Does Internet Reduce Inflation?

Take-home Exam SØK3001 - Group 1278

May 14th, 2020

1 Introduction

Inflation is a measure of percentage growth in the general price levels of a country. Traditionally we expect it to be a function of the expected inflation and a number of other characteristics. Such characteristics may be unemployment, domestic prices, and other factors that determine the amount of imported inflation through trade. However, recent studies indicate that also globalization has an effect on inflation, having contributed to the declined inflation in recent years. A continuous trend with globalization is the increased usage of internet. One can argument that the internet leads to more symmetrical price information in competing industries and thereby contributes to keeping prices at lower levels. Internet usage also makes it easier for the everyday consumer to order imported goods, which contributes to globalisation and imported inflation. An interesting question to ask is whether the coinciding trend of increased internet usage and the declined inflation of recent years are related, or more specifically, if the internet has a negative effect on inflation.

In this paper we will empirically study the relationship between the internet and inflation using 30 countries with annual observations for the time period from 1995 to 2014. Using both an OLS and a fixed effect estimator, with and without lagged dependent variable we find a negative relationship between internet and inflation. However, when we in addition to this control for seasonality and shocks such as policy changes by adding indicator variables for the different time periods, we find no clear relationship between internet and inflation.

The contents of this paper are as follows: First, a description of the dataset that will be used. Thereafter, a baseline OLS model is applied to the data, before this is altered to an extended version using fixed effects, eventually adding a lag on the dependent variable, and finally adding year indicators. Then follows a section with a discussion of the results and the limitations we face with the analysis, and finally a section with an attempted conclusion on the relationship between internet and inflation.

2 Data

The dataset includes a set of variables that have been retrieved from various statistical websites. We have observations for the same 30 countries during the period from 1995 to 2014, implying that we are in a panel data context.

As mentioned in the introduction, the primary focus of this paper will be to investigate whether we have evidence to suggest a negative relationship between the internet and the level of inflation. Inflation is measured as the consumer price index of a commodity basket, and internet is measured as the amount of broadband-subscriptions divided by the total population. This method yields an attempted measure for the proportion of the population that has access to internet, but it should be noted that households tend to share subscriptions, so the measurement may not truly indicate how many people have internet access.

Figure 1 displays a scatterplot for inflation (Consumer Price Index) and broadband subscriptions (Internet) per capita. The fitted line suggests a negative relationship between the two variables at first sight, and the purpose of this paper will be to discuss whether or not this relationship is causal.

In order to look at the relationship between internet and inflation, more factors need to be taken into account. Table 1 provides us with descriptive statistics of the variables of interest in our dataset, which in total consists of 600 observations. Firstly, it is important to note that the panel is highly unbalanced, meaning that we have many missing observations. For instance, the variables for internet and telephone subscriptions both have approximately 150 missing values.

The consumer price index is a measure of inflation, in percentage levels. On average, we see from Table 1 that this lies at about 3%. Internet is a measure of broadboand subscriptions per capita, and has an average of 0.18 over time. It never exceeds 46% of the population, which seems like an underestimation of how many people actually have access to the internet, especially considering that we have years as recent as 2014 in our dataset. The reason for this is low percentage is probably that more members in the same household tend to use the same internet subscription, as mentioned above. Other variables are the commodity price index, output gap, real exchange rate, trade openness, unemployment, telephone subscriptions and the oil price. Many of these are natural to include in a model for inflation, as they capture the effects of domestic price changes and imported inflation. We note that the variable for telephone subscriptions might help determine unique variation between internet subscriptions and inflation as an instrumental variable, if we face problems of endogeneity. It should also be noted that our dataset does not contain any variable for the rent or national debt, although economic intuition suggests that such variables might be important when explaining inflation.

3 Baseline Model

Firstly, we will apply pooled OLS estimation to the following baseline model:

$$inflation_{it} = \beta_0 + \beta_1(internet100_{it}) + \chi'_{\mathbf{it}}\gamma + v_{it} \tag{1}$$

where i indicates the specific country and t is the year indicator. $inflation_{it}$ measures the inflation for country i at time t, and $internet100_{it}$ measures the number of fixed broadband-subscriptions per 100 capita. The variable is generated from multiplying the internet-variable in the dataset with 100, and will be easier to interpret than the original $internet_{it}$ variable in our dataset. $\chi'_{\mathbf{it}}\gamma$ represents all other control factors that are included in the model in order to avoid an omitted variable bias, and is v_{it} is the error term which we assume to be well-behaved.

