The effect of increased e-commerce on inflation

By: Frida Calson-Öhman

Supervisor: Mikael Stenkula

Södertörns högskola | Institution for Social Sciences

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Abstract

The purpose of this essay is to answer the following questions: Has the increased e-commerce had a negative impact on the inflation, and is the effect decreasing? and: Is there a long term and/or short term effect by the increased e-commerce on the inflation? To answer the first question a fixed effects regression model is applied, based on panel data for 28 European countries for the time period 2006-2017. The regression obtains results that support the hypothesis that the increased e-commerce has had a negative effect on inflation. Furthermore, the result indicates that the effect is decreasing. The second question is answered with the help of an Error Correction Model and time series data for Sweden during the period 2006-2017. The result shows that there is an error correction towards a long run equilibrium and the short term estimates indicate that there is a negative short term effect of the increased e-commerce on inflation. These results are in line with the hypothesis of this essay as well as previous studies that have examined similar questions.

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1. Introduction

The digitization has been spreading fast since it took off in the 1990's. One part of the digitization is the e-commerce which has become more common the last years, both in retail and business-to-business markets. There has been development in specific methods for e-commerce which has made the selling process faster and more efficient. Eurostat (2018) reports that during the period 2008-2016 there has been a significant increase in e-commerce in the EU-28. The digitization has surly made an imprint on the economy and it has lately been discussed whether the increased e-commerce has affected the inflation (Riksbanken 2015).

E-commerce has created new markets and increased the consumer's choices, companies is not just competing with the closest companies geographically but also with similar companies from the whole world. Internet makes it possible for the consumers to compare prices and quality of the products which entails more price and quality conscious customers. This in turn leads to a higher competition and less market power among the companies. It gets harder for the companies to increase their prices which gives incentive to increase the productivity to retain or increase their margins (Riksbanken 2015). This reasoning suggests that the increased e-commerce might affect the inflation, therefore it would be interesting to examine this more closely.

Even though the value of e-commerce in EU is growing, the full potential is not utilized. It is likely that the market will develop even more the following years. The European Commission and the Commission's Digital Single Market strategy has a plan to boost the e-commerce by prevent geoblocking, promote customer trust through better protection and enforcement (European Commission 2018). Gerdesmeier (2009) from the European Central Bank suggest that the impact of the e-commerce can be expected to decline once a new equilibrium is established, i.e., when the spread of e-commerce has stabilised throughout the markets. However, the e-commerce is in a development phase which can take a prolonged period of time (Gerdesmeier 2009). It can be difficult to identify structural changes like this because the effects can vary over time, they can also be complex and problematic to predict. As long as the change is proceeding it will affect the inflation, but in the long run the inflation does not depend on structural changes. Basically, the effect is temporary although it can be relatively lasting

(Riksbanken 2015). Despite this it would be interesting to examine if there is any evidence of a temporary short term effect and if there is a maintaining long term effect.

There are previous studies have been examine similar subjects. Yi and Choi (2005) investigate the effect of the internet on inflation and receive significant results that there is a negative effect on inflation of an increased internet ratio. Coffinet and Perillaud (2017) have made a systematic overview study on the effects of the internet on inflation which indicate that in short term the increasing use of internet has a dampened the inflation. Nilssons and Mårtenssons (2015) study investigates the effect of increased e-commerce on inflation. They receive significant results that indicates that there is a negative impact of growing e-commerce on inflation. Eriksson and Berntsson (2017) have made a study that examine the long and short term effects of e-commerce on inflation. They receive significantly negative result of a long term causality. This essay will have a similar purpose as Nilsson and Mårtenson (2015) and Eriksson and Berntsson (2017), however, with a partially different approach.

The main purpose of this essay is to examine whether there has been a dampening effect on the inflation due to the increasing e-commerce and also if the effect is decreasing. Furthermore the essay will try to distinguish long term from short term effects. The essays questions are thus the following:

- *Has the increased e-commerce had a negative impact on the inflation, and is the effect decreasing?*
- *Is there a long term and/or short term effect by the increased e-commerce on the inflation?*

To answer the first question, a fixed effects regression based on panel data for 28 countries the period 2006-2017 is used. The results indicates that there is a negative effect of increased e-commerce on inflation and that the effect is decreasing. The second question is answered with help of a Vector error correcting model based on time series data for Sweden during the same period. The result shows support for an error correction towards the long run equilibrium and a negative short term effect of the increased e-commerce on inflation.

A brief outline is recounted to get an overview of the essay. In chapter two, previous studies that examined similar subjects as this essay are summarized. Next, in chapter three, the

underlying theories for hypothesis in this essay are described. Further, in chapter four, an account of the data is presented which includes a description and explanation of the variables used in this essay as well as the sources, shortcomings and descriptive statistics of the material. Furthermore, in chapter five, the essay's models are presented which underlie the regressions and tests that are preformed to answer the essays questions. In chapter six, the results and analysis of the essay is presented. Following is a summary discussion and conclusion in chapter seven.

2. Previous studies

The purpose of this essay is to examine whether there has been a dampening effect on the inflation due to the increased e-commerce. Furthermore, it will examine if there is a long term and/or short term effect. There are previous studies that have examine similar subject but only a few with resembling purpose.

Yi and Choi (2005) was one of the first to examine a similar subject but with somewhat different variables relative to those this essay includes. They investigate the effect of the internet on inflation. Their hypothesis is that the internet improves productivity and thus will reduce inflation. They use a pooled OLS model with random effects on cross country panel data from 1991 to 2000 to answer their question. Their independent variable, Internet, is defined by the log of the ratio of internet users to total population. Their results shows that when internet ratio increases by one percentage point, the inflation decreases by 0.043 percentage points. They thereby mean that internet can affect the traditional relationship between money and inflation. They suggest that the authorities should be more careful with switching to contractionary monetary policy, because internet development can dampening the inflation in the new economy.

