DO MEASUREMENT ERRORS IN GDP ANNOUNCEMENTS CAUSE OUTPUT FLUCTUATIONS?

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1 INTRODUCTION

1.1 Background and intuition

Every quarter Statistics Finland reports the gross domestic product (GDP) growth in the last quarter. These announcements are well publicised by the media. They are also eagerly analysed by economists, who use them to make predictions concerning the future and proclamations about the past. Using this information, consumers, firms and policymakers make decisions regarding the future. A firm's decision to invest in a new factory, a consumer's decision to buy a new house, a government's decision to start a new public works project–all of these depend to some degree on the decision maker's expectations about the future. Since these decisions also influence the future, it seems intuitively obvious that the expectations regarding the future affect the realisation of the future. Since agents form their expectations about the future partly based on announcements of past GDP growth, it follows that the GDP announcements affect future GDP growth.

The relationship between announcements of past growth and the realisation of future growth seems intuitively obvious.

Empirically verifying this relationship is not straight-forward, since GDP growth can be autocorrelated for any number of other reasons as well. The announcement effect, however, can be isolated and studied because these initial announcements of GDP growth are only preliminary. They are periodically revised to take into account new information and new methods. Thus in retrospect it is possible to decompose the initial announcement into two components, the true[1] value and measurement error. Thus, if the intuition above is correct, then not only the true value of past GDP growth, but also the measurement error in its initial announcement, should be correlated with future growth.

[1] Throughout this paper we will assume that the latest published values of GDP growth are true. This is not strictly correct. There is always some degree of uncertainty in national accounts statistics and they are revised even decades after initial publication. After a certain number of revisions, however, revisions are so small that it is reasonable to assume that the numbers are final.

These revisions can be rather large: for example in Finland, the absolute value of the revision to the initial announcement of quarterly GDP growth has been on average 0,62%, which is about 50% relative to the final value (Paavonen 2008). It is clear that there is significant uncertainty in the initial announcement, and the above intuition suggests that this noise could be of macroeconomic significance.

1.2 Structure of the study

The aim of this thesis is to study the economic significance of measurement error in GDP announcements.

To accomplish this, we will first discuss theoretical models which incorporate noisy announcements to show that the intuition regarding the significance of measurement error of aggregate production is theoretically justified. We will not present any specific model in great detail, but rather give an overview of a variety of models which predict output fluctuations caused by measurement errors. Secondly, we will give a brief overview of related empirical studies. Our aim is to show that it is empirically plausible that false announcements cause output fluctuations. Then we will briefly discuss GDP announcements and their revision process, to illustrate under what circumstances GDP announcements are likely to cause shocks in the economy. In the fifth chapter, we will conduct various empirical tests to demonstrate that noisy GDP announcements affect sentiment and cause output fluctuations. Finally we will conclude with a discussion of the practical implications of our findings and some possible directions for future research.

2 THEORETICAL BACKGROUND

In this chapter we will briefly discuss how strategic complementarity provides the theoretical justification for the economic significance of measurement errors in aggregate production. Strategic complementarity is a feature of an economy, in which higher aggregate production increases each agent’s incentive to produce. When strategic complementarity is present, agents’ expectations regarding future aggregate production affect their optimal strategies. As elaborated upon in section 2.2, the presence of strategic complementarity makes announcements regarding aggregate production relevant. Before examining the theoretical implications of strategic complementarity, however, it is interesting to see what models exhibit this feature.

2.1 The existence of strategic complementarity

Cooper and John (1988) found that there are a variety of models which can be shown to exhibit strategic complementarity due to coordination failure. They demonstrated that strategic complementarity can arise due to input games, trading externalities or demand externalities. Additionally Matsusaka and Sbordone (1995) demonstrated that strategic complementarity can arise due to customised goods. We will discuss each of these cases briefly.

2.1.1 Input games

Cooper and John (1988) show that strategic complementarity can arise if there is a problem of coordination among input suppliers to shared production process. In this model the utility of each agent depends upon the shared production process. Their inputs to the shared production process are complementary (that is, an increase of one input increases the marginal productivity of all other agents' inputs). If the agents are unable to coordinate their inputs, each takes the other agents' inputs as a given and chooses his input accordingly. Since the agents do not know the others' input decisions with certainty, their decisions depend on their expectations of aggregate output. There exists a continuum of equilibria, the selection of which depends on the agents' perception of the aggregate economy. If everyone expects aggregate output to be low, they decide to produce a lower quantity, and the as a result aggregate output turns out to actually be low. In this way expectations of aggregate output can be self-fulfilling.

2.1.2 Trading externalities

Following Diamond (1982), Cooper and John (1988) show that trading externalities can also cause strategic complementarity. This model economy is composed of agents who make their decisions to produce before seeking a trading partner, with whom they then trade on a one-to-one basis. Trading partners arrive stochastically, so the probability of finding a trading partner is an increasing function of the number of individuals seeking to trade. If the agent fails to find a trading partner, the produced good perishes. Since the decision to produce is made before finding the trading partner, the agent decides to produce if the cost of production is lower than the expected selling price. Since the probability of a successful trade depends on the number of individuals seeking to trade, the expected selling price depends on the expected number of possible trading partners. Because of this, each individual agent's decision to produce depends on his expectation of the number of other agents producing. In this way aggregate production depends on the agents' expectations of aggregate production. In the absence of coordination between the agents, this results in multiple possible equilibria and self-fulfilling expectations.

2.1.3 Demand externalities

Demand externalities are the third example of a model shown by Cooper and John (1988) to induce strategic complementarity. They show that demand linkages between agents in a multisector economy with imperfect competition can cause coordination problems where a low-level equilibrium could be avoided if all firms increased output, even if no individual firm has an incentive to do so. These positive demand linkages between sectors of the economy are caused by assumed normality of consumption goods and specialisation in production. Normality of consumption goods means that demand rises with income, and specialisation in production implies that agents consume goods produced outside their sector of the economy. These conditions imply that the demand for goods in any given sector depends on the aggregate production of all other sectors. Because of this, the amount any given firm decides to produce depends on the firm's expectation of aggregate production. Thus on the aggregate level, future production depends on the firms' expectations of future production.