When we run a pooled OLS regression on this data set, we treat it as a pooled cross-section, meaning that we assume independently sampled random observations from the population. As we know that we are following the same countries over time, we know that this must be violated, but we will still apply the pooled OLS baseline model as a basis for comparison to the extensions we will make in the next section.

The results of the OLS regression on equation (1) is reported in Table 2. It should be noted that the sample size of the regression decreases as we add more controls, which is due to the missing observations in our dataset. Column (1) shows the raw correlation between internet and inflation. The result here indicates that an additional broadband-subscription per 100 capita reduces inflation by -0.032%-points, ceteris paribus. As expected, we see a negative relationship, but the estimate is expected to be biased as the model probably suffers from omitted variable bias.

Column (2) extends the model to take into account the output gap, unemployment rate, commodity price index and oil price. We see that the estimated effect of internet on inflation has increased. We now expect that an additional broadband-subscription per 100 capita reduces inflation by -0.079%-points, ceteris paribus. The commodity price index and the oil price are included in order to take into account that prices affect inflation. Seperately they are statistically insignificant, but they are jointly significant. They have a high correlation, making it hard to separate their ceteris paribus effects, but together they contribute to explaining inflation and should therefore be included in the model. We expect oil prices to have a greater significance in some economies than others.

In column (3) we additionally account for the real exchange rate and trade openness. The Breusch-Pagan test suggest that this regression suffers from heterogeneity, and we therefore report heterogeneity-robust standard errors. The estimated effect of an additional internet subscriptions per 100 capita on inflation is estimated to be -0.085%-points. The additional explanatory variables that are added here are meant to capture the effect of imported inflation. Separately they are statistically insignificant, but they are jointly significant. Similarly to the effects capturing domestic prices, it is hard computing their ceteris paribus effects, but they should still be included in the model.

Something column (2) and (3) both have in common is that they strongly suggest unemployment to be insignificant. This seems surprising given that economic theory suggests unemployment to have a strong effect on inflation. This surprising result might indicate that we have misspecified our model and should apply extensions. In our simple model we have not taken into account the unobserved heterogeneity in the different countries, neither the possible seasonality. Maybe our key variables are correlated with country-specific properties that do not vary as over time, such as educational levels or national debt. It seems appropriate to expand our model in order to take possible unobserved heterogeneity into account, especially since we in the regression reported in column (3) find evidence suggesting heterogeneity.

4 Extensions

We expand the analysis by now treating our data as longitudinal, meaning that we assume that a random population was drawn in the first time period, which we then continue following across time. The expanded regression equation now takes the form:

$$inflation_{it} = \beta_0 + \beta_1 internet100_{it} + \chi'_{\mathbf{it}}\gamma + a_i + u_{it} \qquad (2)$$

where we have specified the composite error term $a_i + u_{it} = v_i$ from equation (1). a_i is the unobserved heterogeneity, while u_{it} is the well-behaved component of the error term. In a panel data context we can differentiate between data that varies for all individuals i and for all time periods t, and data that varies for all individuals (i) but is time-invariant. These are individual-specific characteristics that if not accounted for can result in heterogeneity and biased estimators. In an inflation context, such a characteristic may for instance be geography, since this affects a country's trade opportunities.

The fixed effects estimator will now be applied to the regression equation above. The choice of the fixed effects estimator, compared to first differencing or random effects comes from multiple reasons. Fixed effects is more efficient than first differencing if we assume that the error terms u_{it} are serially uncorrelated, meaning that they have stochastic properties. It also gives us greater opportunity to compare countries than with first differencing. Random effects would be beneficial if the key explanatory variable remained constant over time, and if we had reason to believe that there was no unobserved heterogeneity. However, we both have a time-varying key explanatory variable, and our discussion has suggested important omitted heterogeneity, such as domestic debt. This rules out the random effects estimator as a good option. Finally, we need to take into account that we are dealing with an unbalanced panel. This is problematic if the reason for the missing observations is related to the error term. The fixed effects estimator is preferred, seeing as it can capture the reasons for the lack of data as unobserved heterogeneity.