Nilsson and Mårtensson (2015) investigate whether the growing e-commerce is pushing down inflation. They use panel data for 30 European countries during the time period 2002-2014. The data for the variable e-commerce is here gathered from Eurostat and is measured as the percentage of the population that has been shopping through internet at some point the last three months. The estimation of the model is based on a reconstructed Phillips curve. Instead of unemployment they use output. They also choose to control for the variables money supply and exchange rate. With a regression analysis they receive a result that support their hypothesis of a negative impact of growing e-commerce on inflation. When they shorten the time period to the most recent years, which is the time when e-commerce has been growing more rapidly, the connection becomes even stronger. The effect of the connection is also stronger in countries with initially lower levels of e-commerce than in countries with relatively high level which indicate that there is a short term effect.

Coffinet and Perillaud (2017) have made a systematic overview study about the effects of the internet on inflation. They investigate whether the development of e-commerce has an effect

on inflation in the short, medium, and long term and identify channels from which such effects could originate. They achieve mixed effects on inflations mainly via three channels, the use of electronic commerce, the consequences on productivity and labour and the direct effect on the price index. They also give evidence that online prices provide information on future price developments. In the short term it is likely that the increasing use of internet has a disinflationary effect. They also state that the long term effects is difficult to identify.

Eriksson and Berntsson (2017) also examine the impact of e-commerce on inflation through time series and an error correcting model. By using this model it is possible to estimate both short and long term relationship. They use quarterly data for USA over the period 2000-2016. As a measure for inflation they use consumer price index. They examine the effects of the channels consumer-, producer-, and market level. The error correction model shows that e-commerce has a negative effect on inflation which is in line with the expectations. They also receive a significantly negative result of the error correction term, which indicate that there is long term causality. There is a correction to equilibrium of 39% each period.

3. Theory

The aim of this essay is to examine whether the increased e-commerce has a dampening effect on the inflation and if there is a short and/or long term effect. This part of the essay will describe different theories of which the effect can be explained by. It will start with a more in depth explanation of the main factors that can affects the inflation in order to further clarify the effect of e-commerce. E-commerce affects the inflation through different channels, consumers, producers and the market as a whole. Therefore, it is relevant to look closer at each channel and try to explain the main theories of the effects.

3.1 Inflation

Inflation can be explained broadly as an increase in the prices of goods and services over an extended period which in turns leads to a decline in the value of money and thereby its purchasing power. When measuring inflation Consumer Price Index (CPI) is the most common measure to use. The inflation is effected by several aspects, e.g., interest rate, money, liquidity (Gerdesmeier 2009).

Prolonged periods of high inflation is often connected with high monetary growth. Variations in aggregated demand, technological changes or commodity price shocks may affect price changes in short term but in long term the effects can be offset by adjustment of money policy. Inflationary pressures occur when there are shocks or unexpected changes in economic development which causes the consumers or producers to act differently. When deflationary pressures emerge, either aggregate demand falls or aggregate supply increase. Generally this is counteracted with monetary policy lowering the interest rate to ensure price stability (Gerdesmeier 2009). When prices have been falling for a longer period it can have a different kind of effect. Consumers are aware that the prices are falling and they have perception of that they will keep falling therefore they are waiting to buy. This is common in the housing market. When this occurs in a larger scale it can affect the whole market economy and result in deflation. If the deflation is strong it can result in a decreasing wages and termination of employees. To counteract deflation the central bank can produce more money or lower the interest rate (Riksbanken 2017).

There is empirical evidence that most prices are fixed for some time. It is common that companies do not instantly adjust the prices they charge in response to changes in supply or demand. The reason for this may be because of long term contracts between firms and customers, which reduce uncertainties and costs associated with frequent negotiations. Companies may also keep their prices steady in order to not upset their regular customers with frequent price changes. Another reason is the way the markets are structured. To change prices and to calculate new prices is costly. Prices are thus sticky in the short run. However, in the long run, prices adjust to new supply and demand (Gerdesmeier 2009).

3.2 E-Commerce

Consumers are nowadays generally more informed when it comes to prices and quality of different products. There are several websites that compare prices which makes it possible for the consumers to get the best deal. This is not only applying to the products or services that are being purchased on the internet but also the ones that can be consumed in regular commerce. The increased amount of price- and quality-aware consumers and increased amount of options are both contributing to higher market competition which makes it harder for the producers to increase their prices. This contributes to a break in the price trend which has a direct effect on the consumer price index (Riksbanken 2015).

The virtual value chain has numerous of advantages compared to the physical value chain (Kannan & Kopalle 2001). The company increases the amount of potential consumers by selling a product online. This makes it possible for the company to take advantage of the economics of scale, which refers to the marginal cost per unit, that arise from an increasing total output of a product. There is no need for a physical store and staff when selling online, which is another cost-reducing aspect. Another benefit is the lower transaction cost (Coppel 2000). The producers are not only competing with similar companies that are positioned geographically close to them but with similar companies all over the world. This contributes to a higher market competition and lower market power. It also gives the producers incentive to be more productive, to be able to push the cost and, thereby, also be able keep or increase their margins. When the company lower their costs in any way it will become possible for them to lower the price of the products (Riksbanken 2015).

