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Evidence from an OECD Panel

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527/2016

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WIFO Working Papers, No. 527

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2016/305/W/0

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Inflation and Broadband Revisited: Evidence from an OECD Panel

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Abstract

This note revisits the conjecture that the use of broadband internet lowers transaction costs and thereby inflation. Using a macro-economic panel of OECD countries, it roughly confirms previous findings reported by Yi and Choi (2005) by addressing conceptual and econometric issues.

JEL classification: E31, O1, O3

Keywords: Inflation, broadband

This Version: 3rd October 2016

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1. Introduction

The use of telecommunication services has promoted economic growth and productivity (Khalil et al. 2009; Hardy 1980; Röller and Waverman 2001). Especially broadband internet is regarded as a general purpose technology that not only allows firms to explore new markets and distribution channels, but also lowers transaction costs economy-wide (Clarke, Qiang, and Xu 2015; Norton 1992). Hence, a higher internet penetration rate significantly reduces the inflation rate.

This note revisits previous findings by Yi and Choi (2005) who confirm this conjecture. However, we argue that these estimates suffer from econometric and conceptual issues, which this note addresses. We validate these previous results with more elaborate econometric techniques and with the next generation of data transmission technology, broadband internet.

We confirm that higher internet penetration rates reduce inflation. The magnitude of the estimated coefficient is roughly comparable with the results reported by Yi and Choi (2005), even though we find a significantly smaller range of the effect. We thereby contribute to the literature on the economic effects of the use of broadband, and add an instrument to the toolbox of macro-economic policy makers.

2. Previous findings

Yi and Choi (2005) estimated the effect of internet on inflation in a worldwide panel of 207 countries for the period from 1991 to 2007. The estimates explained levels of the consumer price index as a function of internet penetration rates as the main explanatory variable. In addition, the regressions considered the oil price, the unemployment rate and the money growth rate as control variables. These estimates suffer from both econometric and conceptual issues.

First, there are econometric issues with regard to the estimation technique, and the choice to estimate the key variables in levels. Especially internet penetration rates have increased steadily over time, thereby causing non-stationarity and autoregression issues. Also, the chosen estimation techniques were OLS and panel random effects. Specification tests are not reported, however.

Second, the control variables only partly capture inflation dynamics. For instance, money growth is an indicator for monetary policy, but does not capture the policy intention to affect real interest rates. Similarly, the oil price is an important indicator for external price developments, but is a single measure that does not capture price developments of other raw materials. In addition, including unemployment is questionable, since its coefficient is typically found to be statistically insignificant.

3. Empirical results

We estimate panel regressions to analyse the effect of broadband on annual inflation rates. We use an unbalanced macro-economic panel of thirty OECD countries for the period 1996–2014 (see Annex A for the country coverage, Annex B for the data and variable definition, and Annex C for descriptive statistics).

The dependent variable is the annual change of the consumer price index (CPI), a measure for the inflation rate. The main explanatory variable is the fixed broadband penetration rate - that is, fixed broadband subscriptions as a share of the total population. Fixed broadband services are part of the basket of consumer goods, but can be regarded as exogenous due to their negligible share in the basket. An unconditional correlation coefficient indicates a negative relationship between the two main variables CPI and fixed broadband penetration (ρ: -0.15, p-value: 0.002).

We control for price developments affecting the inflation rate which capture both global and country specific developments, and add structural aspects in the robustness checks (Aisen and Veiga 2008; Aisen and Veiga 2006). We use the output-gap as a relative measure of demand and supply conditions of the domestic economy. The output-gap also mirrors the real interest rate gap, which is the difference between the observed real interest rate - that is, the nominal short-term interest rate minus expected inflation - and the natural rate of interest. Hence the output-gap provides a measure for monetary policy, and is therefore preferable to other cyclical measures such as GDP growth (Cúrdia 2015; Cúrdia et al. 2015). Since higher inflation rates are associated with poor macro-economic performance, we expect a positive relationship between the output-gap and inflation (Fischer, Sahay, and Végh 2002).