The results of the fixed effects regression are reported in Table 3. Column (1) reports a simple fixed effects regression where the time-demeaned $internet100_{it}$ is the only dependent variable. This regression implies that one additional internet subscription per 100 capita is expected to decrease inflation by -0.021%-points, ceteris paribus. However, as previously discussed, there are many other factors affecting inflation that we should include. Column (2) and (3) expand the regression with the same control variables as we used in our pooled OLS estimation, but they are now estimated using a fixed effects estimator. Column (2) reports that one additional internet subscription per 100 capita is expected to decrease inflation by -0.053%-points, ceteris paribus, while column (3) reports a reduction of -0.040%-points, cetris paribus. Looking at the results from our additional controls in column (3), we find that when the output gap increases by 1%-point compared to potential GDP, inflation is expected to increase by 0.148%-points. We find that when the unemployment rate increases by 1%-point, inflation is expected to decrease by -0.046%-points. However, this result is not statistically significant. When the price developments in world commodity markets increase by one dollar, inflation is expected to increase by 0.020%-points. When the oil price increases by one dollar, inflation is expected to decrease by -0.012%-points. This effect is not statistically significant alone, but jointly significant with commodity prices. An increase in the real effective exchange rate by one dollar is expected to decrease inflation by -0.047%-points. And finally, an increase in the traded merchandise of 1%-point is expected to decrease inflation by -0.011%-points. This effect is not statistically significant alone, but jointly significant with the real exchange rate.

4.1 Lagged dependent variable

Another extension that can be done is to account for how the dependent variable might depend on itself. Economic theory suggests that inflation is greatly affected by expectations through wage negotiations. These expectations are formed by observing the previous level of inflation. Therefore, it would be reasonable to suggest that the model should take into account a lagged value of inflation itself, representing this expected inflation variable. We expand the panel data equation to take the following form:

$$inflation_{it} = \beta_0 + \beta_1 inflation_{it-1} \beta_2 internet100_{it} + \chi'_{\mathbf{it}}\gamma + a_i + u_{it} \qquad (3)$$

The results of the regression using equation (3) are reported in Table 4. We find that the lagged value of inflation is indeed important in determining current inflation. For all three versions of the regression in the table we find that a 1%-point increase in previous inflation is expected to increase current inflation by approximately 0.3%-points. When comparing column (3) in Table 4 with column (3) in Table 3, we find that all explanatory variables have stronger significance in the lagged version. Our previously omitted lagged variable led to a serial correlation in the error terms and an omitted variable bias in our estimates, and this new model seems better suited. Column (1) reports that one additional internet subscription per 100 capita is expected to decrease inflation by -0.017%-points, ceteris paribus. Column (2) reports that one additional internet subscription per 100 capita is expected to decrease inflation by -0.073%-points, ceteris paribus. And finally column (3) reports that one additional internet subscription per 100 capita is expected to decrease inflation by -0.060%-points, ceteris paribus. When controlling for the dependent lag (and multiple control factors), we find that the effect of internet on inflation appears to be stronger compared to our first model extension.

4.2 Time indicators

Finally, we make an extension where we include yearly dummy variables in order to control for seasonality and policy changes. This is a natural approach, seeing as many of our variables are expected to follow a time trend depending on the state of the economy (seasonality), and that policy changes (such as trade policies) may have a large impact on our model. Our regression equation takes the form:

$$inflation_{it} = \beta_0 + \beta_1 internet100_{it} + \chi'_{\mathbf{it}}\gamma + \eta_t + a_i + u_{it} \tag{4}$$

Where η_t represents yearly dummies. The results of the regression is reported in Table (5) Here the commodity price index and the oil price get omitted due to high collinearity. This could be explained by how they previously captured shocks or time trends in our data, but now we are directly controlling for such shocks and time trends through using time dummies. However, this is not the most important result to note. Now that we have controlled for seasonality and policy changes, the internet variable is no longer statistically significant. What does this mean? Perhaps we are facing a spurious relationship between the development of increased internet subscriptions in recent years and the decline in inflation. It seems likely that other factors than the internet is the explanation for why we have seen a deflationary trend in recent years.

Looking at the further results in column (3), we find that when the output gap increases by 1%-point compared to potential GDP, inflation is expected to increase by 0.111%-points. We find that when the unemployment rate increases by 1%-point, inflation is expected to decrease by -0.034%-points. However, this result is not statistically significant. The commodity price index and oil price variables are omitted due to high collinearity. An increase in the real effective exchange rate by one dollar is expected to decrease inflation by -0.036%-points. And finally, an increase in the traded merchandise of 1%-point is expected to decrease inflation by -0.005%-points. This effect is not statistically significant alone, but jointly significant with the real exchange rate.