2.1.4 Customised goods

Matsusaka and Sbordone (1995) show that strategic complementarities can also arise due to the presence of customised goods in an economy. They assume that many goods are produced to buyer specification, so that their value is higher to the original buyer than to anyone else. An obvious example is construction, where various decisions such as floor plan or choice of paint can be customised for the buyer with little extra cost, but these customised features increase the house's value only to the original buyer. In the secondary market the customised goods are worth more to the seller than buyer, so consumers experience a loss if they are forced to enter the secondary market due to ordering too few or too many goods.

Matsusaka and Sbordone assume that all consumers are employees in industries making customised goods. Assuming a one-period economy where goods are ordered before production takes place, the amount of goods a consumer orders depends on his expectation of income. Since consumers experience a loss if they order too few or too many customised goods, they order as much as they expect their income to be. Since the consumers are employees in industries making customised goods, their incomes depend on the aggregate number of customised goods ordered in the economy. Thus, each individual consumer's order of customised goods depends on his expectation of aggregate number of customised goods ordered in the economy. Aggregating all the consumers, it follows that future production depends on the consumers' expectations of future production.

2.2 The implications of data uncertainty under strategic complementarity

For our purposes we can remain agnostic regarding which of the before-mentioned causes of strategic complementarity is most convincing. For the purposes of empirical study it is interesting to note that there is theoretical justification for both consumer and producer expectations to be self-fulfilling.

Oh and Waldman (1989) analysed the effect of announcements regarding the state of the aggregate economy in the presence of strategic complementarity. They assumed there to be binary announcements regarding the state of the economy. They found that if these announcements are perfectly accurate, compared to a situation with no such announcements, the announcements increase production when the state of the economy is good and decrease production when the state of the economy is bad. Intuitively these results are straightforward. Under strategic complementarity each agent has an incentive to produce more when aggregate production is higher. Thus, an announcement that the state of the economy is good increases each agent's incentive to produce, resulting in increased aggregate production.

The case of imperfect announcements is empirically more interesting. The imperfect announcements are assumed to indicate that there is a higher probability that the economy is in a good (bad) state. Often these announcements turn out to be accurate, but sometimes they do not. This makes them conceptually similar to initial announcements of aggregate production, which are periodically revised. Because of the revision process, the announcements regarding aggregate production are not perfectly accurate statements regarding the state of the economy, but rather noisy estimates of the truth. Oh and Waldman (1989) showed that holding the announcement fixed, aggregate production is higher when the state of the economy is good than when it is bad. In addition, holding the true state of the economy fixed, an announcement that the state of the economy is good increases production while an announcement that the state of the economy is bad decreases production. This result is intuitively very similar to the one regarding perfect announcements. Even though the announcements are uncertain, an announcement that the state of the economy is good increases the conditional probability that the state of the economy is good. Since a good state of the economy increases the individual’s incentive to produce, an uncertain positive announcement increases the expected payoff of production. In this way positive announcements regarding the state of the economy increase production even if they turn out to be false.

There are other theoretical models which suggest that noisy signals can cause fluctuations in output. Bomfim (1999a, 1999b) showed that noisy economic data can either dampen or exacerbate cyclical volatility, depending on whether agents use an efficient or a simple bounded rational signal extraction strategy. When agents use efficient signal extraction methods, increased noise in the economic data dampens cyclical volatility, because agents do not take the announcements at face value and don’t fully react to them. In this model all fluctuations are the result of optimal responses to shifts in the consumption-leisure trade-off. Thus the socially optimal goal is not to minimise fluctuations, but rather to ensure that fluctuations reflect the shifts in the consumption-leisure trade-off. Since noisy data makes it harder to identify and react to those shifts, noisy data is costly regardless of what signal extraction method agents use. Comparing the cyclical volatility of two periods during which the economic data is of differing noisiness, allows use to discover whether agents use efficient or simple bounded rational signal extraction strategy. For our purposes the important point is that noisy signals can cause fluctuations in output. The finding that when agents use efficient signal extraction strategies increased noise results in decreased volatility suggests that in our empirical study it is important to take into consideration the reliability of the initial announcement. While measurement errors in imperfect announcements may cause output fluctuations, if the initial announcement is so noisy as to be useless, then its measurement errors may not matter at all.

Lorenzoni (2008) presented a model of business cycles in which a noisy signal about aggregate productivity causes “noise shocks” which can cause significant short-run volatility. This is simply yet another example of a theoretical model under which noisy signals cause output fluctuations, motivating our empirical studies on the matter. Aruoba (2004) used a calibrated general equilibrium framework to estimate that data uncertainty creates a precautionary motive costing about $33 billion annually in the United States. While this cost-estimate is quite sensitive to the parameters used to calibrate the model, it is nonetheless interesting.

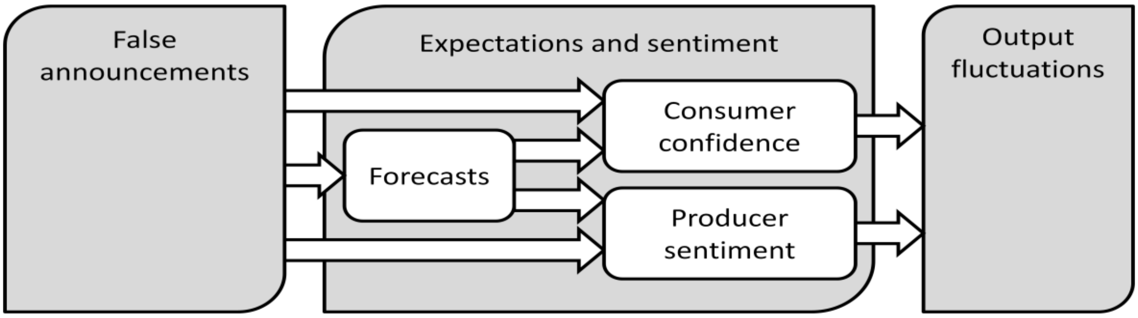
For the purposes of this paper we can remain agnostic regarding the method by which noisy announcements affects the economy. The purpose of this discussion was merely to provide an overview of the variety of theoretical models which suggest noisy signals, such as the initial announcement of GDP, can affect future production. The brief discussion of the intuition behind these models serves merely to motivate and guide the examination of empirical studies.