In the early phase of diffusion of the e-commerce there are some early adopters who experience efficiency gains by using the internet. However, the efficiency gains from a lower marginal production cost is rather small because of the small amount of firms on the market. When more companies invest in e-commerce, more suppliers of intermediate goods also has incentive to do so. The marginal production cost will decrease which attracts other companies to invest in e-commerce and the efficiency gains increase for all users. The profit is relatively high in the initial phase and as more companies enter the market there is a rising competition. As the market is growing the mark-up margin on production decreases and thereby also the profit. If a company has a higher market power they also has some power over pricing depending on the price elasticity. This means that they can choose a price that is higher than the marginal price of the good and thereby get a higher profit margin. However, if the good has a high price elasticity a small change in the price will contribute to a great effect on the demanded quantity which means that it is harder for the company to control the price. As the market is growing it goes towards perfect competition, less market power and less price control for all the companies. To be able to still have some power the companies differentiate their goods and thereby gain some market power (Meijers 2005).

In short, the increased e-commerce contributes to increased competition which is followed by downward pressure on prices. The effect will be a slower pace of the price rise or no increase at all which in turn entails a lower inflation.

4. Data

In the following chapter the data that this essay is based on is presented. It includes a description and explanation of the chosen variables used in this essay as well as descriptive statistics and shortcomings of the material. The essay is based on panel data and time series created from secondary data gathered from different databases. The scope of the data has been limited to 28 countries due to the lack of homogenous data on e-commerce. Even though e-commerce has existed for a relatively long time there is only annually data available for 28 countries and over the period 2006-2017. These countries are listed in appendix. The total amount of observations would be 336, however, there are 33 observation losses in this variable due to low reliability[1], which means that the final amount of observations is 303.

4.1 Variables

The dependent variable, Inflation, is gathered from Eurostat (2018) and is the annual average rate of change in percentage of the Harmonised Indices of Consumer Prices (HICPs) which is designed for international comparisons of consumer price inflation. Data for the variable E-commerce is gathered from Eurostat (2018) and is the share of enterprises' turnover on e-commerce in percentage. The enterprises have at least ten persons employed.

The control variables are chosen based on the factors that usually affect the inflation and the fulfilled expected results from earlier studies. The variable Exchange rate is gathered from Bank of International Settlement (BIS) (2018) and is constructed by using monthly data of the effective nominal exchange rate and transformed to annual data by taking the average of the twelve months of each year for each country. The base year of the index is 2010. An appreciation or a depreciation of the exchange rate means that foreign goods will become cheaper compared to domestic produced goods. This means that imports will increase and exports will decrease. The lower demand for domestic goods contributes to a slower activity in the economy so that the inflationary pressures are dampened. The exchange rate also affects the inflation through changes in the domestic price on goods trades across borders. Companies and consumers importing goods need to pay a lower price in the domestic currency calculated for

[1] Eurostat (2018) finds that there is low reliability in these observations and has therefore not reported them in the data set.

their imports. Therefore, a stronger currency usually lowers inflation, as imported and import-competing goods become cheaper. This reinforces the anti-inflationary effect of reducing demand (Riksbanken 2018).

Exchange rate affects the price developments through the impact on import prices. The import prices do affect domestic producer and consumer price development even in relatively closed economies. The price competitiveness of domestically produced goods on international markets may also be affected by changes in exchange rate and thereby influencing demand conditions and, eventually, the outlook for prices (Gerdesmeier 2009).

The variable Unemployment is gathered from World Bank (2018) and is measured in percentage of the total labour force. The relationship between the unemployment and inflation has been a talked about topic for a while. This relationship takes off in the hypothesis where there is a stable negative relation between the level of unemployment and the rate of change of wage. A high level of unemployment entails falling wages and low levels of unemployment entails increasing wages. The wage change is in turn linked to price changes by allowing for the secular increase in productivity and treating the excess of price over wage cost as given by a roughly constant mark-up factor. This hypothesis has unfortunately been failed to conform by additional empirical evidence (Friedman 1977). This has been followed by another hypothesis that distinguish between the short term and long term effects of unexpected changes in aggregated nominal demand. If an unexpected acceleration of aggregate nominal demand occur the producer will react by seeking to produce more to sell at a higher than expected market price for future output. This will also mean that the producer is willing to pay higher nominal wages than before in order to attract additional workers. According to the producer the real wage is the wage in terms of the price of the product. A higher nominal wage can therefore mean a lower real wage. The situation is perceived differently by the workers. To them the purchasing power of the wages is the most important, not necessarily the particular good that is produced by them but goods in general. Since it is easier for both the producers and the workers to get information about the price of the good that is produced than the prices of goods in general, it is likely that they adjust their perception of prices more slowly in general. A rise in nominal wage may be perceived as a rise in real wage by the workers, and hence cause an increase in supply while the employers perceive it as a fall in real wages and hence calls forth an increase offer of jobs. Expressed in terms of the average of perceived future prices, real wages are lower and in terms of the perceived future average price, real wages are higher. This, however, is

temporary. If the higher rate of growth of aggregate nominal demand and prices continues the perceptions will adjust to reality. This means that the initial effect will disappear and then might even reverse. Eventually, the employment will be back at the same level as before the unexpected change in aggregate nominal demand. This hypothesis has not been fully explored but despite this yet another hypothesis have been shaped which suggests that there is a positive relation between inflation and unemployment. There has been evidence that the inflation and unemployment has been rising mutually in some countries the recent years. This relationship may reflect the impact of events such as the oil crisis or independent forces that have imparted a common upward trend to inflation and unemployment. Another view on it could be that the countries are in a transitional period and the public has not adapt its attitudes or institutions to a new monetary environment (Friedman 1977).