5 Discussion and Limitations

Overall, both the pooled OLS, the fixed effects and the fixed effects with a lag seem to suggest a negative relationship between internet and inflation. Pooled OLS suggests a stronger negative effect than the other estimation methods, but this estimation is biased and not valid for inference, since it assumes new random samples for all time periods and that it does not account for time-invariant factors a_i. When we use fixed effects, the effect of internet on inflation still appears negative, but now weaker than before. When a lag of the dependent variable is included, we find a stronger negative economic effect of internet on inflation, with stronger statistical significance. However, once we finally take seasonality into account by adding time indicators, we find weak to no statistical significance of internet subscriptions on inflation.

All though the fixed effects method solves for issues with random sampling and time-invariant factors, there are other issues that may weaken our results. Firstly, by using the fixed effects estimator we have implicitly assumed there to be enough variation over time in our explanatory variables. In other words, we do not simply require them to change over time, but to change sufficiently fast. When looking into the internet subscription variable, we notice that it often takes the same value for several years in a row, and only changes by small margins. This yields problems when trying to time-demean the data, and may lead to inconsistent and biased estimates. Although the proportion of the population with an internet subscription varies too much for it to be beneficial to use a random effects estimator, it might still vary too little to make the fixed effects estimation (or the first difference estimator, for that matter) efficient.

Furthermore, the model is likely to suffer from endogeneity. As previously discussed, internet subscriptions per capita most likely has some measurement error. This can lead to endogeneity and will result in a the bias of the OLS estimate towards zero. In other words, if this variable in fact suffers from measurement error, our estimated effect on inflation will be an underestimation compared to the true population value. If endogeneity is the case, this should be solved for using an instrumental variable. A possible extention of the work reported in this paper could be to test whether the phone subscription variable in our dataset may work as an instrumental variable for internet subscriptions. It is expected to be correlated with internet subscripstions, and perhaps more representative for how many residents actually have internet access.

A question we also should ask is why it is so difficult to estimate the effect of unemployment on inflation in the pooled OLS and fixed effects estimation, when economic theory so strongly suggests unemployment to have an effect in inflation. The answer to this question may be that there is some endogeneity caused by the simultaneous relationship between inflation and unemployment, due to a two-way mechanism of determining wages in the labour market. On one side, more unemployment leads to lower wages, which contributes to decreased inflation. But on the other side, an expected increase in consumer prices will put pressure on higher wages and therefore result in decreased unemployment. If unemployment and inflation have such a simultaneous relationship, this is a good explanation for why we experience issues with using unemployment in our regressions, and overlooking it is a serious shortcoming to our regression.

Another issue which is likely to make some of our estimates biased is if other important factors are omitted. Using panel data methods that control for unobserved heterogeneity, we need not worry about omitted time-invariant factors, but we should be worried about factors that vary across both individuals and time periods. In the inflation context our main concern may be that we have no variable for rent or national debt. This is likely to be correlated with both our explanatory variable, and some of our control variables, for instance the commodity price index and oil price. Their estimates are likely to capture some of the effects of the omitted variables, and are therefore likely to suffer from a bias. This will also lead to a problem of heteroskedasiticty in the error terms. If we have omitted a variable with a lag, we will even have serially correlated error terms and the fixed effects estimator is no longer more efficient than using first differences. In this paper we simply assumed no serial correlation of error terms without testing for it, and it should be noted that it is a very strong assumption which ideally should have been tested before it was imposed.

6 Conclusion

Based on the analysis in this paper it is difficult to conclude that the growth in internet usage has a negative effect on inflation. Although many of our regressions suggest such a negative relationship, the picture changes when we account for seasonality, and it would be wrong not to account for it in a context which is this likely to be seasonally dependent. Both inflation, output gaps, unemployment prices and exchange rates are likely to be seasonal, and trade openness is responsive to policy changes. The results of this paper make too strong suggestions of a spurious relationship between inflation and internet to conclude that internet usage increases inflation.