3 EMPIRICAL BACKGROUND

In this chapter we will give a brief overview of previous empirical studies, to demonstrate that it is empirically plausible that false announcements of macroeconomic statistics cause output fluctuations.

As noted previously, the noise shock is propagated by consumers or producers who either directly observe statistics announcements or observe forecasts made by economists who observe the statistics announcements. Figure 1 summarises the possible propagation paths of a noise shock.

Figure 1. The possible propagation paths of a noise shock.



Since there are necessarily multiple steps in the propagation path, it is possible to take two complementary approaches to studying whether the measurement errors in initial announcement affect future output. We can either study the various steps of the propagation path individually or examine the relationship between initial announcements and future output directly. If false announcements cause output fluctuations, it must be the case that false announcements affect sentiment and sentiment affects future output. While directly testing the statistical relationship between false announcements and future output is certainly a sufficient method, being able to confirm the findings by testing the relationship stepwise makes the results more robust.

In this chapter we will briefly discuss earlier studies which shed light on the relationships between false announcements, sentiment and future output. While most of them do not deal directly with expectational shocks caused by false announcements of GDP growth, they show that at least in some cases output fluctuations caused by false announcements are empirically plausible.

3.1 The effect of measurement errors on sentiment

We will first focus on the first step of the propagation path in Figure 1. The effect of false announcements on expectations has received surprisingly little attention in previous empirical studies. The most relevant previous study is Oh and Waldman (2005), who studied expectational shocks caused by measurement mistakes in the initial announcement of the Index of Leading Indicators.

Oh and Waldman (2005) used the measurement mistakes in the initial announcement of the Index of Leading Indicators published by the US Department of Commerce as the source of expectational shocks. The Index of Leading Indicators is a widely publicised composite statistic, designed to help in business cycle forecasting in the United States. It is revised periodically to take into account updated information. Thus, similar to the GDP announcements discussed in the introduction, the initial announcement can be decomposed into the true value and error term. As a proxy for expectations they used data from the ASA-NBER Survey of Forecasts by Economic Statisticians. This survey, also known as the Survey of Professional Forecasters, is the oldest quarterly survey of macroeconomic forecasts in the United States. From this, they used the mean forecast for the growth in industrial production in each of several quarters beyond the forecast date. The data they used ranged from 1968 to 1990.

Controlling for the previous forecast and the final revised value of the Index, Oh and Waldman (2005) found that the errors in initial announcement of the Index were positively correlated with professional forecasts of industrial production.

Based on this they conclude that forecasters place significant weight on either the Index of Leading Indicators, or some component of it, when making forecasts. Thus, uncertainty in the initial announcements causes expectational shocks in the economy.

Interestingly, Oh and Waldman (2005) found that the strength of the relationship between forecasts and the announcements of the Index changed in 1976, when the Leading Indicators underwent a major update. After the 1976 update, the predictive power of the Index increased substantially. As expected, the influence the announcements had on forecasts also increased. The relationship was statistically significant in both subsamples, but the amount of residual variability explained by the revision term was greater in the post-1976 subsample. Before 1976, the revision variable explained about 8 % of the residual variability, while in the post-1976 sub-sample it explained around 30 % of the residual variability. This is a useful reminder of the fact that the magnitude of expectational shocks caused by false announcements depends on the usefulness of the statistic for forecasting.

Carroll (2003) studied the formation of household inflation and unemployment expectations. The studied a model under which households form their expectations based on media reports of professional forecasts. In the model households are assumed to update their forecasts probabilistically toward the views of the professional forecasts. An empirical test suggested that the model captures much of the variation in the University of Michigan's survey of consumers. Though this study focused on inflation and unemployment, rather than aggregate production expectations, it suggests that professional and consumer expectations are linked. This link between professional forecasts and consumer sentiment suggests that the findings of Oh and Waldman (2005) might imply that false announcements affect consumer sentiment as well.

3.2 The effect of expectations on output fluctuations

Keeping in mind the propagation path of a noise shock in Figure 1, the next step is to examine how expectations regarding the future affect the future. Expectations or sentiment is a sort of forecast of the future, so even if they do not affect the future, they are expected to correlate with the future. Because of this, it is necessary to control for various variables available to forecasters to extract the non-fundamental part of the expectations. In this way it is possible to determine whether sentiment was more or less pessimistic than the economic fundamentals warranted, and then this non-fundamental sentiment can be used to determine the effect of perceptions.

In this section we will provide a brief overview of previous empirical studies addressing this question to demonstrate that this step of the propagation path is plausible. We will abstain from conducting any empirical studies of our own, because this is question is outside the immediate focus of this thesis.

3.2.1 Consumer sentiment and household spending

Carroll, Fuhrer and Wilcox (1994) found that consumer sentiment forecasts household spending in the US. As the dependent variable, they used growth in personal consumption expenditure PCE. Additionally, they partitioned the total personal consumption expenditure into three sub-groups: motor vehicles, goods excluding motor vehicles and services. As the dependent variable of interest, they used the University of Michigan Index of Consumer Sentiment ICS to measure consumer sentiment. They studied the time period 1955Q1 through 1992Q3. This start date was dictated by the availability of ICS data. Carroll, Fuhrer and Wilcox (1994) also divided the time period into two subperiods at 1978, from which onwards the consumer sentiment survey has been conducted monthly. The end of the time period studied was chosen to exclude dramatic tax-motivated shifts in wage and salary income in 1992Q4 and 1993Q1.

Carroll, Fuhrer and Wilcox (1994) conducted reduced-form regressions with four lags of the ICS as independent variables and each of the four measures of personal consumption expenditure alternatively as the dependent variable. They found the lags of ICS to be statistically significant for all model specifications, except motor vehicles in the post-1978 subperiod. They found that the lags of ICS explain up to 20% of the variation in the growth of real PCE. To investigate whether the ICS has predictive power when controlling for other variables available to forecasters, Carroll, Fuhrer and Wilcox (1994) included four lags of PCE growth and growth in real labour income as controls. Using this specification, they found the ICS parameters to be statistically significant in five out of eight specifications. With these control variables included, the ICS variables add up to 8% to the explanatory power of the model as measured by the adjusted R-squared statistic. Carroll, Fuhrer and Wilcox (1994) conclude that on its own sentiment has considerable predictive power for growth of various measures of household spending. When controlling for other variables, sentiment likely has some incremental predictive power. Thus, changes in consumer sentiment help predict changes in personal consumption.