Next, we control for openness to trade by the merchandise trade share in percent of GDP, whose effect might be ambiguous. While countries that are more open to trade may be more exposed to external price shocks which potentially increase inflation rates, they might also be better able to absorb such shocks. The control variables capturing international markets comprise two price indices. We control for the price of raw materials, and thereby also consider the price of crude oil. A second index controls for the real effective exchange rate. We expect this raw material index to be positively, and the foreign exchange rate index to be negatively associated with inflation (Aisen and Veiga 2006). In addition, we include global developments by time dummies for five periods (1995-1997, 1998-2000, 2001-2003, 2004-206, 2007-2009, 2010-2012 and 2013-2014). All specifications consider an outlier dummy for the UK in 2007 due to an erratic spike in the broadband series.

To address possible concerns about non-stationarity, the inflation rate, fixed broadband penetration and the control variables are estimated in first-differences (see Annex C for illustrations of both key variables). Fisher-type panel unit-root tests fitting an augmented Dickey-Fuller regression for each panel reject non-stationarity (Choi 2001).

We implement four different regression techniques to examine the effect of broadband on inflation. The first two regressions are fixed effects specifications controlling for unobserved

time-invariant, country-specific effects. The first regression leaves out fixed broadband (1) which is added in the second specification (2). This allows examining the effect of broadband on the explanatory power of the model, the within-R^2. The third specification is a random effects estimator (3), which is implemented because a Hausman specification test does not reject random effects (p-value: 0.994). The standard errors of these specifications are bootstrapped with 300 replications.

The next regressions consider possible disturbances due to a possibly autoregressive lagged dependent variable. A Wooldridge test does not reject the null-hypothesis that there is no first-order autocorrelation in the error term (p-value: 0.108). However, the p-value is close to being statistically significant, which is why specification (4) is a fixed-effects and specification (5) a random-effects model with a first-order autoregressive disturbance term. The Baltagi-Wu locally best invariant test statistic and the Durbin-Watson statistic do not indicate serial correlation in either of these specification (Baltagi and Wu 1999; Wooldridge 2010; Baltagi and Li 1995; Drukker and others 2003).

The regression results indicate a statistically significant, negative effect of fixed broadband penetration on the inflation rate. The estimated elasticity ranges between -0.09 and -0.11. Including the broadband indicator improves the within R^2 of the fixed effects specification by 7.6 percentage points. The control variables largely perform as expected (see Table 1).

Table 1 – Estimation results for fixed broadband penetration on inflation (CPI)

	(1)	(2)	(3)	(4)	(5)
Estimator	FE	FE	RE	FE (AR1)	RE (AR1)
Broadband, fixed		-0.1047***	-0.0869**	-0.0962**	-0.0871**
		(0.038)	(0.036)	(0.043)	(0.039)
Output gap	0.0483	0.0917	0.0910*	0.1033***	0.0986***
	(0.067)	(0.059)	(0.054)	(0.038)	(0.036)
Trade openness	0.0200	0.0276	0.0225	0.0196	0.0176
	(0.019)	(0.024)	(0.019)	(0.017)	(0.014)
Raw materials	0.0366***	0.0342***	0.0348***	0.0342***	0.0344***
	(0.004)	(0.005)	(0.004)	(0.004)	(0.004)
FX	-0.0587**	-0.0489	-0.0505**	-0.0438**	-0.0498***
	(0.029)	(0.030)	(0.025)	(0.017)	(0.015)
Time dummies	Y	Y	Y	y	Y
Observations	472	387	387	357	387
R^2	0.325	0.401	0.4008	0.427	0.4004

Note: This table describes the regression results for fixed broadband penetration on the annual change of the consumer price index (in percent) for 30 OECD countries in the period 1996-2014. The results show an inflation reducing effect of fixed broadband usage. All variables are estimated in first differences. Regressions (1), (2) and (4) are fixed-effects estimations (FE), and regressions (3) and (5) are estimated as random-effects (RE). Bootstrapped standard errors with 300 replications are reported in parentheses are used in specifications (1), (2) and (3); specification (4) and (5) use a first-order autoregressive disturbance term (AR1). All estimations include time effects and an outlier dummy taking on a value of 1 for the UK in 2007, and 0 otherwise (see Annex C). The raw material index and the FX index use 2005 as the base year. *** Statistically significant at 1% significance level; ** Statistically significant at 5% significance level; * Statistically significant at 10% significance level.

