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Forecasting Mortgages: Internet Search Data as a Proxy for Mortgage Credit Demand

Branislav Saxa*

Abstract

This paper examines the usefulness of Google Trends data for forecasting mortgage lending in the Czech Republic. While the official monthly statistics on mortgage lending come with a publication lag of one month, the data on how often people search for mortgage-related terms on the internet are available without any lag on a weekly basis. Growth in searches for mortgages and growth in mortgages actually provided are strongly correlated. The lag between these two growth rates is two months. Evaluation of out-of-sample forecasts shows that internet search data improve mortgage lending predictions significantly. In addition to forecasting performance evaluation, an experimental indicator of restrictively tight mortgage credit standards and conditions is proposed. Nowadays many countries run bank lending surveys to monitor the tightness of bank lending standards and conditions. The proposed indicator represents a complementary tool to such a survey.

Abstrakt

Práce zkoumá možnost využití dat ze služby Google Trends pro krátkodobé predikce vývoje hypotečních úvěrů v České republice. Zatímco oficiální měsíční statistika hypotečních úvěrů je k dispozici s měsíčním zpožděním, data o vyhledávání informací o hypotékách jsou k dispozici na týdenní bázi bez jakéhokoli zpoždění. Četnost vyhledávaní je silně korelována s objemem skutečně poskytnutých hypoték, zpoždění mezi těmito časovými řadami je dva měsíce. Vyhodnocení „out-of-sample" predikcí ukazuje, že data o vyhledávání na internetu signifikantně zlepšují predikce vývoje hypotečních úvěrů. Ve druhé části práce je navržen experimentální indikátor přísnosti úvěrových podmínek a standardů. Mnoho zemí k monitorování přísnosti úvěrových podmínek a standardů dnes využívá šetření úvěrových podmínek bank. Navržený indikátor představuje doplňkový nástroj k podobným šetřením.

JEL Codes: C22, C82, E27, E51.

Keywords: Credit demand, credit standards and conditions, credit supply, forecast evaluation, forecasting, Google econometrics, Internet search data, mortgage, smoothing.

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Nontechnical Summary

People who search for mortgage-related terms on the internet typically do so to get a new mortgage or refinance an existing one. More people searching for mortgages on the internet means higher demand for mortgages. This paper investigates the usefulness of publicly available internet search data for forecasting mortgage lending.

While the official monthly statistics on mortgage lending come with a publication lag of one month, the data on how often people search for mortgages on the internet are available without any lag on a weekly basis. This paper shows that the volume of internet searches for mortgages and the volume of actual mortgage contracts are strongly correlated and that the volume of searches leads the volume of mortgages provided by two months. This relationship can be exploited for mortgage forecasting with a forecast horizon of up to two months.

To see how useful internet search data are for mortgage forecasting, simulations are run. In every round of the simulation, we assume that the history is known only up to a certain date. Based on the information available up to that date, the relationship between searches and mortgages is estimated and used to produce one-month and two-months-ahead forecasts of mortgage growth. In the next round of the simulation, the end of the available history moves forward, a new model is estimated and new forecasts are calculated. At the end, all the forecasts are compared with the actually observed mortgage growths, the forecast errors are calculated and the forecasting performance of two models – one predicting mortgage growth with the use of search growth, the other without – is compared. As shown in this paper, data on mortgage-related internet searches significantly improve the mortgage forecasts at horizons of one and two months.

When predicting mortgages using internet search data, it is assumed that the willingness of banks to provide mortgages does not change over time and the amount of mortgages provided is equal to the demand for mortgages. In the last part of the paper, an experimental indicator of restrictively tight mortgage credit standards and conditions is proposed. Once the assumption of non-changing willingness of banks to provide mortgages is dropped, fewer mortgages can be provided in certain periods not due to lower demand, but because of restricted supply.

The proposed experimental indicator is based on the difference between the number of people searching for a mortgage and the number of people getting a mortgage two months later. A greater difference between these two numbers indicates a lower willingness of banks to provide mortgages. The experimental indicator identifies the third quarter of 2008, i.e. the outbreak of the financial crisis, as a period of substantially restricted credit supply. This is in line with information on credit standards and conditions from the bank lending survey for Eurozone countries. Nowadays many countries run bank lending surveys to monitor the tightness of bank lending standards and conditions. The proposed indicator represents a complementary tool to such a survey.

1. Introduction

In their seminal paper, Choi and Varian (2009a) show how Google Trends data improve near-term forecasts of several economic indicators, including retail sales, car sales, home sales and travel destinations. Other papers followed, showing how unemployment, private consumption and house prices can be forecasted using internet search indices. The official statistics on mortgage lending are published monthly and come typically with a lag of several weeks.[1] In contrast, Google Trends data on the search volumes of queries that users enter into Google are available on a weekly basis without any lag. This paper explores to what extent the Google Trends data can be helpful in predicting mortgage growth.

The analyses in this paper are based on the data for the Czech Republic. Google's share of the search engine market in the country was 71% and internet penetration was 73% in 2013.[2]

Mortgage lending in the Czech Republic has a relatively short history, but the credit market is highly competitive. The volume of new mortgages almost tripled between 2004 and 2007, while real estate prices almost doubled. The demand for mortgages decreased in 2008–2010, but returned to solid growth afterwards. New mortgages doubled between 2010 and 2014, to large extent on the back of increasing importance of mortgage refinancing[3] and decreasing attractiveness of building savings. Volumes of new mortgages have often been influenced by factors other than economic growth, interest rates and inflation, so forecasting models based on these variables struggle to provide reliable forecasts. In this situation, data on how often people google for mortgage rates might contain information useful for improving near-term mortgage growth forecasts.

In the main part of the paper, we assume the supply of mortgages is not limited and we use Google Trends data to forecast mortgage growth. At the end of the paper, it is assumed that the willingness of banks to provide mortgages changes over time and banks might be less willing to lend in certain periods. By comparing the demand for mortgages (proxied by the amount of internet searching for mortgages) and the amount of mortgages actually provided, we construct an experimental indicator which can signal tightening of bank lending standards and conditions. Nowadays many countries run bank lending surveys to monitor the tightness of bank lending standards and conditions. The proposed indicator represents a complementary tool to such a survey.