Bram and Ludvigson (1998) conducted a similar test, testing the comparative usefulness of the Conference Board and University of Michigan consumer surveys in forecasting future household expenditure. Their data ranged from 1967Q1 to 1996Q3. As control variables, they used four lags of the dependent variable, growth in real labour income, log first difference of the real S&P 500 stock price index and first difference of the three-month Treasury bill rate. They found that the Conference Board survey was significantly more useful in forecasting than the Michigan consumer survey, which added little or no incremental explanatory power. Considered together, the two measures of consumer confidence added 13% of incremental explanatory power. While Bram and Ludvigson (1998) caution that their results do not necessarily imply that consumer attitudes cause changes in consumer spending, but they suggest that consumer attitudes may act as a catalyst for economic fluctuations.

Ludvigson (2004) replicated the Bram and Ludvigson (1998) tests, with updated data and some minor changes in methodology. The time period considered was extended from 1968Q1 to 2002Q4. Instead of including only the latest consumer confidence index as an independent variable, as was done in Bram and Ludvigson (1998), Ludvigson (2004) included four lags. Additionally, to ensure that the results are not skewed by the unusual movements in consumer attitudes during the Persian Gulf War and the 1990-1991 recession, a dummy variable set equal to one during the recession was included. With these methodological changes, the incremental explanatory power of the consumer confidence surveys were between 5% and 7% individually, but 10% combined.

The three previously discussed studies were done using latest available data, rather than the data available to forecasters in real-time. Croushore (2005) modified the approach, by using as independent data the variables as they were available at the time. Growth in household consumption in particular is subject to significant revisions, so using the latest available data rather than the data available to forecasters in real-time is potentially troublesome. As control variables, Croushore (2005) used the real time equivalents of the ones used by Bram and Ludvigson (1998). He considered the time period from 1968Q1 to 2002Q4. Croushore (2005) conducted out-of-sample forecasts from 1982Q1 onwards. Comparing the root-mean-square-forecast errors from using the control variables only to the errors when the consumer sentiment was included in the model, Croushore (2005) concluded that the consumer sentiment does not help forecast consumer spending in real time.

Reconciling the results from Croushore (2005) and the other studies merits some discussion. Carroll, Fuhrer and Wilcox (1994), Bram and Ludvigson (1998) and Ludvigson (2004) all found there to be correlation between consumer sentiment and future consumption when controlling for revised controls. Croushore (2005) found that this correlation disappears when using real time variables as controls. This could imply that the portion of consumer sentiment that added explanatory power is not actually exogenous, but rather reflects the measurement errors in the data available to consumers during the survey. Thus, the results suggest that consumer sentiment does not cause, but rather propagates the noise shocks caused by noisy announcements. In this sense the results from Croushore (2005) are not necessarily at odds with a theory of measurement error induced expectational shocks causing output fluctuations.

3.2.2 Consumer sentiment and GNP growth

Matsusaka and Sbordone (1995) studied the relationship between GNP growth and the Index of Consumer Sentiment in the US. They used data from 1953Q1 through 1988Q1. The time period was determined by data availability, with ICS available from 1953Q1. They used vector autoregressions with GNP growth and ICS, with between one and four lags, to study the interdependencies between the time series. They found that ICS helps predict GNP growth.

Similar to Carroll, Fuhrer and Wilcox (1994), Matsusaka and Sbordone (1995) chose to test whether ICS provides any incremental forecasting power when controlling for various other variables. As control variables, Matsusaka and Sbordone (1995) included the various combinations of money supply, government spending, sensitive materials prices, the Index of Leading Indicators and its individual components, and default risk (the interest rate spread between treasury bills and corporate debt). The various specifications resulted in qualitatively similar results. Matsusaka and Sbordone (1995) found that the ICS is largely exogenous of the control variables and explains between 13 and 26 percent of the variance of GNP innovations. They concluded that consumer sentiment has a statistically and economically significant effect on GNP growth. Matsusaka and Sbordone caution that their evidence does not prove that the expectations cause output fluctuations, since the results could be caused by a missing third variable. Nonetheless, the study provides significant evidence that in the US, expectations appear to be macroeconomically significant in their own right, rather than merely being a forecast based on other publicly available variables.

3.2.3 Professional forecasts and aggregate output

Choy, Leong and Tay (2006) found that forecasts by professional forecasters are not a statistically significant source of output fluctuations, when controlling for a set of real-time fundamentals. They used the one quarter ahead forecast for real GNP/GDP as the variable of interest. As control variables, they included a wide array of variables for which real-time series are available. These control variables include output, inflation, interest rate, stock returns, and consumption and investment growth. Additionally they included the revised values of output growth as the independent variable of interest. The time period they studied was due to data availability limited to 1974Q4 through 2002Q2.

They used a VAR model to extract changes in the professional forecasts not explained by the set of real-time control variables. They then used this non-fundamental component of the professional forecasts to determine whether it helps predict future output. They found that it does not. This paper is somewhat similar to Croushore (2005), in that both find that after controlling for real-time fundamentals, sentiment does not help predict the future. Thus, Choy, et al. leave open the possibility that measurement errors in real-time variables cause swings in sentiment which affect future output. While Choy, et al. rule out forecasts by professional economists as the source of output fluctuations, they do not rule out the possibility that the forecasts propagate noise shocks caused by measurement errors in real-time fundamentals.

3.2.4 Perceptions and recessions

Chauvet and Guo (2003) determined that pessimistic perceptions may have played an important role in several recessions in the United States. As a measure of consumer and entrepreneur sentiment they used the University of Michigan's Index of Consumer Sentiment and the Index of Net Business Formation. They also included a wide array of control variables, selected from a list of over 50 series. Similar to Choy, Leong and Tay (2006), they used a VAR model to determine when consumers and entrepreneurs were more or less pessimistic than the fundamentals warranted. They then studied movements in this non-fundamental consumer and entrepreneur sentiment around recessions, and found that self-fulfilling increases in pessimism may have played an important independent role in three recessions.