These results do not mean that other factors contributing to globalization are not worth looking at as explanations for deflationary trends, further research should on the contrary look explicitly into such factors. The last model we estimate indicates that increased trade has a deflationary effect, and this might capture some of the effect of globalization on inflation. However, we should be careful making conclusions based on the regressions in this paper, as it it likely to suffer from great issues, such as endogeneity, too low variance in the explanatory variables, important omitted variables, heterogeneity and simultaneous relationships.

Figures

Scatterplots between CPI and Internet

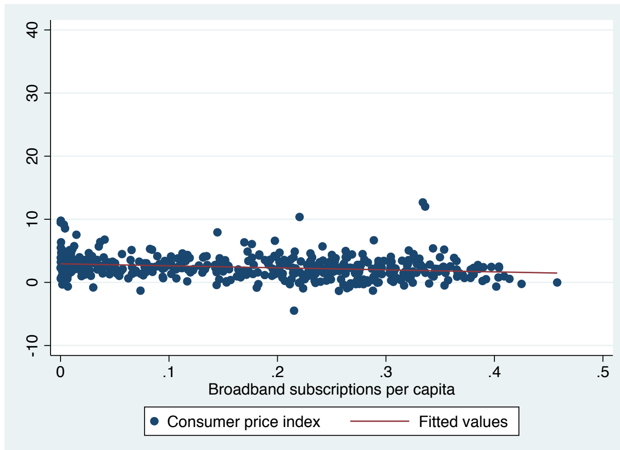

Figure 1: Scatterplot in levels

Tables

Table 1: Descriptive statistics

	count	mean	sd	min	max
Inflation	600	3.052	3.897753	-4.479938	34.99928
Internet	451	.1808245	.1236193	.0000291	.4578626
Commodity price index	540	109.5078	57.09809	36.25427	195.4666
Output gap	558	-.0979987	3.057601	-12.69645	13.61854
Real exchange rate	580	98.15309	11.42123	62.29737	137.1887
Trade openness	593	66.84535	36.18486	14.60459	180.891
Unemployment	600	7.627167	4.07749	1.8	27.2
Telephone subscriptions	450	.4525873	.1342062	.1169193	.7446185
Oil price	600	53.28571	30.84375	14.36	99.725
N	600				

Table 2: Baseline OLS regression, internet and inflation

	(1)	(2)	(3)
Internet	–0.032***	–0.079***	–0.085***
	(0.007)	(0.012)	(0.012)
Output gap		0.154***	0.157***
		(0.033)	(0.038)
Unemployment		–0.003	0.001
		(0.026)	(0.026)
Commodity price index		0.015	0.017
		(0.015)	(0.011)
Oil price		0.006	0.008
		(0.028)	(0.021)
Real exchange rate			–0.066***
			(0.014)
Trade openness			0.009***
			(0.002)
R-Squared	0.05	0.18	0.30
N	451	421	406

Source: see text for explanation.

The dependent variable is the Consumer Price Index (inflation).

Internet is measured per 100 capita.

All variables are explained in Table 1.

Standard errors in parenthesis. Robust standard erros for column (3)

Table 3: Fixed effects regression

	(1)	(2)	(3)
Internet	–0.021**	–0.053**	–0.040*
	(0.008)	(0.021)	(0.022)
Output gap		0.134***	0.148***
		(0.039)	(0.044)
Unemployment		–0.029	–0.046
		(0.047)	(0.038)
Commodity price index		0.013	0.020*
		(0.011)	(0.010)
Oil price		–0.001	–0.012
		(0.021)	(0.019)
Real exchange rate			–0.047***
			(0.015)
Trade openness			–0.011
			(0.009)
R-Squared	0.03	0.17	0.23
N	451	421	406

Source: see text for explanation.

The dependent variable is the Consumer Price Index (inflation)

Internet is measured per 100 capita.

All variables are explained in Table 1.

Robust standard errors in parenthesis.

Table 4: Fixed effects regression with lagged dependent variable

	(1)	(2)	(3)
Inflation_{t-1}	0.299***	0.303***	0.290***
	(0.053)	(0.068)	(0.066)
Internet	–0.017***	–0.073***	–0.060***
	(0.006)	(0.013)	(0.013)
Output gap		0.150***	0.151***
		(0.037)	(0.042)
Unemployment		0.005	–0.020
		(0.044)	(0.036)
Commodity price index		0.012	0.017
		(0.010)	(0.010)
Oil price		0.010	0.001
		(0.019)	(0.018)
Real exchange rate			–0.039***
			(0.011)
Trade openness			–0.005
			(0.008)
R-Squared	0.12	0.28	0.32
N	451	421	406

Source: see text for explanation.