The paper is structured as follows. The next section reviews the economic literature on the use of internet search data for nowcasting and near-term forecasting. Section 3 describes the data employed and provides stylised facts. In section 4, a forecasting exercise shows the usefulness of internet search data for predicting mortgage growth under the assumption that the mortgage supply does not change. Subsequently, an experimental indicator of restrictively tight credit standards and conditions is proposed for cases where this assumption can be dropped and banks are assumed to limit the credit supply in certain periods. The fifth section concludes.

[1] The publication lag for mortgage loan statistics in the Czech Republic is one month.

[2] Source: The Webcertain Global Search and Social Report 2013 (http://internationaldigitalhub.com/en/publications/the-webcertain-global-search-and-social-report-2013)

[3] Refinanced mortgages appear as new mortgages in the statistics too.

2. Internet Search Data in the Economic Literature

The potential of internet search data was first demonstrated in the work of Ginsberg et al. (2009), who suggested a method to analyse Google search queries to track influenza-like illness in a population. The usefulness of internet search data for economic nowcasting and forecasting is demonstrated in Choi and Varian (2009a, 2009b, 2012). In their examples, simple autoregressive models are augmented with search engine data to produce near-term forecasts of automobile sales, unemployment claims, travel destination planning and consumer confidence. In most of their examples, the authors find a reduction in the mean absolute error coming from out-of-sample one-step-ahead forecasting exercises. In the case of initial claims for unemployment benefits, Google Trends data help with the identification of turning points.

Several studies showing how internet search data improve predictions followed. Askitas and Zimmerman (2009) perform a forecasting exercise on German unemployment data, showing the potential of internet search data in unemployment predictions. D'Amuri and Marcucci (2012) propose the use of an index of internet job-search intensity as the best leading indicator to predict the US unemployment rate. Fondeur and Karamé (2013) employ the unobserved components approach and use the Kalman filter to estimate a model for nowcasting and forecasting French youth unemployment. Pescyova (2011) uses the data on unemployment in Slovakia, showing that internet search data improve in-sample predictions substantially. Predictions of unemployment in the UK can also be improved using internet search data, as McLaren and Shanbhogue (2011) show. In addition, they illustrate that in the case of house prices, predictions using internet search data can outperform some existing indicators. The extent to which cross-sectional differences in home prices can be predicted using internet search data is studied in Beracha and Wintoki (2013). Schmidt and Vosen (2009) show how Google Trends beats the forecasting performance of the two most common indicators of private consumption in the U.S. (the University of Michigan Consumer Sentiment Index and the Conference Board Consumer Confidence Index).

3. The Data and Stylised Facts

Two time series are used for the analyses in this paper – the nominal volume of new mortgages provided to households by banks in the Czech Republic, and Google Trends data on the search volumes of mortgage-related Czech words with and without diacritics[4] searched for from computers in the Czech Republic.

The statistics on newly provided mortgages are available on a monthly basis and are published by the Czech National Bank one month after the end of the month to which they apply. Data on search volumes of specific terms are available from www.google.com/trends as an index.[5] These data are available on a weekly basis without any publication lag.

[4] "hypotéka" + "hypoteka" + "hypoteční" + "hypotecni" + "hypotéku" + "hypoteku" + "hypotéky" + "hypoteky" + "úvěr na bydlení" + "uver na bydleni"

[5] Google Trends provides search data that are already normalised (divided by a common variable, such as total searches, to cancel out the variable's effect on the data). Values are therefore between 0 and 100.

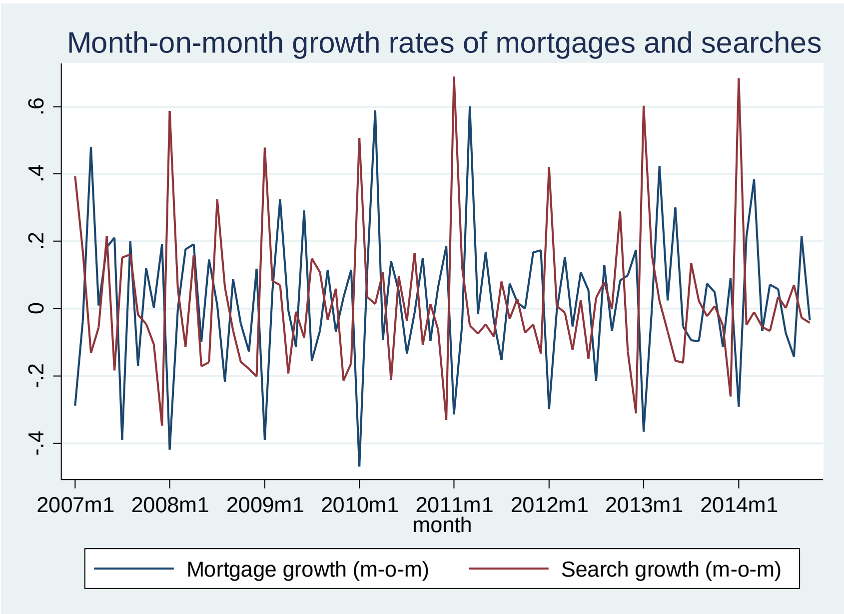
For data downloaded at different times, Google Trends returns different data series for the same search query, presumably calculated using different random samples of searches. As the differences between the time series can be rather substantial for the search terms and geographical location used in this paper, ten different data series obtained using the same query at different times were averaged for further use. The pairwise correlations between the ten individual search data series are in the range of 0.78–0.85, while the pairwise correlations between the individual series and the averaged series are in the range of 0.90–0.93. The standard deviations of the individual series range from 11.0 to 12.7, and the standard deviation of the averaged series is 11.0.

Once downloaded and averaged, the search volume data were transformed into monthly frequency in the following way. First, the weekly search volume data were transformed into daily data so that the index for each day was set equal to the value of the index for the relevant week. Subsequently, the daily data were transformed into monthly data so that the monthly value of the index was set to be equal to the average of all the daily values of the index for the respective month.