We perform several robustness checks ensuring the structural validity of the key finding. Both significance levels and the magnitude of the estimated coefficient for broadband penetration remain qualitatively the same across these specifications:

- Implementing a dynamic panel estimator: a lagged dependent variable estimation with a small-sample bias-control with bootstrapped standard errors (Bun and Kiviet 2003). The results show a statistically insignificant autoregressive term (p-value: 0.355); the one-step Sargan statistic indicates that the overidentifying restrictions used by the underlying Blundell-Bond specification are not satisfied (see also Bruno 2005). Statistical insignificant lagged dependent variables have been reported before in inflation estimates (Aisen and Veiga 2008; Castro and Veiga 2004).
- Using a different set of control variables. Instead of the output-gap, we include other explanatory variables that are also commonly used in inflation estimates. The alternative control variables used are real annual GDP growth, GDP per capita in constant prices (base year 2005), the GDP share of agriculture and the regulatory quality from the World Governance Indicators as a proxy for pro-market regulations. This set of variables mainly controls for characteristics that are more relevant to developing countries, which are, however, hardly represented in the present sample. (Veiga and Aisen 2006).
- Estimating the regression with inflation rates (annual change of CPI in percent) as the dependent variable instead of first differences, or estimating the model with a crisis dummy instead of time effects. The crisis dummy takes on the value 1 for years after 2008 and 0 otherwise.
- Dropping outliers, i.e. the top and bottom one-percentile of the CPI indicator, and dropping the observations for the UK due to spike in the broadband indicator.

The present analysis focuses on fixed broadband usage rates. Data for mobile broadband is poorly available, since its deployment began at the end of the period analysed. Estimates including mobile broadband point towards a negative effect on inflation. However, the coefficient is statistically insignificant and less pronounced than for fixed broadband.

4. Conclusions

This note revisited the inflation reducing effect of internet using broadband penetration rates. We confirm this conjecture in a panel of OECD countries, and address both measurement and econometric issues of previous estimations (Yi and Choi 2005). The coefficients obtained range from -0.11 to -0.09, which differs from previous results ranging between -0.05 and -0.13. This finding is relevant to research on the economic effects of broadband, and also adds to macro-economic policy tools.

Appendices

Supplementary material related to this article can be found online.

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Annex A – Country Coverage

The total sample covers 389 observations from 30 OECD member countries. Due to lacking information about broadband coverage, data points are often missing in the initial years. Korea, Slovenia and Turkey are not considered in the analysis due to lacking information about output-gaps. Observations for Chile were also dropped, because the available time series covers only three years.

Country	Observations
Australia	10
Austria	14
Belgium	15
Canada	15
Czech Republic	13
Denmark	13
Estonia	12
Finland	13
France	15
Germany	13
Greece	10
Hungary	13
Iceland	14
Ireland	11
Israel	12
Italy	13
Japan	15
Luxembourg	12
Mexico	13
Netherlands	13
New Zealand	13
Norway	13
Poland	12
Portugal	14
Slovak Republic	11
Spain	13
Sweden	13
Switzerland	13
United Kingdom	13
United States	15