The dependent variable is the Consumer Price Index (inflation)

Internet is measured per 100 capita.

All variables are explained in Table 1.

Robust standard errors in parenthesis.

Table 5: FE regression with lagged dependent variable and year dummies

	(1)	(2)	(3)
$Inflation_{t-1}$	0.359***	0.307***	0.295***
	(0.040)	(0.051)	(0.040)
Internet	–0.001	0.017	0.022
	(0.014)	(0.012)	(0.014)
Output gap		0.108*	0.111*
		(0.061)	(0.065)
Unemployment		–0.016	–0.034
		(0.052)	(0.051)
Commodity price index		0.000	0.000
		(.)	(.)
Oil price		0.000	0.000
		(.)	(.)
Real exchange rate			–0.036***
			(0.009)
Trade openness			–0.005
			(0.006)
R-Squared	0.44	0.43	0.46
N	451	421	406

Source: see text for explanation.

The dependent variable is the Consumer Price Index (inflation)

Internet is measured per 100 capita.

All variables are explained in Table 1.

Robust standard errors in parenthesis.

Do-file

```
**********************

* Take Home Project

**********************
clear all
use "/Users/bruker/Documents/  konometri  /Datasets/data_s20_final.dta

* Choosing working directory
 cd "/Users/bruker/Documents/  konometri  "

* Defining that we are in a panel data context
xtset country year

*****************************************************************

* SUMMARY STATISTICS

*****************************************************************


* Summarystat

ssc install estout, replace

eststo clear
estpost sum cpi internet hwwi gdpgap fx tradeopen unemp phone oilprice
esttab using summarystat.tex, replace cells("count mean sd min max")
//varlabels(crmrte "Crime p.c." polpc "Police p.c." pctmin80 "\% Minority, 1980"
"Density" taxpc "Tax Revenue p.c." urban "Urban"  ) ///
title("Descriptive statistics\label{summarystat}") ///

scatter cpi internet  || lfit cpi internet
graph export "scatter.pdf", as(pdf) replace

scatter cpi linternet || lfit cpi linternet
graph export "scatterlog.pdf", as(pdf) replace

* Measuring internet per 100 capita
gen internet100 = internet*100
label var internet100 "Broadband subscriptions per 100 capita"
```

```
*****************************************************************
* Per capita or per 100 capita
*****************************************************************
reg cpi internet
reg cpi internet100

reg cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen

*RESET test
ovtest

*****************************************************************
* Heteroskedasticity
*****************************************************************
reg cpi internet100
hettest, rhs iid
reg cpi internet100 gdpgap unemp hwwi oilprice
hettest, rhs iid
reg cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen
hettest, rhs iid

//Suggests heteroskedasticity, should use hetereoskedasticity-robust (white) err

*****************************************************************
* BASELINE OLS
*****************************************************************

reg cpi internet100
reg cpi internet100 gdpgap unemp hwwi oilprice
test hwwi oilprice

reg cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen, robust
test fx tradeopen
test hwwi oilprice fx tradeopen
test fx unemp

eststo clear
```

```
eststo: reg cpi internet100
est save "b1", replace
eststo: reg cpi internet100 gdpgap unemp hwwi oilprice
est save "b2", replace
eststo: reg cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen, robust
est save "b3", replace

forvalues i=1(1)3 {
est use "b`i'"
est store b`i'
}

estout  b1 b2 b3  ///
using "ols.tex", stats(r2 N, fmt(2 0) labels("R-Squared" "N"))
///
cells("b(star label( )  fmt(3))" " se(par label( ) fmt(3))") ///
 varlabels(internet100 "Internet" gdpgap "Output gap" fx "Real exchange rate" tra
"Unemployment" oilprice "Oil price" hwwi "Commodity price index" )
keep(internet100 gdpgap fx tradeopen unemp oilprice hwwi) ///
replace mlabels(none) collabels(none) ///