The sample period used for the analyses shown in this paper is 2007m1–2014m10. Although Google Trends data are available from 2004, the individual search data time series contain many zeros before 2007, presumably due to a low number of related searches (Google Trends sets the index value to 0 if the number of searches does not exceed a certain threshold).

Both time series are shown in levels in Figure A1 in the appendix. For further use, the series are transformed into month-on-month growth rates. These are shown in Figure 1. Both series are stationary; the augmented Dickey–Fuller test strongly rejects the null hypothesis of a unit root in both cases. The two series are highly seasonal.[6]

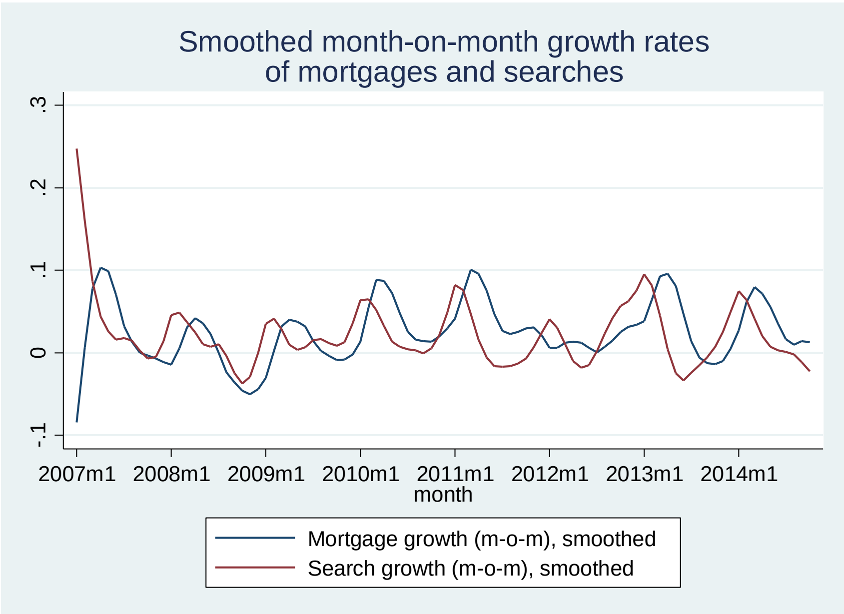
Figure 1: Month-on-month Growth Rates of Mortgages and Searches



[6] Google Trends data also have a specific type of seasonality. Search volume indices tend to decrease towards the end of the year as a result of the overall volume of searches being inflated by Christmas-related shopping searches.

To inspect for potential co-movement of the two growth rates, several smoothing methods were applied. Figure 2 shows the growth rates smoothed using the Hodrick–Prescott filter with lambda set to 10.[7] While the beginning and the end of sample suffer from the typical Hodrick–Prescott end-point bias, the search growth rate in general mimics the mortgage growth rate reasonably well, with an obvious lead. The cross-correlogram for the whole sample period (Figure A3 in the appendix) suggests that searches lead mortgages by two to three months. The correlations of the growth rates at these lags are 0.75 and 0.74 respectively.

Figure 2: Smoothed (HP filtered) Month-on-month Growth Rates of Mortgages and Searches



However, just by looking at Figure 2, one cannot reject the hypothesis that the lag between searches and mortgages changes over time. When cross-correlations are calculated for three different overlapping subsamples (2007m1–2009m12, 2009m1–2011m12, 2011m1–2014m10), the correlation is strongest at the three-month lag in the first period, but at the two-month lag in the second and third periods (details in Table A1 in the appendix).

To see whether the lag structure changes over time, rolling window correlations between the smoothed growth rates of mortgages and searches are calculated for lags 0 to 4. The window width is 48 months. Figure A4 in the appendix shows how the correlations at different lags change over time (the times on the horizontal axis indicate the end of the subsample used for the calculation of the correlation). The correlation is strongest for the two-month lag over the whole sample period, but the correlation at the three-month lag gets equally high towards the end of the sample.

Table A2 in the appendix shows summary statistics for all the variables used.

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[7] The lambda parameter is substantially lower than the values typically used for monthly frequency data. This is because the aim here is to obtain smoothed short-term changes, not to isolate business cycle frequencies from the long-run trend component. The result of alternative smoothing using a symmetric moving-average filter with $\hat{x} = \frac{1}{9}(1x_{t-2} + 2x_{t-1} + 3x_t + 2x_{t+1} + 1x_{t+2})$ is depicted in Figure A2 in the appendix (the search growth rate is lagged by two months in Figure A2).

4. Empirical Approach and Results

4.1 Forecasting Mortgages

In the first part of this paper, Google Trends data are used to forecast mortgage lending. A simple autoregression process with and without a seasonal component is estimated to judge whether internet search volume data can improve the mortgage lending forecast.

To see how much of the monthly dynamics in mortgage lending can be captured by the amount of googling for mortgages two months earlier, the month-on-month mortgage growth is first regressed on its lagged values (referred to as the AR(1) model). The results are then compared to the results of the same regression augmented with the month-on-month growth in searching for mortgages, lagged by two months (referred to as the ARX model). As Table 1 shows, the amount of variation explained by the regression (proxied by adjusted R-squared) increases substantially, from 0.05 to 0.39.

Table 1: Variation in Mortgage Lending Explained by Amount of Searching Two Months Earlier

	AR(1)	ARX
L.Mortgage growth (m-o-m)	-0.24 **	-0.41 ***
	(0.10)	(0.09)
L2.Search growth (m-o-m)		0.58 ***
		(0.08)
Constant	0.03 *	0.03
	(0.02)	(0.02)
Adjusted R-squared	0.05	0.39
Number of observations	93	92

Note: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Least squares estimation; the dependent variable is month-on-month growth of mortgage lending; standard errors in parentheses.

In the next step, the usefulness of search growth data in forecasting mortgage lending is assessed in an out-of-sample forecasting exercise.[8] The baseline forecast of mortgage growth is compared with the forecast exploiting the data on search growth lagged by two months. The two estimated equations take the following form:

AR(1): $\Delta mortgage_t = \alpha + \beta \Delta mortgage_{t-1}$

and

ARX: $\Delta mortgage_t = \alpha + \beta \Delta mortgage_{t-1} + \gamma \Delta search_{t-2}$

[8] Performed in STATA using the STATICFC module authored by Baum (2013).