It would be optimal to include some more control variables such as money supply and output gap. Unfortunately there is no data available for these variables that matches the data that is obtained for the e-commerce, therefore these variables are not included.

4.2 Descriptive Statistics

Table 1: Descriptive statistic of the panel data

Variables	Observations	Mean	Standard deviation	Min	Max
$Inflation$	336	2.06	2.13	-1.7	15.3
$ECommerce$	304	12.97	7.03	0	37
$ExchangeRate$	336	100.24	4.87	80.62	129.50
$Unemployment$	336	8.93	4.48	2.50	27.50

Sources: Eurostat (2018), BIS (2018) & World Bank (2018).

Table 1 shows a summary of the variables for all countries included in the panel data. These are the variables that will help answering the first question of this essay. There are some observations that should be contemplated a bit closer. The min and max value for Inflation. The min value is -1.7 which is low, however, the period for this essay includes the years of the financial crisis and during this time some countries had deflation. The max value is 15.3, which is high. The value is for Latvia in 2008. It can be explained by the strong economic growth that the Baltic countries had the period 2000-2007, which ended up in a bust (Reiner 2010).

The second question of the essay will be answered with the help of time series data. This means that only one country will be examined in this part. It is relevant to choose a country that has a

relatively large spread in the increase of e-commerce since a greater variation in the explanatory variable will with higher probability receive a result with higher precision (Stock & Watson 2012). It would also be inappropriate to choose a country which was heavily affected by the crisis because the observations may cause a misleading results. It is of course important to choose a country that has no statistical loss in the dataset. Sweden is a suitable country for the model since it is in line with the above statements.

Table 2: Descriptive statistic of the time series data for Sweden

Variables	Observations	Mean	Standard deviation	Min	Max
$Inflation$	12	1.41	0.84	0.2	3.30
$ECommerce$	12	17.33	2.77	13	21
$ExchangeRate$	12	102.69	4.50	93.37	110.54
$Unemployment$	12	7.50	0.79	6.2	8.60

Sources: Eurostat (2018), BIS (2018) & World Bank (2018).

Table 2 shows descriptive statistics of the variables for Sweden included in the time series data. The table shows that the observations seems relatively normal and there is no observations that stands out. E-commerce has a spread from 13 to 21 which is relatively large compared to some of the other countries. There is no extreme values in Inflation.

The main weaknesses of the panel data is the statistical loss of observation in E-commerce. One potential solution to this problem could be to remove the countries with the losses, however, this would lead to much fewer observations which is a worse problem than the previous. The optimum would be to include more control variables, unfortunately there is no data available for this. The panel data, in addition to E-commerce, has high reliability with no losses. The time series data has one major shortcoming which is the short period of time. There is no solution to this problem because there only exists limited amount of data for the variable E-commerce. Despite the short time period the time series data has high reliability with no statistical losses.

5. Models

In order to answer the first questions of this essay a regression model based on panel data is applied. This choice is based on the former studies from Yi and Choi (2005) and Nilsson and Mårtensson (2015) who receive expected result in their studies using an OLS regression model. It is therefore relevant to use a similar model in this essay. The regression model will make it possible to see how the e-commerce has affected the inflation. This model will be similar to what Nilsson and Mårtensson (2015) did in their study, however, the e-commerce variable was measured as the percentage of the population that has been shopping via internet at some point the last three months. This essay use an e-commerce variable that is measured as the share of enterprises' turnover which is more suitable measure to use. Furthermore, this essay will include a squared e-commerce to analyze whether there is a decreasing effect.

The next model applied is the Vector error correcting model (VECM). This model distinguish short term effects and long term effects which will make it possible to answer the second question of this essay, if there is a long term and short term effect by the increased e-commerce on the inflation. Eriksson and Berntsson (2017) uses an Error correcting model which is similar to the VECM and the result they receive supports their hypothesis that there is a long term relationship. It is therefore relevant to use the VECM in this essay.

5.1 OLS Regression Model

Model 1 is based on the panel data and includes 28 countries. It examines if there is a significant effect of e-commerce on inflation, but also if the effect is decreasing with time.

A fixed effects model is more suitable when the entities in the sample effectively constitute the entire population and the random effects model is more appropriate when the entities in the sample can be thought of as having been randomly selected from the population. A Hausman test will be performed to see whether the model will be executed with fixed or random effects (Brooks 2008). A fixed effects regression model has as many intercepts as there are entities, in this essay the entities are represented by countries. The intercepts can be represented by a set of binary variables which absorb the influences of all omitted variables that differ from one entity to the next one but are constant over time. It may also be important to use time fixed

effects. The time fixed effects control for variables that are constant across entities but evolve over time. If there are some omitted variables that are constant over time but vary across states and some that are constant across states but vary over time it is appropriate to include both entity and time effects (Stock &Watson 2012). An alternative to the fixed effects model is the random effects model. The random effects model is similar to the fixed effects model in the way of proposing different intercept terms for each entity which are constant over time. The main difference of the random effects model is that the intercepts for each cross-sectional unit are assumed to arise from a common intercept and a random variable that varies cross-sectionally but is constant over time (Brooks 2008).

Furthermore, a test for time fixed effects will be performed. The model will be estimated with robust standard errors to decrease the effect of heteroscedasticity. The original model looks as follows.

$$Inflation_{it} = \beta_0 + \beta_1 ECommerce_{it} + \beta_2 ECommerce^2{}_{it} + \beta_3 ExchangeRate_{it} + \beta_4 Unemployment_{it} + u_{it} \quad (1)$$

Where u_{it} is an error term.