starlevels( * 0.1 ** 0.05 *** 0.01) nostardetach   label msign (--)
varwidth(12)  style(tex) ///
title(Baseline OLS regression, police and crime \label{ols}) ///
prehead("\begin{table}[!h]\begin{center}" ///
"\begin{threeparttable}\topcaption{@title}" ///
"\begin{tabular}{@{}l  c c c    } \toprule "  ///
"& (1) & (2) & (3)  \\  \cmidrule(r){2-4} " ) ///
prefoot("\midrule" ) ///
postfoot("\bottomrule\end{tabular}" ///
"\begin{tablenotes}"  ///
"\item Source: see text for explanation." ///
"\item The dependent variable is the Consumer Price Index (inflation)." ///
"\item Internet is measured per 100 capita." ///
"\item All variables are explained in Table 1." ///
"\item Standard errors in parenthesis. Robust standard erros for column (3) " //
"\end{tablenotes} \end{threeparttable} \end{center} \end{table}" )

*****************************************************************

* BASELINE FE

*****************************************************************

* Testin for serial correlation of error terms
reg D.cpi D.internet100, ro
predict uhat1, residual
```

```
reg D.uhat D.L.uhat

xtreg D.cpi D.internet100 D.gdpgap D.unemp D.hwwi D.oilprice , fd ro
predict uhat2, residual
reg D.uhat2 D.L.uhat2

xtreg D.cpi D.internet100 D.gdpgap D.unemp D.hwwi D.oilprice D.fx D.tradeopen , f
predict uhat3, residual
reg D.uhat3 D.L.uhat3


* FE within + testing for serial correlation

xtreg cpi internet100, fe ro
predict uhat1, residual
reg D.uhat D.L.uhat

xtreg cpi internet100 gdpgap unemp hwwi oilprice, fe ro
test hwwi oilprice
predict uhat2, residual
reg D.uhat2 D.L.uhat2

xtreg cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen, fe ro
test hwwi oilprice fx tradeopen
test fx tradeopen
predict uhat3, residual
reg D.uhat3 D.L.uhat3

eststo clear

eststo: xtreg cpi internet100, fe ro
est save "b1", replace
eststo: xtreg cpi internet100 gdpgap unemp hwwi oilprice, fe ro
est save "b2", replace
eststo: xtreg cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen, fe ro
est save "b3", replace

forvalues i=1(1)3 {
est use "b`i'"
est store b`i'
}


estout  b1 b2 b3 ///
using "fe.tex", stats(r2 N, fmt(2 0) labels("R-Squared" "N"))
///
```

```
cells("b(star label( )  fmt(3))" " se(par label( ) fmt(3))") ///
 varlabels(internet100 "Internet" gdpgap "Output gap" fx "Real exchange rate" tra
"Unemployment" oilprice "Oil price" hwwi "Commodity price index")
keep(internet100 gdpgap fx tradeopen unemp oilprice hwwi) ///
replace mlabels(none) collabels(none) ///
starlevels( * 0.1 ** 0.05 *** 0.01) nostardetach   label msign (--)
varwidth(12)  style(tex) ///
title(Fixed effects regression \label{fe}) ///
prehead("\begin{table}[!h]\begin{center}" ///
"\begin{threeparttable}\topcaption{@title}" ///
"\begin{tabular}{@{}l  c c c  c  } \toprule "  ///
"& (1) & (2) & (3) \\  \cmidrule(r){2-5} " ) ///
postfoot("\bottomrule\end{tabular}" ///
"\begin{tablenotes}"  ///
"\item Source: see text for explanation." ///
"\item The dependent variable is the Consumer Price Index (inflation)" ///
"\item Internet is measured per 100 capita." ///
"\item All variables are explained in Table 1." ///
"\item Robust standard errors in parenthesis. " ///
"\end{tablenotes} \end{threeparttable} \end{center} \end{table}" )



*****************************************************************

* BASELINE FE + lag of cpi

*****************************************************************

* FE within + testing for serial correlation

xtreg cpi L.cpi internet100 , fe ro

xtreg cpi  L.cpi internet100 gdpgap unemp hwwi oilprice , fe ro
test hwwi oilprice

xtreg cpi L.cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen , fe ro
test hwwi oilprice fx tradeopen
test fx tradeopen

eststo clear

eststo: xtreg cpi L.cpi internet100 , fe ro
est save "b1", replace
eststo: xtreg cpi L.cpi internet100 gdpgap unemp hwwi oilprice , fe ro