The window used for the estimation of the equations' coefficients extends from 2007m1–2008m8 to 2007m1–2014m9.[9] The one-month and two-months-ahead forecasts constructed using the estimated coefficients are then compared with the actually observed values and the forecast errors are calculated. Two forecast evaluation measures are shown in Table 2: the mean absolute error (MAE) and the square root of the mean-squared forecast error (RMSE). Inclusion of lagged search growth reduces the MAE and RMSE of the one-step-ahead mortgage forecasts by approximately 18% and 23% respectively. A similar improvement is observed with the two-steps-ahead forecasts.[10] In both cases, the Diebold–Mariano test strongly rejects the null hypothesis that the forecast accuracy of the models with and without lagged searches is the same. Figures A5 and A6 in the appendix show the observed mortgage growth as well as the one-step-ahead predictions without and with search growth used as an explanatory variable.

Table 2: Mortgage Growth Out-of-sample Forecasting Exercise

	AR(1)	ARX	Change	Diebold-Mariano	
				S(1)	p-value
One-step-ahead forecast					
MAE	0.1411	0.1162	-18%		
RMSE	0.1919	0.1475	-23%		
				4.25	0.00
Two-steps-ahead forecast					
MAE	0.1420	0.1150	-19%		
RMSE	0.1924	0.1466	-24%		
				4.27	0.00

Note: Mean absolute errors (MAE) and square roots of mean-squared forecast error (RMSE) for one-month and two-months-ahead forecasts.

Finally, mortgage growth lagged by 12 months is added to the regressions so that all seasonal effects can be captured by this term. Most of the variation in mortgage growth is now explained by seasonality. Nevertheless, lagged search growth still improves the fit, as Table 3 shows.

[9] 2007m1–2008m8 to 2007m1–2014m8 in the case of the two-months-ahead forecast comparison

[10] A number of alternative specifications were estimated too. Two versions with smoothed lagged search growth rates (HP and moving average) in the ARX equation beat the forecasting performance of the AR(1) model, but their performance is worse than that of the ARX model with non-smoothed lagged search growth rates. A version with non-smoothed lagged search growth rates entering the ARX equation with a lag of three months instead of two months does not beat the forecasting performance of the AR(1) model.

Table 3: Variation in Mortgage Lending Explained by Amount of Searching Two Months Earlier and Seasonal Term

	SAR(1)	SARX
L.Mortgage growth (m-o-m)	-0.17 **	-0.28 ***
	(0.08)	(0.07)
L12.Mortgage growth (m-o-m)	0.67 ***	0.47 ***
	(0.07)	(0.08)
L2.Search growth (m-o-m)		0.35 ***
		(0.08)
Constant	0.01	0.01
	(0.02)	(0.01)
Adjusted R-squared	0.53	0.61
Number of observations	82	82

Note: * p<0.10, ** p<0.05, *** p<0.01. Least squares estimation; the dependent variable is month-on-month growth of mortgage lending; standard errors in parentheses.

The two equations estimated in the out-of-sample forecasting exercise now look as follows:

SAR(1): $\Delta mortgage_t = \alpha + \beta \Delta mortgage_{t-1} + \theta \Delta mortgage_{t-12}$

and

SARX: $\Delta mortgage_t = \alpha + \beta \Delta mortgage_{t-1} + \theta \Delta mortgage_{t-12} + \gamma \Delta search_{t-2}$

The results of the out-of-sample forecasting exercise with a seasonal term are summarised in Table 4. The inclusion of lagged search growth reduces the MAE and RMSE of the one-step-ahead mortgage forecasts by approximately 8% and 10% respectively. The reductions in the forecast error for the two-steps-ahead forecasts are approximately 7% and 10% respectively. However, as the differences in forecasting performance between SAR(1) and SARX are smaller, the Diebold–Mariano test does not reject the null hypothesis that the forecast accuracies of the two competing models are equal at any conventional significance level (the p-values are 0.13 and 0.16 for the one-step and two-steps-ahead forecasts respectively).

Table 4: Mortgage Growth Out-of-sample Forecasting Exercise With Seasonal Term

	SAR(1)	SARX	Change	Diebold-Mariano	
				S(1)	p-value
One-step-ahead forecast					
MAE	0.0985	0.0909	-8%		
RMSE	0.1299	0.1168	-10%		
				1.50	0.13
Two-steps-ahead forecast					
MAE	0.0992	0.0925	-7%		
RMSE	0.1307	0.1182	-10%		
				1.41	0.16

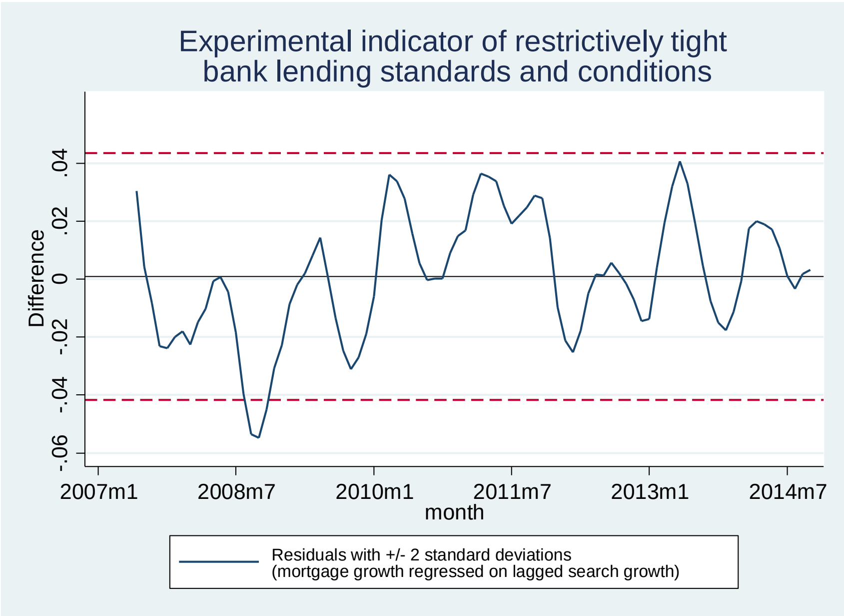
Note: Mean absolute errors (MAE) and square roots of mean-squared forecast error (RMSE) for one-month and two-months-ahead forecasts.