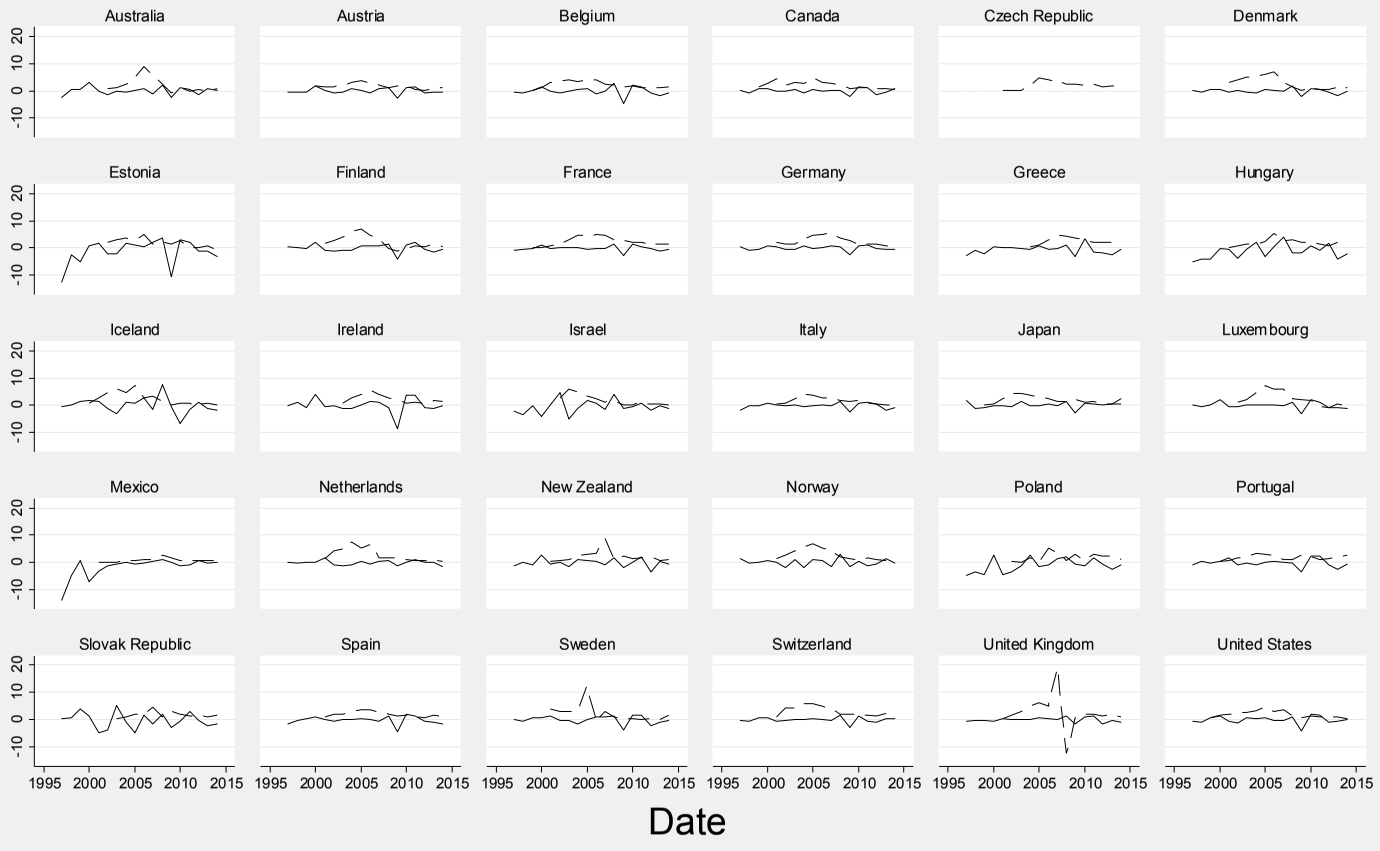
Annex B – Data Description and Variable Definition

Variable	Description	Source
Inflation	Inflation, consumer prices (annual %).	World Development Indicators, World Bank
Fixed bb	Fixed-broadband subscriptions as a per cent of total population.	World Telecommunication/ICT Indicators Database 2015, ITU
Output gap	Output gap. Deviations of actual GDP from potential GDP as a per cent of potential GDP.	OECD Economic Outlook 91 database, OECD
Trade openness	Merchandise trade (% of GDP).	World Development Indicators, World Bank
Raw materials	HWWI-Index of world market prices of commodities, base year 2005.	HWWI Consult / Wifo Data System (WDS)
FX	Real effective exchange rate index (based year varies) from the World Development Indicators and Eurostat, Indices re-calculated to 2005 as the common base-year. Data for Estonia were obtained from the IMF.	World Development Indicators, World Bank. / Own Calculation
Time effects	Dummy variables taking on the value of one for the periods 1995-1997, 1998-2000, 2001-2003, 2004-206, 2007-2009, 2010-2012 and 2013-2014, and zero otherwise.	Own calculation
UK	Dummy variable capturing a break in the broadband series for the UK. It takes on the value of one for the the UK in 2007, and zero otherwise.	Own calculation