3.2.5 Consumer sentiment in Finland

Djerf and Takala (1997) conducted some tests regarding the causal relationships between consumer sentiment and growth in consumption and GDP. They analysed ten years of Finnish consumer sentiment survey data. Because of the small sample studied, including multiple control variables would not have been feasible. Using as control variables only four lags of the dependent variable, Djerf and Takala (1997) found that consumer sentiment helps forecast both consumption and GDP.

3.3 The effect of measurement errors on aggregate production

Having previously studied the relationship between false announcements and output fluctuations stepwise, we now turn our attention to studying the relationship directly.

Oh and Waldman (1990) found that expectational shocks caused by measurement errors in initial announcements of the Index of Leading Indicators accounts for a significant part of the fluctuation in the quarterly growth rate of industrial production.

Similarly to Oh and Waldman (2000), Oh and Waldman (1990) used the measurement mistakes in the initial announcement of the Index of Leading Indicators published by the US Department of Commerce as the source of expectational shocks. As the measure of output they used seasonally adjusted quarterly growth rate in industrial production. The data they used ranged from 1968 to 1988.

Controlling for the lagged industrial production and the final revised value of the Index, Oh and Waldman (1990) found that the errors in initial announcement of the Index were positively correlated with future growth in industrial production. Assessing the economic significance of their results, Oh and Waldman (1990) found that the revision term explains about 5% of the variability in industrial production before 1976 and about 20% after 1976. Similar to Oh and Waldman (2000), Oh and Waldman (1990) find that the significance of the revision term increased in 1976, after the Index of Leading Indicators was revised.

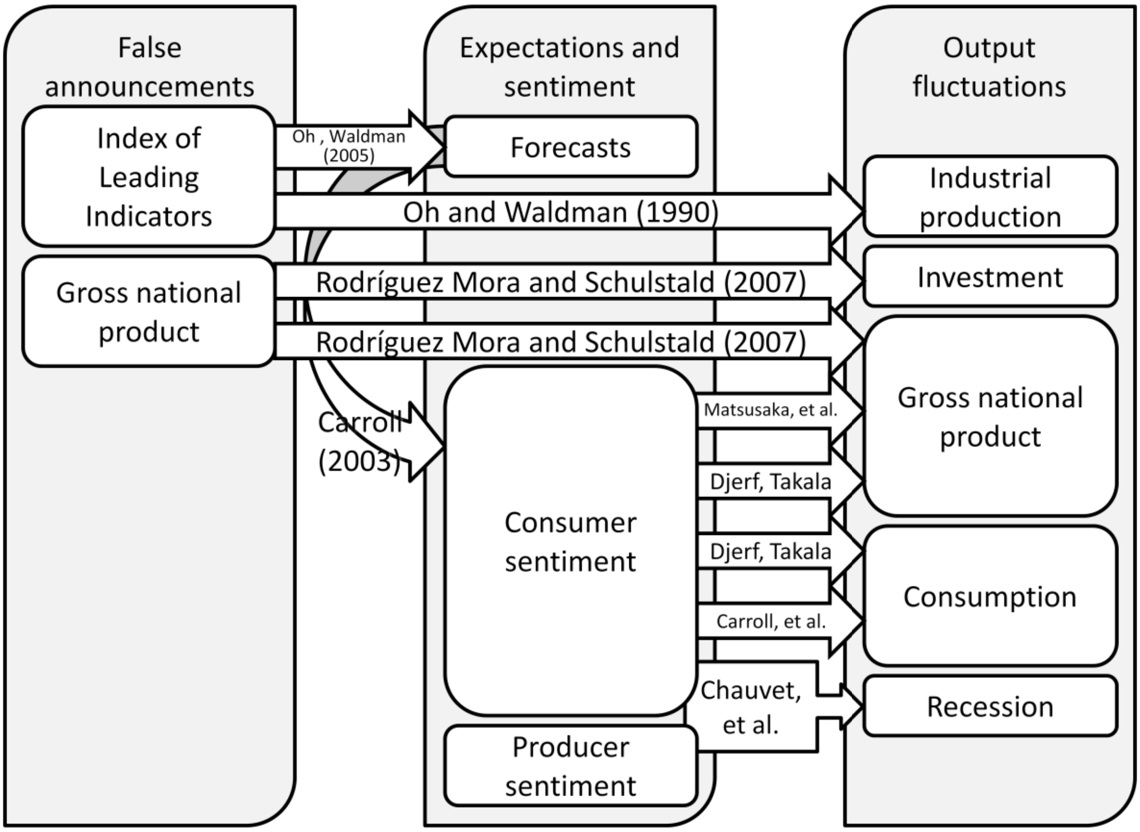
They conclude that their results suggest that false announcements can be a source of output fluctuations.

Similarly, Rodríguez Mora and Schulstald (2007) found that errors in initial GNP announcements cause fluctuations in GNP growth. Studying US data from 1967 through 1991, they found that when controlling for the final revised value, the measurement mistake of the initial announcement of GNP growth is negatively correlated with growth in GNP in the next quarter. Studying the individual components of the GNP, they found that the announcement affects GNP through investment. This study is discussed in greater detail in chapter 5.2.1.

3.4 Summary of previous empirical studies

The relevant results of the studies discussed above are summarised in Figure 2. From this figure we can see that the link between false announcements and future output is empirically validated with US data both directly and indirectly.

Figure 2. Results of previous empirical studies.



Rodríguez Mora and Schulstald (2007) and Oh and Waldman (1990) demonstrate a strong link between false announcements and future aggregate production using different variables for both the initial announcements and the future output. The fact that the relationship is validated using different sets of data shows that the results are robust.