If the Hausman test suggest that the model should be a fixed effects model the parameter α_i, which represent the different intercept for each entity, will be included. Furthermore, if the time fixed effects test propose that time fixed effects should be included, time dummies for each year will be added as well. If the Hausman test suggest that the model should be run with random effects the same alfa parameter will be included but also the parameter ω_{it} which is the sum of the error term and the random deviation of each entity's intercept term from the overall intercept term α_{it}.

Table 3: Excepted results for Model 1

Variables	Expected notation
$ECommerce$	-
$ECommerce^2$	+
$ExchangeRate$	-
$Unemployment$	-

The expected result of this model is that the e-commerce will have a negative effect on inflation, i.e., if the e-commerce increase the inflation will decrease. If E-commerce receives a negative

estimate the squared E-commerce is expected to have a positive effect on inflation, if the effect is supposed to be declining. All the control variables are expected to be negative, which means that if there is an increase in any of them it will affect the inflation negatively.

5.2 Vector Error Correcting Model

In order to answer the second question of this essay a Vector error correcting model is used. The VECM model has the benefit of taking both short and long term effects into account which is what this essay wants to examine. This model is executed on the time series data for Sweden. Since it is important that the model is based on cointegrated variables they will be tested in a two-step Engle-Granger augmented Dickey-Fuller (EG-ADF) test prior to the VECM.

Cointegration

When two or more time series variables are integrated of the same order and the combination of them are stationary they are said to be cointegrated. When variables occur to be cointegrated a regression analysis can reveal long term relationship between these (Stock & Watson 2012). One way to find out if there is cointegration is a two-step test, EG-ADF test, which will be applied in this essay.

Engle-Granger Augmented Dickey-Fuller Test

The EG-test is performed on a model with non-stationary variable and it tests if the error term, z_t, is stationary. The variables are cointegrated if all variables are non-stationary and integrated of order one I(1) and z_t is stationary and integrated of order zero I(0) (Brooks 2008). In this case the cointegrated coefficient θ is unknown which means that it has to be estimated. That is done by an OLS estimation of the following model, Model 2.

$$Inflation_t = \alpha + \theta_1 ECommerce_t + \theta_2 ExchangeRate_t + \theta_3 Unemployment_t + z_t \quad (2)$$

If the variables are cointegrated z_t should be I(0), if the variables are not cointegrated z_t will still be non-stationary. A Dickey-Fuller t-test will (with an intercept but no time trend) be executed to test the residual, $\hat{z}_t$ (Stock & Watson 2012). The hypothesis for this test will be the following.

$$H_0: \hat{z}_t \sim I(1)$$
$$H_A: \hat{z}_t \sim I(0)$$

(3)

If the null hypothesis is true a stationary linear combination of the non-stationary variables has not been found. This means that there is no cointegration. If the alternative hypothesis is true there is stationary in the residuals and a stationary linear combination of the non-stationary variables has been found. This means that the variables are cointegrated and a long term relationship exists. Furthermore, a VECM can be estimated (Brooks 2008). In this test the null hypothesis must be rejected in order to conclude that the variables are cointegrated.

Vector Error Correcting Model

If the variables are cointegrated the first differences of each variable can be modelled followed by an additional regressor, $Y_{t-1} - \theta X_{t-1}$, i.e., the deviation from the long term relationship, which is known as the error correction term. The VECM is interpreted as follows. The dependent variable is changing between $t-1$ and t due to the changes in the values of the explanatory variables, $t-1$ and t, but also in part to correct for any disequilibrium that existed during the previous period (Stock & Watson 2012). Since there is no interest to examine the effects on any of the variables in addition to the inflation only the first part of the model will be included in the following part. The entire model can be found in the appendix, Model A3. Model 3 will be the following.

$$\begin{aligned}\Delta Inflation_t &= \beta_{10} + \sum_{i=1}^{p} \beta_{1i} \Delta Inflation_{t-i} + \sum_{i=1}^{p} \gamma_{1i} \Delta ECommerce_{t-i} \\ &+ \sum_{i=1}^{p} \omega_{1i} \Delta ExchangeRate_{t-i} + \sum_{i=1}^{p} \tau_{1i} \Delta Unemployment_{t-i} \\ &+ \alpha_1 (Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1} \\ &+ \theta_3 Unemployment_{t-1}) + u_{1t}\end{aligned}$$

(4)

Where:

Δ = The first difference.

$(Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1} + \theta_3 Unemployment_{t-1})$ = Error correction term.

θ_k = Cointegrated coefficients, Long term relationship

β_{j0} = Constant

$\beta_{ji}, \gamma_{ji}, \omega_{ji}, \varphi_{ji}, \tau_{ji}$ = Coefficients, Short term relationship

α_j = Speed of adjustment

u_{jt} = Error term

(Stock & Watson 2012)

Model 3 examines if e-commerce has a long term effect on inflation. The parameters of interest are α_j, γ_{ji} and θ_k. The parameter α_j examines whether there is a long term correction towards long term equilibrium. If there is an error correction this parameter will receive a significant negative value. The parameter γ_{ji} is expected to receive similar results as the parameter of e-commerce in Model 1, i.e., a negative effect on inflation. The other control variables are also expected to receive similar results as in Model 1, i.e., exchange rate and unemployment will have a negative effect on inflation.

6. Result & Analysis

The following chapter presents and analyzes the results from the OLS regression, tests and Vector error correction model.

6.1 Result OLS Regression Model

To verify if the variables are reliable a correlation analyses are generated for Model 1.