4.2 Experimental Indicator of Restrictively Tight Bank Lending Standards and Conditions

In the second part of the paper, demand for mortgages is compared with mortgages actually provided and an experimental indicator of restrictively tight bank lending standards and conditions is constructed. In this part, it is assumed that the willingness of banks to provide mortgages changes over time and in some periods fewer mortgages are provided not due to lower demand, but because of restricted supply. While nowadays many countries run bank lending surveys to monitor the tightness of bank lending standards and conditions, the proposed indicator could be useful in countries without such a survey.

The idea behind the indicator is straightforward. The smoothed growth rate of mortgages actually provided is regressed on the smoothed growth rate of searches lagged by two months. The residuals from this regression represent the part of the variation in mortgages that cannot be explained by the variation in demand for mortgages. Growth of demand substantially above the growth of mortgages actually provided can signal a lower willingness of banks to provide mortgages.

Figure 3: Experimental Indicator of Restrictively Tight Bank Lending Standards and Conditions



Note: As the smoothed series suffer from the typical Hodrick–Prescott end-point bias and the indicator becomes very low in the first few months, the chart begins in 2007m6.

If the lagged amount of searching grows faster than the amount of mortgages, the indicator is negative and suggests that fewer mortgages are provided than demanded. Figure 3 shows the values of the experimental indicator for the Czech Republic, along with the two-standard-deviation band around the mean of the indicator.[11] The indicator leaves the band only in the third quarter of 2008.

What happened with credit standards and conditions in this period (which saw the outbreak of the financial crisis)? The bank lending survey did not yet exist in the Czech Republic in 2008, but it is possible to check the bank lending survey for the Eurozone. The net tightening of credit standards applied to loans to households for house purchase reached 36% in the Eurozone in the third quarter of 2008. This is the second-highest number in the history of the Eurozone bank lending survey.[12] The period identified using the suggested experimental indicator thus very likely coincides with the period of most significant tightening of credit standards and conditions during the period analysed.

Of course, reasons other than excessively tight credit standards and conditions might influence the value of the experimental indicator too. These could include changing behaviour of people searching for mortgages and a changing lag between searching for a mortgage and signing a mortgage contract.

Two alternative specifications were considered. If a 1:1 relationship is imposed on the growth rates of mortgages and lagged searches, the indicator can be constructed as a simple difference of

[11] Under the assumption that the residuals are distributed normally, the indicator leaves the two-standard-deviation band in approximately 5% of cases.

[12] The only higher number was reported one quarter later.

growth rates. As Figure A9 in the appendix shows, this approach delivers qualitatively similar results. Finally, if a lag of three months is assumed instead of a lag of two months, the extreme values of the indicator are different but the dynamics of the indicator remain the same (Figure A10 in the appendix).

5. Conclusion

This paper investigates the usefulness of internet search data for forecasting mortgage lending. While the official monthly statistics on mortgage lending come with a publication lag of one month, the data on how often people search for mortgages on the internet are available without any lag on a weekly basis. As this paper shows, the growth rates of searches and mortgages are strongly correlated and the volume of searches leads the volume of mortgages provided by two months. The variation in month-on-month search growth explains a substantial part of the variation in month-on-month mortgage growth. Most importantly, out-of-sample near-term forecast exercises show that the volume of searches improves the short-term predictions of mortgage lending.

When predicting mortgages using internet search data, it is assumed that the supply of mortgages is unrestricted and the amount of mortgages provided is equal to the demand for mortgages. In the last part of the paper, an experimental indicator of restrictively tight mortgage credit standards and conditions is proposed. Once the assumption of unrestricted credit supply is dropped, the willingness of banks to provide mortgages can change over time. In certain periods, fewer mortgages are provided not due to lower demand, but because of restricted supply. The proposed indicator identifies the third quarter of 2008, i.e. the outbreak of the financial crisis, as a period of substantially restricted credit supply. This is in line with information on credit standards and conditions from the bank lending survey for Eurozone countries. While nowadays many countries run bank lending surveys to monitor the tightness of bank lending standards and conditions, the proposed indicator could be useful in countries without such a survey.

Together with the available studies on forecasting unemployment and private consumption, the two applications in this paper illustrate the usefulness of internet search information for monetary policy and economic forecasting in general.

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Appendix

Figure A1: Levels of Mortgages and Searches

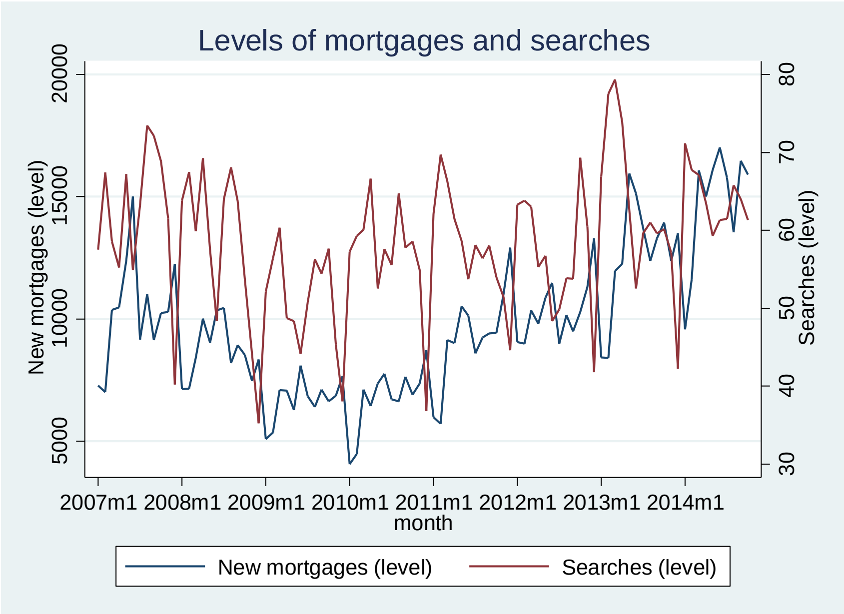


Figure A2: Smoothed Month-on-month Growth Rates of Mortgages and Searches (moving average)