The link between false announcements and sentiment is empirically less clear. Oh and Waldman (2005) show that false announcements of the Leading Indicators affect forecasts of professional economists. Carroll (2003) suggests that professional forecasts affect consumer sentiment. However, it was not demonstrated that false announcements actually affect consumer or producer sentiment. Nonetheless, since professional forecasts are a measure of sentiment, in broad terms the link between announcements and sentiment is empirically verified.

The relationship between sentiment and future consumption is established in Carroll, Fuhrer and Wilcox (1994), Bram and Ludvigson (1998) and Ludvigson (2004). Additionally, Matsusaka and Sbordone (1995) and Chauvet and Guo (2003) demonstrate that consumer and producer sentiment help forecast GNP growth and recessions. Choy, Leong and Tay (2006) and Croushore (2005) find that when controlling for real-time fundamentals, sentiment loses its forecasting power. This suggests that the swings in consumer sentiment that the other studies suggested affect output, are not truly exogenous, but based on noisy real-time data. Taken together, these studies suggest that sentiment might be the path through which noise shocks caused by measurement errors affect future output. Djerf and Takala (1997), studying Finnish data, provide some evidence that these findings are applicable outside the US as well.

In conclusion, this review of previous empirical studies provides evidence that measurement errors in initial announcements of statistics can be a source of fluctuations in future aggregate output. Now we will shift our focus to GDP announcements in particular.

4 GDP ANNOUNCEMENTS AND REVISIONS

In the previous chapters we demonstrated that some theoretical models predict that false announcements of aggregate economy statistics could cause output fluctuations. We then showed that there is some empirical evidence of measurement errors in macroeconomic statistics affecting sentiment and future output. In this chapter we will take this finding a step closer to the real-world by examining a specific macroeconomic statistic, GDP announcements. We will first discuss under what circumstances GDP might be the sort of aggregate economy statistic discussed previously. We will then briefly discuss the uncertainty in GDP announcements and their revision process. Finally, we will take a quick glance at the literature on real-time data analysis relating to GDP.

4.1 GDP announcements as a source of output fluctuations

The presence of strategic complementarity is not in itself a sufficient condition for output fluctuations caused by false announcements of statistics. It is almost trite to note, but nonetheless important to remember, that announcements of statistics matter only if economic agents pay attention to them. In practice this generally happens indirectly, with the media reporting the statistics announcements or professional macroeconomic forecasts based on statistics announcements. However, if the statistic is not considered relevant for forecasting purposes, there is no reason to expect it to affect sentiment. Thus, false announcements of irrelevant statistics are not expected to cause output fluctuations even under strategic complementarity. This means that only measurement errors in variables that are considered useful for forecasting are of interest to us.

From this it follows that announcements of GDP growth are expected to affect output only if they are useful for forecasting the future. Usually GDP growth is autocorrelated, so lagged values of GDP growth are useful in predicting future GDP growth. This does not necessarily mean that the initial announcements are relevant for forecasting purposes. For the announcements to be relevant, they must also be timely and accurate. It is possible that the initial announcements are made with such a long lag that by the time it is released, the data is already useless. It is also possible that the initial announcements are so noisy or biased that economic agents ignore them. Only reliable and timely statistics affect sentiment and thus potentially output.

In order to provide as timely statistics as possible, in many cases statistical offices report monthly aggregate production indicators as well. These are often based on a subset of the data the quarterly GDP announcements are based on, so the measurement error in them is expected to be correlated with the measurement error in initial GDP announcements. We have verified this to be the case at least in Finland. This means that the effect we ascribe to GDP announcements may in fact have been transmitted by an earlier monthly indicator. However, since real time databases of monthly indicators are so far very rare, we use initial announcements of GDP growth as a proxy for early aggregate production announcements in general.

4.2 The revision process

To understand the inevitable trade-off between timeliness and reliability in GDP announcements, it is necessary to briefly discuss how GDP statistics are compiled.

Measuring the aggregate value of all the goods and services produced in a country is by no means a simple task. The national accounts, which the GDP is a product of, are formed by combining general government accounts, corporate accounts, financial accounts and balance of payments. While aggregating all these data is not a trivial task in itself, the real challenge is that much of this data is available only after a certain time-lag. As an important example, company accounts are compiled on an annual basis, so they are unavailable for compiling quarterly national accounts. Since there is great demand for quick publication of quarterly data, statistical offices in various countries have devised different ways of compiling preliminary estimates. These methods can be based on small-scale samples of firms or on provisional data such as VAT declarations. The precise methods used differ from country to country, but in every case the initial announcements of the national accounts are based on incomplete data. Because of this, the initial announcement is followed by a series of revisions. In most cases it takes about two years before all the underlying data is ready and the published statistic can be considered final. (Blades and Lequiller 2007 and Paavonen 2008)

Even after this, however, the national accounts are subject to revision. Certain seasonal adjustment methods can cause small changes to even decades old numbers. Additionally, comprehensive revisions take place regularly. These usually incorporate some rarely collected statistic (such as census or housing survey), definitions and methodology changes, and a new reference year for chained-prices. As a result, all previous numbers are revised. Thus, GDP statistics are never truly finalised and there is always some degree of uncertainty in them. However, after about two years of revisions they can be considered quite reliable. It is always the latest revised number which should be considered the best estimate of the true state economy at a given time. (Blades and Lequiller 2007)

As noted earlier, the seasonal adjustment process causes revisions to earlier announcements. Because of this, at least initial announcements of seasonally adjusted quarterly growth are subject to greater uncertainty than announcements of annual growth. Seasonally adjusted quarterly growth is in theory a more timely measure of current economic activity and more useful in identifying business cycle turning points than the annual growth rate. There is a trade-off between timeliness and accuracy. While in theory the seasonally adjusted quarterly growth rate is a more timely measure, it is also noisier because of the seasonal adjustment process. Some countries, such as the United States, have opted to use the seasonally adjusted quarterly growth rate as the headline variable. Others, such as Finland and Sweden, use the real year-on-year growth rate as the headline variable. Nevertheless, in general both measures are reported and it is unclear which measure is considered more useful by forecasters. Thus, in theory measurement errors in initial announcements of either measure could be a source of expectational shocks and output fluctuations. (Öller and Hansson 2002)

As an example of the revision process, we will look at announcements regarding the quarterly growth of seasonally adjusted GDP in quarter 1992Q3 in Finland. The data is from the real-time database of GDP for Finland assembled by Paavonen (2008).