Table 4: Correlation Matrix for Model 1

Variables	$Inflation$	$ECommerce$	$ECommerce2$	$ExchangeRate$	$Unemployment$
$Inflation$	1				
$ECommerce$	-0.29	1			
$ECommerce2$	-0.24	0.94	1		
$ExchangeRate$	0.11	-0.13	-0.15	1	
$Unemployment$	-0.21	-0.22	-0.20	-0.02	1

Numbers of observations: 304

Table 4 confirms that there are no issues with multicollinearity in Model 1. A Hausman test is performed to see whether the model will be executed with fixed or random effects. The test suggests that the model should be executed with fixed effects[2]. It is also possible that time-fixed effects are needed in the model, therefore a test is performed to determine this. This test suggests that the model should include time dummies for all years[3]. Table 5 shows the results obtained for the regression of Model 1 with fixed effects and dummies for all years. It examines if the e-commerce has an effect on the inflation and whether this effect is diminished or not.

Table 5: OLS Regression of Model 1

Variables	Parameter Estimates
$Intercept$	8.84**
	(4.02)
$ECommerce$	-0.23**
	(0.11)
$ECommerce2$	0.006**
	(0.003)
$ExchangeRate$	-0.04
	(0.04)
$Unemployment$	-0.07**
	(0.04)
$R2$	0.51

The table shows the coefficients for the variables and the standard error in the parentheses.
* significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level.
Time dummies are included in the regression.
Numbers of observations: 304.

[2] Hausman test result: P-value 0.0058.
[3] Test for time-fixed effects: P-value 0.0000

Table 5 shows the result from Model 1. The result indicates that e-commerce has a significant negative effect on the inflation. If the e-commerce would increase with one percentage point the inflation would decrease with 0.23 percentage points, ceteris paribus. This is in line with the essay's expectation and the results from the earlier studies. The squared E-commerce has received a significant positive estimate, which means that there is a decreasing effect. This is also in line with the expectations of this essay. However, this value is relatively small. Unemployment has a significant negative effect on the inflation which is expected. If the unemployment increases with one percentage point the inflation will decrease with 0.07 percentage points, ceteris paribus. Furthermore, the intercept has a significant positive result and the exchange rate does not receive significant result.

6.2 Result Vector Error Correcting Model

The second part of the question of this essay, whether there is a long and/or short term effect, will be answered with help of the Vector Error Correcting Model. A correlation matrix is generated for Model 2 to verify that the variables are reliable.

Table 6: Correlation Matrix for Model 2

Variables	$Inflation$	$ECommerce$	$ExchangeRate$	$Unemployment$
$Inflation$	1			
$ECommerce$	-0.34	1		
$ExchangeRate$	-0.50	-0.27	1	
$Unemployment$	-0.45	-0.46	-0.01	1

Observations: 12

Table 6 confirms that there are no issues with multicollinearity in Model 2. Before the VECM is performed four separate Dickey-Fuller test is made to see if the variables of Model 2 are stationary or not, and in which order they are integrated.

Table 7: Dickey-Fuller Test

Variables	T-value	Integration Order
$Inflation$	-3.14	I(1)
$ECommerce$	-4.53	I(1)
$ExchangeRate$	-3.60	I(2)
$Unemployment$	-3.57	I(1)

The table shows the T-value and integration order of the variables.
Critical value is -3.00 at the 5% level.

The results in Table 7 indicate that Inflation, E-commerce and Unemployment are stationary when taking first difference, which means that cointegration may exist between them. However,

unemployment had to use one lag to become I(1). The exchange rate is stationary in I(2), i.e., it is stationary in the second difference, and thus cannot be included in the following test.

In addition to the Dickey-Fuller test an Engle and Granger-test is preformed to examine whether the residuals are non-stationary, i.e., if the variables are cointegrated. This model is based on the variables, Inflation, E-commerce and Unemployment since Exchange rate was not integrated at the same order as these.

Table 8: Engle and Grange Test

Variables	T-value	Integration Order
Residuals	-6.77	I(0)

The table shows T-value and the integration order of the residuals of the variables.
Critical value is -4.59 at the 5% level.

Table 9: Cointegrated connection

Variables	Parameter Estimates
Intercept	5.25
	(2.40)
ECommerce	-0.05
	(0.10)
Uneployment	-4.00
	(0.35)

The table shows the cointegrated connection of the variables.
* significant at the 10% level, ** significant at the 5% level,
and *** significant at the 1% level.

The test in Table 8 indicates that the residuals are stationary and that a stationary linear combination of the non-stationary variables have been found. This means that the variables are cointegrated. However, the test had to be executed with two lags in order to become I(0). Table 9 shows the cointegrated connection. Since the variables Inflation, E-commerce and Unemployment were I(1) and had residuals that were I(0) they can be integrated in the VECM.

Table 10: Vector Error Correction Model, Model 3

Variables	Parameter Estimates
$Intercept$	0.80**
	(0.39)
$Error\ Correction\ Term$	-0.57***
	(0.19)
$Inflation$	
LD	1.07*
	(0.55)
$LD2$	0.66
	(0.41)
$ECommerce$	
LD	-0.23*
	(0.13)
$LD2$	-0.17*
	(0.09)
$Unemployment$	
LD	0.59
	(0.46)
$LD2$	0.58*
	(0.35)

The table shows the coefficients for the variables and the standard error in the parentheses.
* significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level.

The VECM is shown in Table 10. The error correction term is significantly negative which means that there is an adjustment against long term equilibrium. The value shows the speed of adjustment towards the long run equilibrium, it measures the speed at which the inflation returns to equilibrium after a change in the independent variables. The error correction term indicates a correction to equilibrium of 57% each year.