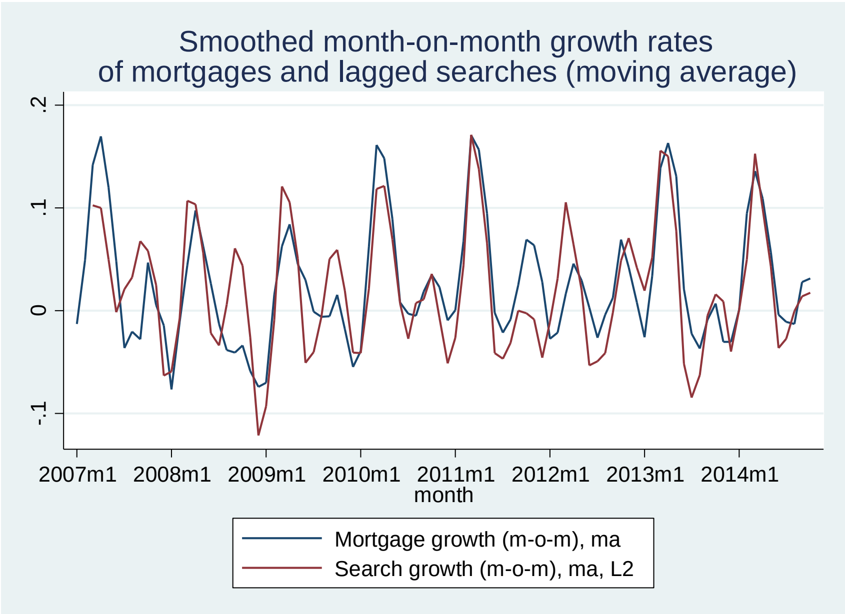


Figure A3: Cross-correlogram Between Smoothed m-o-m Growth Rates of Mortgages and Searches

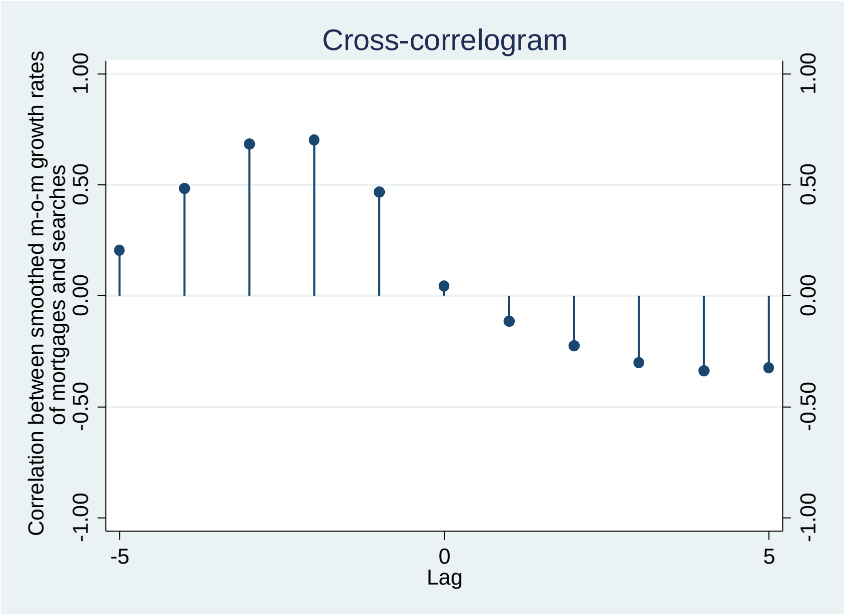


Table A1: Cross-correlations Between Mortgages and Searches for Different Lags and Subsamples

Lag in months	Subsample			Whole sample
	2007m1-2009m12	2009m1-2011m12	2011m1-2014m10	2007m1-2014m10
0	-0.08	0.20	0.24	0.04
	(0.66)	(0.24)	(0.11)	(0.67)
1	0.47	0.62	0.60	0.49
	(0.00)	(0.00)	(0.00)	(0.00)
2	0.78	**0.83**	**0.84**	**0.75**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**
3	**0.81**	0.74	0.83	0.74
	(0.00)	(0.00)	(0.00)	(0.00)
4	0.67	0.45	0.63	0.54
	(0.00)	(0.01)	(0.00)	(0.00)

Note: Significance levels in parentheses, lags with the highest correlation coefficient in bold.

Figure A4: Rolling Window Correlations Between Smoothed m-o-m Growth Rates of Mortgages and Searches at Different Lags