Figure 3. Development of the estimate for seasonally adjusted quarterly growth of GDP in 1992Q3 in Finland.

From this figure we can see that the initial announcement indicated relatively strong growth in GDP. However, after a year of revisions, the strong growth had changed into contraction. After about two years the revisions are smaller, with the exception of larger revisions due to definitional changes. The initial announcement of strong growth was in effect false: actually the economy had contracted. Especially in the midst of a recession, it seems intuitively obvious that this sort of false announcement would affect expectations.

4.3 The initial announcement as an estimate of true GDP growth

As noted earlier, initial announcements of GDP are useful for forecasting purposes only if they are reliable. Ideally, the initial announcement should be an efficient and unbiased estimate of the final value. Equivalently, the revisions to the initial announcement should be random and small. There exists a wealth of interesting literature regarding the revisions to GDP announcements (see Croushore (2008a) and Croushore (2008b) for an excellent literature review), but for our purposes a very brief overview of the results of past studies suffices.

Paavonen (2008) compiled the results of several studies to determine in which countries the initial announcement is an efficient estimate of the latest publication of seasonally adjusted quarterly growth of GDP. Paavonen (2008) concluded that the initial announcement is an efficient estimate only in the United States, while in Canada, Germany, Italy, Japan, United Kingdom, Netherlands, Sweden and Finland the revisions are, at least to some degree, predictable. In Finland, however, the revisions are predictable to a smaller degree than in the other countries. This result suggests that the initial announcement of GDP growth should be comparatively important in the United States and Finland. However, it should be remembered that just because the initial announcement is not an efficient estimate, does not mean it is not a useful estimate. Even if the revisions to the initial estimate are to some degree systematic and predictable, the revisions are not entirely predictable. Thus, it is not unreasonable to expect that GDP announcements would have an effect on perceptions in other countries as well. In addition, there is no guarantee that past predictability is evidence of future predictability. Because of this, neither statistical offices nor users of statistics can reliably correct for systematic revisions.

While systematic revisions to the initial announcements are a sign that the initial announcement is not an efficient estimate of the truth, it does not mean that the initial announcement is not useful for economic agents.

4.4 The initial announcement as a predictor of future GDP

Whether GDP announcements are used by economic agents in forming their perceptions about the future depends on whether initial announcements of GDP growth help predict future true GDP. A preliminary answer to this question can be obtained by using a very simple regression model:

$$y_{t+j}^{final} = \beta_0 + \beta_1 y_t^{initial} + e_t,$$

where y_{t+j}^{final} is the latest announced value of GDP growth in period t+j and $y_t^{initial}$ is the initial announcement of GDP growth in period t. Testing for what values of j the parameter β_1 is statistically significant gives us a very crude estimate of the usefulness of the initial announcement for forecasting the final estimate of GDP.

We will use the seasonally adjusted, quarter on quarter GDP growth rate announcement data from the OECD Main Economic Indicators real-time data set. This data set contains publications from February 1999 onwards, but the amount of data varies slightly from country to country. We've included in the analysis only countries for which the revision record is long enough to permit meaningful analysis[2]. In order to allow for sufficient revisions between the initial and final announcement, we included only quarters for which there have been at least two years between the initial and latest announcement. As noted in section 4.2, after two years the revisions generally reflect definitional changes or seasonal adjustment, rather than new data. While the number of revisions required to consider the data final is somewhat arbitrary, two years is a common choice.

In addition, we have longer time series from other sources for several countries. For USA, we have seasonally adjusted, quarterly GNP/GDP growth data from 1965Q3 onwards provided by Croushore and Stark (2001). For Finland we have both real year-on-year and seasonally adjusted quarterly GDP growth data from 1978Q4 onwards from Paavonen (2008). For Sweden we have real year-on-year GDP growth data from 1980Q1 to 1998Q4 courtesy of Öller and Hansson (2002). For New Zealand, which we will use the data from the real-time database made available by Reserve Bank of New Zealand, which ranges from 1984Q2 onwards. For England the data is from the real-time database maintained by the Bank of England, which ranges from 1975Q4 onwards.

The results for the regressions are tabulated below:

[2] The countries we chose to analyse were the same ones as McKenzie and Adam (2007) selected, in their analysis of revisions using the same database. In addition we included the aggregated Euro area, since that time series is also long enough.

Table 1. The initial announcement of GDP/GNP growth as a forecast of future GDP growth: the parameter estimate of the initial announcement term ($\boldsymbol{\beta_1}$).

Source	Country	Num of obs.	t+1	t+2	t+3	t+4
OECD	Australia	33	0.280	-0.031	-0.182	-0.317
	Belgium	34	0.242	0.092	-0.179	-0.124
	Canada	33	**0.498***	0.131	-0.047	-0.329
	Denmark	33	-0.160	-0.125	0.328	-0.111
	Spain	33	**0.509****	**0.483****	**0.482****	0.228
	Euro area	30	**0.738****	**0.483***	0.263	0.044
	Finland	33	-0.034	**0.279***	-0.049	0.002
	France	33	0.145	0.203	0.198	-0.182
	United Kingdom	33	-0.054	0.022	-0.226	-0.301
	Germany	33	0.210	0.383	-0.004	0.052
	Italy	32	0.347	0.051	0.176	0.088
	Japan	33	0.140	-0.046	-0.006	-0.0002
	Korea	29	0.025	0.091	-0.273	-0.097
	Netherlands	32	**0.547****	**0.411***	0.139	0.255
	Norway	32	-0.067	0.119	-0.300	-0.092
	New Zealand	31	0.021	0.244	-0.318	-0.133
	Portugal	28	0.146	-0.061	0.050	0.229
	Switzerland	33	0.382	0.136	-0.131	0.011
	United States	31	0.155	0.144	-0.029	-0.030
Other	**United States**	160	**0.371****	**0.215****	0.059	0.059
	Sweden (real YoY)	72	**0.702****	**0.610****	**0.495****	0.251
	Finland	103	0.081	**0.235***	**0.372****	0.064
	Finland (real YoY)	103	**0.815****	**0.722****	**0.635****	**0.444****
	New Zealand	79	0.046	-0.058	0.123	0.148
	United Kingdom	111	0.115	**0.155***	**0.156***	**0.224****

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

From this we can see that in some cases the initial announcement of GDP growth is positively correlated with future true GDP growth. Thus, the initial announcement can be useful in forecasting future GDP growth.