The short term estimates that are significant are the intercept, the first lag of Inflation, the first and the second lag of E-commerce and the second lag of Unemployment. As expected, E-commerce has a significantly negative short term effect on Inflation, i.e., if the change in e-commerce increases with one percentage point the change in inflation will decrease with 0.23 percent points one year ahead, respectively with 0.17 percent points two years ahead, ceteris paribus. The Inflation and Unemployment have a significantly positive short term effect on Inflation. The positive sign of Unemployment is not expected. It means that if the change in unemployment increases with one percentage point the change in inflation will increase 0.58 percentage points two years ahead, ceteris paribus. The entire result for Model 3 is found in appendix, Table A10.

7. Discussion & Conclusion

The purpose of this essay was to answer the questions: Has the increased e-commerce had a negative impact on the inflation, and is the effect decreasing? and: Is there a long term and/or short term effect by the increased e-commerce on the inflation?

According to the first regression based on Model 1 the increase in e-commerce has had a negative effect on inflation which is in line with previous study results. This is a reasonable result given that increased e-commerce contributes to increased competition which puts downward pressure on prices and finally results in a slower pace of the price rise and thereby a lower inflation. There is also support for the effect being decreasing which is expected as well. This is in line with Gerdesmeier's (2009) statement that it is likely that the impact of the increased e-commerce will decline once a new equilibrium is established. Both of the estimated values of the variable E-commerce and the squared E-commerce are relatively small, this perhaps could be because of the slow adjustment of the prices.

The result of Vector error correction model shows that there is support for an error correction, an adjustment of 57 percent towards a long run equilibrium each year. This is also in line with the previous statement of Gerdesmeier (2009) which also denote that the e-commerce is in a development phase which can take a prolonged period of time. Riksbanken (2015) writes that structural changes can vary over time and also be problematic to predict which should be taken into account when looking at the result. The short term estimates of E-commerce confirms the same notation as the regression of Model 1. It receives a negative estimate which shows that the change e-commerce has a negative short term effect on the change in inflation. Both the long term and short term results is in line with the results of Eriksson and Berntssons (2017) study.

The parameter estimates of the VECM should be interpreted with some caution as they are not completely reliable. The model is performed on a relatively small scale set of observations due to the lack of data for the variable E-commerce.

Summarizing the essay, it received expected results for the main hypothesis. Furthermore, improvements can be made in the future. A greater number of observations should be included in the time series data set which would lead to more reliable estimates and thus more

representative results. Another problem that should be addressed is the period of time that the essay is based on. During this period the financial crisis took place which is reflected in the observations in some of the variables included. This may have affected the result slightly However, the descriptive statistics does not show any extreme outliers which is positive. Both of these improvements are somewhat difficult to accomplish in the nearest future due to the fact that more observations of e-commerce only will come with time. The essay could also be improved by adding some more control variables to Model 1, such as money supply.

References

Literature:
Gerdesmeier, D (2009). *Price stability: Why is it important for you?.* Frankfurt: European Central bank.

Stock, J.H and Watson, M.M (2012). *Introduction to Econometrics.* Third edition. Harlow: Pearson Education Limited.

Brooks, C (2008). *Introductory Econometrics for Finance.* Second edition. The ICMA Centre, University of Reading. Cambridge: Cambridge university press.

Reports:
Riksbanken (2015). *Digitaliseringen och inflationen* (Penningpolitisk rapport Februari 2015). Stockholm: Riksbanken.

Articles:
Kannan, P.K and Kopalle, K (2001). *Dynamic Pricing on the Internet: Importance and Implications for Consumer Behaviour,* International Journal of Electronic Commerce, 5:3, 63-83.

Meijers, H (2005). *Diffusion of the Internet and low inflation in the information economy,* Information Economics and Policy 18, 1-23. Maastrich Economic Research Institute on Innovation and Technology, Netherlands: University Maastricht

Coppel, J (2000). *E-commerce: Impacts and Policy Challenges,* OECF Economics Department Working Papers, No. 252, OECD Publishing, Paris.

Friedman, M (1977). *Nobel Lecture: Inflation and Unemployment,* Journal of Political Economy, Vol. 85, No. 3. Chicago: Univerity of Chicago.

Studies:
Yi, M.H and Choi, C (2005). *The effect of the Internet on inflation: Panel data evidence*, Journal of Policy Modeling 27. Department of Economics, Seoul: Myongji Univerity.

Nilsson, H and Mårtensson, M (2015). *E-handelns effect på inflationen: En paneldatastudie om den ökade e-handelns konsekvenser,* Bachelor essay. Nationalekonomiska institutionen, Lund: Lunds Univeritet.

Coffinet, J and Perillaud, S (2017). *Effects of Internet on inflation: an overview of the literature and empirical analyses*, JEL classification: E31, L1. France.