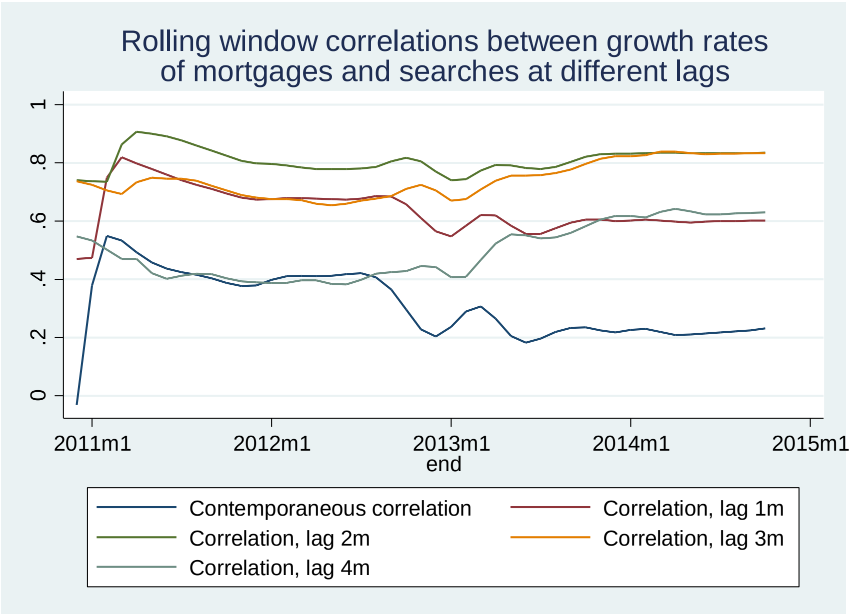


Table A2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
mortgages	94	9831.5	3027.5	4074.5	17021.4
searches	94	58.5	8.8	35.2	79.4
m-o-m mortgage growth	94	0.0250	0.2000	-0.4675	0.6015
m-o-m search growth	94	0.0224	0.2053	-0.3468	0.6889
smoothed m-o-m mortgage growth (HP filter, λ=10)	94	0.0250	0.0367	-0.0842	0.1031
smoothed m-o-m search growth (HP filter, λ=10)	94	0.0224	0.0406	-0.0376	0.2477
experimental index	92	0.0000	0.0234	-0.0943	0.0407

Figure A5: One-step-ahead Out-of-sample Forecasts of Month-on-month Growth Rate of Mortgages (without seasonal term, without search growth)

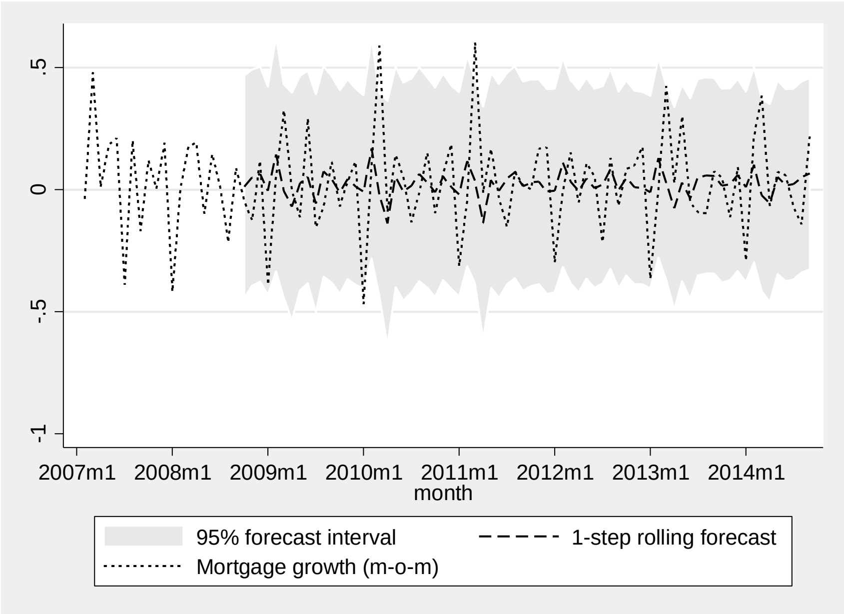


Figure A6: One-step-ahead Out-of-sample Forecasts of Month-on-month Growth Rate of Mortgages (without seasonal term, with search growth)

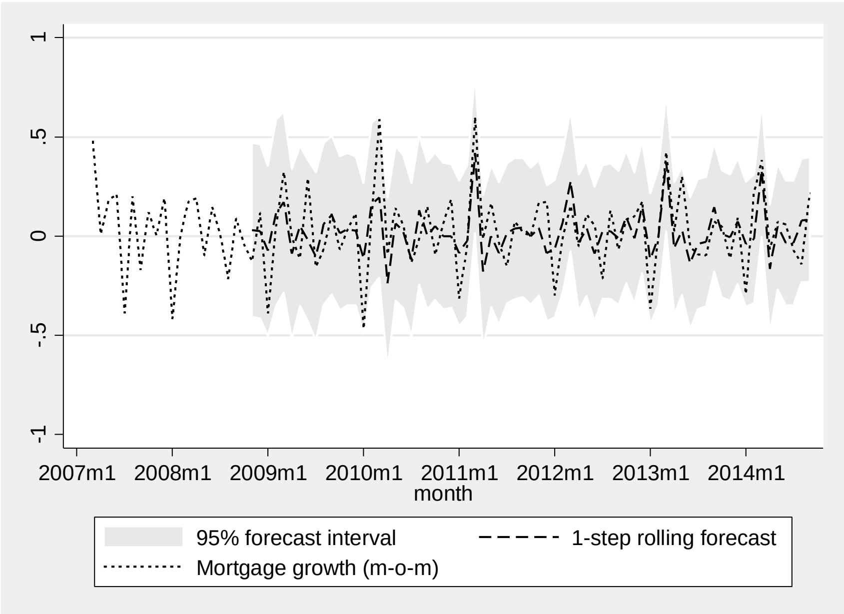


Figure A7: One-step-ahead Out-of-sample Forecasts of Month-on-month Growth Rate of Mortgages (with seasonal term, without search growth)

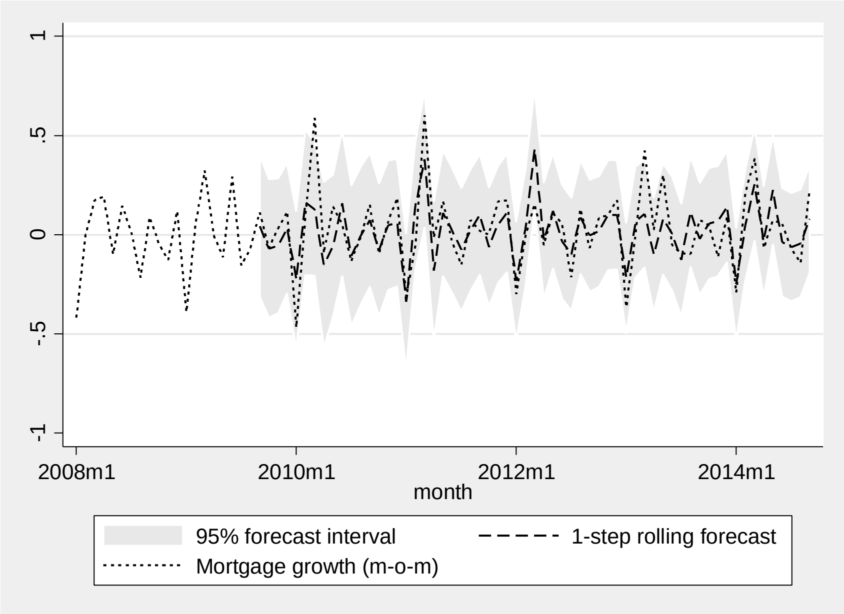


Figure A8: One-step-ahead Out-of-sample Forecasts of Month-on-month Growth Rate of Mortgages (with seasonal term, with search growth)