est save "b2", replace
```

```
eststo: xtreg cpi L.cpi internet100 gdpgap unemp hwwi oilprice fx tradeopen, fe
est save "b3", replace

forvalues i=1(1)3 {
est use "b`i'"
est store b`i'
}


estout  b1 b2 b3 ///
using "felag.tex", stats(r2 N, fmt(2 0) labels("R-Squared" "N"))
///
cells("b(star label( )  fmt(3))" " se(par label( ) fmt(3))") ///
 varlabels(L.cpi "Inlflation_{t-1}" internet100 "Internet" gdpgap "Output gap" f
"Unemployment" oilprice "Oil price" hwwi "Commodity price index")
keep(L.cpi internet100 gdpgap fx tradeopen unemp oilprice hwwi) ///
replace mlabels(none) collabels(none) ///
starlevels( * 0.1 ** 0.05 *** 0.01) nostardetach   label msign (--)
varwidth(12)  style(tex) ///
title(Fixed effects regression with lagged dependent variable \label{fe}) ///
prehead("\begin{table}[!h]\begin{center}" ///
"\begin{threeparttable}\topcaption{@title}" ///
"\begin{tabular}{@{}l  c c c  c  } \toprule "  ///
"& (1) & (2) & (3) \\  \cmidrule(r){2-5} " ) ///
postfoot("\bottomrule\end{tabular}" ///
"\begin{tablenotes}"  ///
"\item Source: see text for explanation." ///
"\item The dependent variable is the Consumer Price Index (inflation)" ///
"\item Internet is measured per 100 capita." ///
"\item All variables are explained in Table 1." ///
"\item Robust standard errors in parenthesis. " ///
"\end{tablenotes} \end{threeparttable} \end{center} \end{table}" )

******************************************************************

* BASELINE FE + lag of cpi + time dummies

******************************************************************

* FE within + testing for serial correlation

xtreg cpi L.cpi i.year internet100, fe ro

xtreg cpi  L.cpi i.year internet100 gdpgap unemp hwwi oilprice, fe ro
test hwwi oilprice
```

```
xtreg cpi L.cpi i.year internet100 gdpgap unemp hwwi oilprice fx tradeopen, fe r
test hwwi oilprice fx tradeopen
test fx tradeopen

eststo clear

eststo: xtreg cpi L.cpi i.year internet100, fe ro
est save "b1", replace
eststo: xtreg cpi L.cpi i.year internet100 gdpgap unemp hwwi oilprice, fe ro
est save "b2", replace
eststo: xtreg cpi L.cpi i.year internet100 gdpgap unemp hwwi oilprice fx tradeop
est save "b3", replace

forvalues i=1(1)3 {
est use "b`i'"
est store b`i'
}


estout  b1 b2 b3 ///
using "felagdummy.tex", stats(r2 N, fmt(2 0) labels("R-Squared" "N"))
///
cells("b(star label( )  fmt(3))" " se(par label( ) fmt(3))") ///
 varlabels(L.cpi "Inlflation_{t-1}" internet100 "Internet" gdpgap "Output gap" f
"Unemployment" oilprice "Oil price" hwwi "Commodity price index")
keep(L.cpi internet100 gdpgap fx tradeopen unemp oilprice hwwi) ///
replace mlabels(none) collabels(none) ///
starlevels( * 0.1 ** 0.05 *** 0.01) nostardetach   label msign (--)
varwidth(12)  style(tex) ///
title(Fixed effects regression with lagged dependent variable and year dummies \
prehead("\begin{table}[!h]\begin{center}" ///
"\begin{threeparttable}\topcaption{@title}" ///
"\begin{tabular}{@{}l  c c c  c  } \toprule "  ///
"& (1) & (2) & (3) \\  \cmidrule(r){2-5} " ) ///
postfoot("\bottomrule\end{tabular}" ///
"\begin{tablenotes}"  ///
"\item Source: see text for explanation." ///
"\item The dependent variable is the Consumer Price Index (inflation)" ///
"\item Internet is measured per 100 capita." ///
"\item All variables are explained in Table 1." ///
"\item Robust standard errors in parenthesis. " ///
"\end{tablenotes} \end{threeparttable} \end{center} \end{table}" )


*****************************************************************
```

```
* BASELINE FE + phone as IV for internet

******************************************************************

* Note: Not included in paper discussion

* First stage regression to test for relevance
xtreg internet100 phone, fe ro

xtivreg cpi (internet100=phone) gdpgap unemp hwwi oilprice fx tradeopen, fe
* Note: Option robust not allowed
```