in July 2008 with a declared initial period (0.53m), and a random sample of mortgage on a fixed rate with a declared initial period at that time (0.74m), ensuring the rate-type balance between the two categories matches the full sample.

**Table A4:** Detailed Mortgage Characteristics Across Samples

Variable	Mean	Median	SD	p25	p75
<b>FRMs</b>					
<i>Full Sample</i>					
Age	37.9	37.0	10.1	30.0	44.0
Household income (£000s)	49.6	39.6	93.5	28.7	55.8
Joint-income mortgages (%)	53.1	100	49.9	0	100
Loan value (£000s)	128.9	110.2	94.6	75.6	156.8
Property value (£000s)	204.4	170.0	169.4	125.0	240.0
Interest rate (where available)	5.53	5.49	0.63	4.99	5.90
<i>Known-period Sample</i>					
Age	38.0	37.0	10.2	30.0	45.0
Household income (£000s)	52.3	40.6	90.4	29.5	57.5
Joint-income mortgages (%)	55.5	100	49.7	0	100
Loan value (£000s)	136.4	115.0	105.5	78.5	165.0
Property value (£000s)	210.3	170.0	187.8	125.0	245.0
Interest rate (where available)	5.63	5.59	0.65	5.09	5.99
<b>Non-FRMs</b>					
<i>Full Sample</i>					
Age	40.5	40.0	10.4	33.0	47.0
Household income (£000s)	67.1	46.2	204.7	32.0	70.3
Joint-income mortgages (%)	50.9	100	50.0	0	100
Loan value (£000s)	146.5	116.0	139.9	73.3	176.3
Property value (£000s)	256.9	200.0	252.5	140.0	292.6
Interest rate (where available)	5.40	5.34	0.64	4.94	5.83
<i>Known-period Sample</i>					
Age	40.1	39.0	10.5	32.0	47.0
Household income (£000s)	57.7	43.5	150.8	30.7	64.7
Joint-income mortgages (%)	50.8	100	50.0	0	100
Loan value (£000s)	136.8	114.0	107.4	72.2	170.0
Property value (£000s)	231.8	185.0	197.4	135.0	269.6
Interest rate (where available)	5.20	5.00	0.66	4.74	5.59

Data Source is PSD. There are 4.58m mortgages in the full sample, of which 58.6% are on a fixed rate in July 2008. The Known-period sample is made up of all mortgages on an adjustable rate in July 2008 with a declared initial period (0.53m), and a random sample of mortgage on a fixed rate with a declared initial period at that time (0.74m), ensuring the rate-type balance between the two categories matches the full sample.