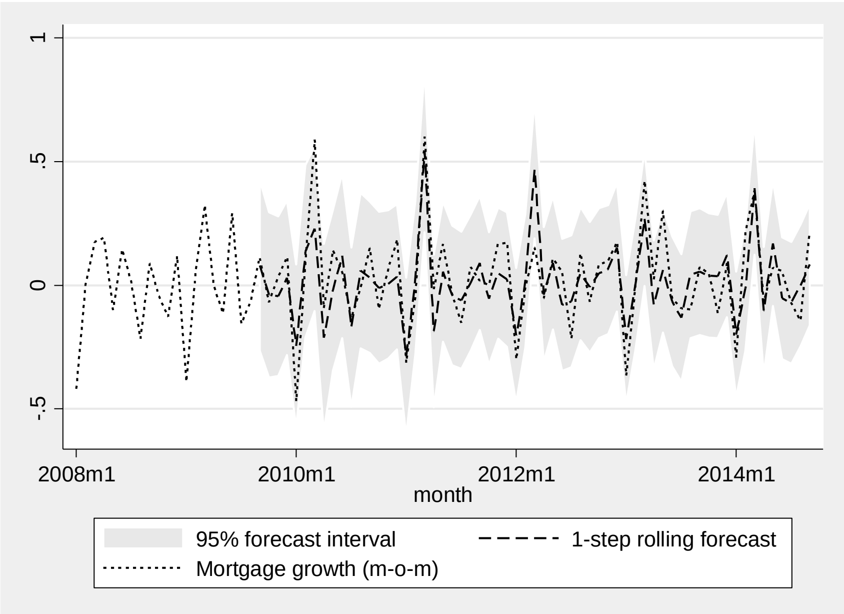


Figure A9: Comparison of Baseline Experimental Indicator With Version Constructed as Simple Difference of Growth Rates

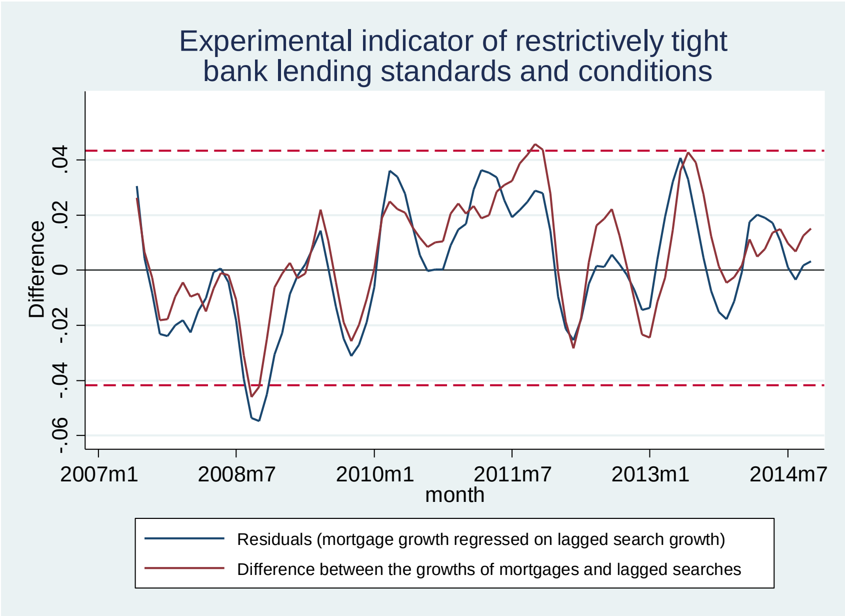
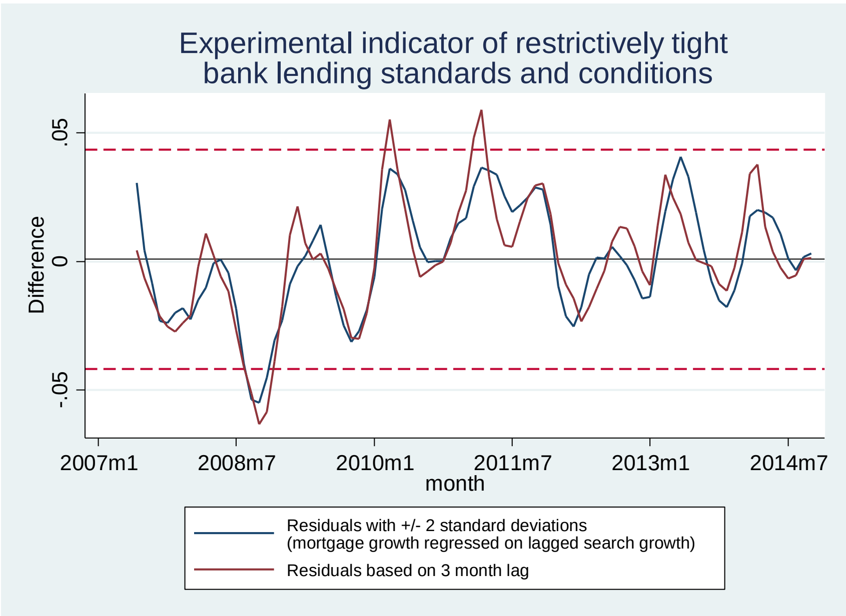


Figure A10: Comparison of Baseline Experimental Indicator With Version Assuming Lag of Three Months Instead of Two Months



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