Annex C – Descriptive Statistics (First Differences)

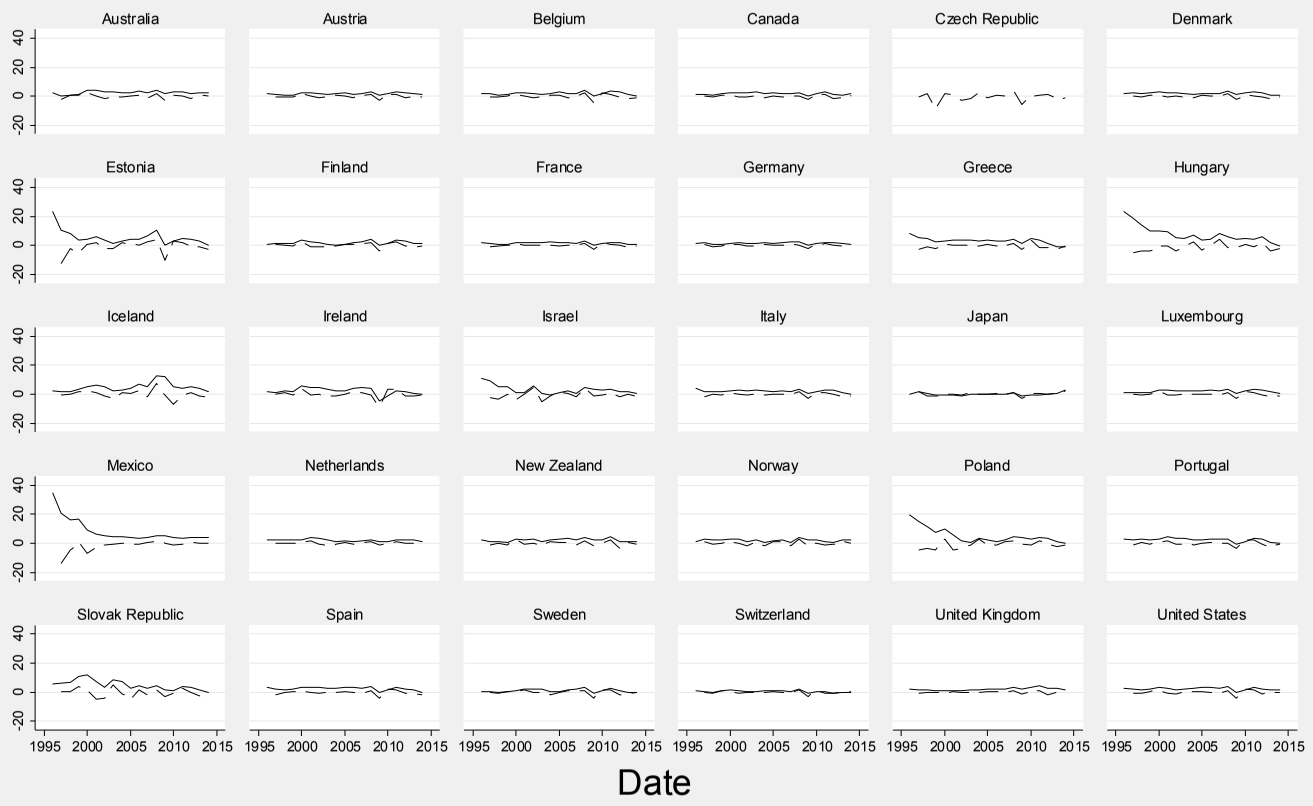
Variable	Obs.	Mean	Std. Dev.	Min.	Max.
CPI	389	-0.12	-0.02	-10.45	7.61
Fixed broadband	389	2.26	1.85	-12.41	19.03
Output gap	389	-0.30	0.11	-16.14	5.97
Trade openness	387	0.69	0.88	-31.58	24.99
Raw materials	389	10.30	15.02	-61.82	43.52
Foreign exchange	389	0.61	0.76	-21.03	16.77

Main variables used in the regression



Graphs by co1

Inflation (annual change of CPI in %) and its first differences; Mexico and Turkey not included as outliers



Fixed broadband penetration and its first differences