Eriksson, H and Berntsson, D (2017). *E-handelns inverkan på inflationen I USA – En tidsserieanalys,* Bachelor essay. Institutionen för ekonomi och IT, Trollhättan: Högskolan i väst.
Electronic Sources

European Commission (2018). *Boosting e-commerce in the EU* (Digital Single Market Policy 2018). https://ec.europa.eu/digital-single-market/en/boosting-e-commerce-eu [2018-05-17]

Eurostat (2018). *E-commerce statistics*. http://ec.europa.eu/eurostat/statistics-explained/index.php/E-commerce_statistics [2018-05-17]
Riksbanken (2017). *Reporäntan, Om reporäntan, inflation, deflation, krediter mm.* Stockholm: Riksbanken. http://xn--reporntan-z2a.se/riksbanken/deflation/ [2018-05-17]

Riksbanken (2018). *Så påverkar penningpolitiken inflationen.* Stockholm: Riksbanken. https://www.riksbank.se/sv/penningpolitik/vad-ar-penningpolitik/sa-paverkar-penningpolitiken-inflationen/

Reiner, M (2010). *Boom and Bust in the Baltic Countries – Lessons to be Learnt.* https://archive.intereconomics.eu/year/2010/4/boom-and-bust-in-the-baltic-countries-lessons-to-be-learnt/ [2018-05-17]

Databases:
Eurostat (2018). *HICP – Inflation rate, Annual average rate of change(%).* http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00118&plugin=1 [2018-05-17]

Eurostat(2018). *Share of enterprises' turnover on e-commerce - %.* http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tin00110&plugin=1 [2018-05-17]

International Settlement (2018). *BIS effective exchange rate*. https://www.bis.org/statistics/eer.htm [2018-05-17]

The World Bank (2018). *World Development Indicators*. http://databank.worldbank.org/data/reports.aspx?source=2&series=SL.UEM.TOTL.ZS&country= [2018-05-17]

Appendix

Countries included in the essay:

Austria	Germany	Poland
Belgium	Greece	Portugal
Bulgaria	Hungary	Romania
Croatia	Ireland	Slovakia
Cyprus	Italy	Slovenia
Czech Republic	Latvia	Spain
Denmark	Lithuania	Sweden
Estonia	Malta	United Kingdom
Finland	Netherlands	
France	Norway	

Model A3

Vector Error Correcting Model

$$\Delta Inflation_t = \beta_{10} + \sum_{i=1}^{p} \beta_{1i} \Delta Inflation_{t-i} + \sum_{i=1}^{p} \gamma_{1i} \Delta ECommerce_{t-i} + \sum_{i=1}^{p} \omega_{1i} \Delta ExchangeRate_{t-i} + \sum_{i=1}^{p} \tau_{1i} \Delta Unemployment_{t-i} + \alpha_1 (Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1} + \theta_3 Unemployment_{t-1}) + u_{1t}$$

$$\Delta ECommerce_t = \beta_{20} + \sum_{i=1}^{p} \beta_{2i} \Delta Inflation_{t-i} + \sum_{i=1}^{p} \gamma_{2i} \Delta ECommerce_{t-i} + \sum_{i=1}^{p} \omega_{2i} \Delta ExchangeRate_{t-i} + \sum_{i=1}^{p} \tau_{2i} \Delta Unemployment_{t-i} + \alpha_2 (Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1} + \theta_3 Unemployment_{t-1}) + u_{2t}$$

$$\Delta ExchangeRate_t$$

$$= \beta_{30} + \sum_{i=1}^{p} \beta_{3i} \Delta Inflation_{t-i} + \sum_{i=1}^{p} \gamma_{3i} \Delta ECommerce_{t-i}$$
$$+ \sum_{i=1}^{p} \omega_{3i} \Delta ExchangeRate_{t-i} + \sum_{i=1}^{p} \tau_{3i} \Delta Unemployment_{t-i}$$
$$+ \alpha_3 (Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1}$$
$$+ \theta_3 Unemployment_{t-1}) + u_{3t}$$

$$\Delta Unemployment_t$$

$$= \beta_{50} + \sum_{i=1}^{p} \beta_{4i} \Delta Inflation_{t-i} + \sum_{i=1}^{p} \gamma_{4i} \Delta ECommerce_{t-i}$$
$$+ \sum_{i=1}^{p} \omega_{4i} \Delta ExchangeRate_{t-i} + \sum_{i=1}^{p} \tau_{4i} \Delta Unemployment_{t-i}$$
$$+ \alpha_4 (Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1}$$
$$+ \theta_3 Unemployment_{t-1}) + u_{5t}$$

(5)

Where:

Δ = The first difference.

$(Inflation_{t-1} - \theta_1 ECommerce_{t-1} + \theta_2 ExchangeRate_{t-1} + \theta_3 Unemployment_{t-1})$ = Error correction term.

θ_k = Cointegrated coefficient, Long term relationship

β_{j0} = Constant

β_{ji}, γ_{ji}, ω_{ji}, φ_{ji}, τ_{ji} = Short term relationship

α_j = Speed of adjustment

u_{jt} = Error term

Table A10

Table A10: Vector Error Correction Model, Model 3

	$\Delta Inflation$	$\Delta ECommerce$	$\Delta Unemployment$
Variables	Parameter Estimates	Parameter Estimates	Parameter Estimates
$Intercept$	0.80**	0.91	-0.37
	(0.39)	(2.92)	(0.49)
$Error\ Correction\ Term$	-0.57***	0.65	0.37
	(0.19)	(1.45)	(0.24)
$Inflation$			
LD	1.07*	1.68	-0.20
	(0.55)	(4.14)	(0.70)
$LD2$	0.66	2.72	0.12
	(0.41)	(3.09)	(0.52)
$ECommerce$			
LD	-0.23*	-0.44	0.10
	(0.13)	(0.95)	(0.16)
$LD2$	-0.167*	-0.43	0.07
	(0.09)	(0.68)	(0.12)
$Unemployment$			
LD	0.59	-1.12	-0.33
	(0.46)	(3.45)	(0.58)
$LD2$	0.58*	2.75	-0.56
	(0.35)	(2.59)	(0.44)

The table shows the coefficients for the variables and the standard error in the parentheses.
* significant at the 10% level, ** significant at the 5% level, and *** significant at the 1% level.