For the longer time series this result is statistically significant for United States, Sweden, Finland and United Kingdom. The number of quarters forward the initial announcement is useful in forecasting varies between two and four. New Zealand is an exception, with the initial announcement useless in predicting future GDP growth. Finland is the only country for which we have long series of both seasonally adjusted quarterly growth and real year-on-year growth announcements. The greater forecasting power of the real year-on-year growth announcements could be due to greater uncertainty in the initial announcements of quarterly growth rate. The absolute value of the relative revisions to the quarterly growth rate is more than twice as those to the real year-on-year growth rate (Paavonen 2008).

Using the OECD data, in the cases of Canada, Spain, Euro area, Finland and Netherlands, the initial announcement is a statistically significant predictor of future GDP growth between one to three quarters forward. For the other countries the results are statistically insignificant and the sign of the parameter estimate varies, which is probably due to the shortness of the time series. Particularly, the fact that the initial announcement is found to be statistically insignificant in forecasting future GDP using the OECD data for United States and United Kingdom, in contrast to the results using the longer time series, suggests that the OECD data is simply too short for meaningful analysis in this respect. Because of this, we will refrain from using the OECD data for future analysis.

While this is a very crude way to assess the utility of GDP growth announcements for forecasters, this demonstrates that at least in some cases GDP announcements can be useful for forecasting the future. This implies that measurement errors in initial announcements of GD growth could be a source of expectational shocks, which, in the presence of strategic complementarity, could cause output fluctuations. The remainder of this thesis is devoted to empirically examining the effect of these measurement errors.

5 EMPIRICAL FINDINGS

Previously we discussed models that predict noisy announcements regarding the aggregate economy cause fluctuations in aggregate output by influencing consumer or producer sentiment. In the previous chapter we discussed GDP announcements in particular, and showed that it is potentially such a noisy announcement. In this chapter we will test this hypothesis empirically, and determine whether false announcements of GDP statistics cause output fluctuations.

As discussed previously, false announcements affect output, if they affect it at all, through producer or consumer sentiment. Thus, there are two ways to test this relationship. We can test directly the relationship between false announcements and future output, or we can test the relationship stepwise. In this chapter we will take both approaches. Since we found in section 3.1 that sentiment appears to affect future output, to test the relationship stepwise requires us to test whether false announcements affect sentiment. We will also take the direct approach, and demonstrate that measurement error in initial announcements of GDP growth can affect future output.

Since the effect of measurement errors of GDP growth can alter over time, we will conduct some test for parameter instability. Since we do not know the date of the possible structural change, we will conduct the Quandt test for structural change of unknown timing. This method is described by Hansen (2001) and the necessary critical values are provided by Andrews (2003). The method is based on dividing the sample into two subperiods, estimating parameters for each subperiod separately and then comparing these estimates using an F-statistic. Since the break date is not known, all possible break dates are tested, and the largest F-statistic is selected. This statistic, known as the Quandt statistic, is then compared against the list of critical values provided be Andrews (2003). We will use the 5% critical value with 15% trimming, meaning that only the middle 70% of the sample is tested for possible breaks. If the Quandt statistic is over the critical value, then the test suggests that there is a break in at least one parameter estimate at that point. We then run similar tests on the two sub-periods, to determine whether there are other breaks as well. The results of the Quandt tests are omitted for conciseness, but we will report on the results in general terms.

Heteroskedasiticity, or unequal variance of the error term, is another potential source of misspecification in our model. Long and Ervin (2000) find that testing for heteroskedasticity in order to determine whether heteroskedasticity robust standard errors are appropriate is inefficient. Rather, if there is an a priori reason to suspect heteroskedasticity, heteroskedasticity robust standard errors should always be used. Since we have no particular reason to suspect heteroskedasticity, we will use ordinary standard errors. However, to ensure the robustness of our results we tested our main regressions using the HC3-type robust standard errors suggested by Long and Ervin

(2000). The results were qualitatively similar using both normal and HC3-type standard errors, with only a few isolated instances in which the statistical significance of our results either increased or decreased somewhat. Thus, we believe our results are not affected by heteroskedasticity, and will omit the results obtained using HC3 standard errors for conciseness.

Autocorrelation of error terms is another common problem with time series data. Where appropriate, we will test for this using the Durbin-Watson statistic, introduced by Durbin and Watson (1950, 1951)[3]. In many cases we have a lagged value of the dependent variable as an independent variable. In these situations the ordinary Durbin-Watson statistic is inappropriate. Instead, we will use a modification of this statistic known as the Durbin h-statistic, introduced by Durbin (1970). As with the Quandt-test, we will omit reporting these statistics for conciseness. We will, however, note the situations in which the Durbin-Watson statistic suggests autocorrelation of the error terms is a problem. When necessary, to correct for this serial correlation, we will use an autoregressive error model as implemented by the SAS AUTOREG procedure. To select the order of the autoregressive model used, we will use stepwise autoregression with ten lags initially. The autoregressive parameters are sequentially removed, until all the remaining ones have t-tests significant at the 5% level. The stepwise procedure is performed using the Yule-Walker method described by Gallant and Goebel (1976) and the final results are maximum likelihood estimates.

Outliers are another potential source of trouble, since ordinary least squares models are highly non-robust to outliers. One way to overcome this limitation is to use robust regression. In particular, we will use M-estimation as introduced by Huber (1973) and implemented by the ROBUSTREG procedure of SAS. The method differs from

[3] An alternative way to deal with possible autocorrelation and heteroskedasticity would be to use heteroskedasticity and autocorrelation robust standard errors, such as those suggested by Newey and West (1987). However, in the interest of maintaining simplicity in estimation, we have elected to use ordinary standard errors and test separately for autocorrelation. We believe these results to be robust to alternative methods as well.

ordinary least squares, in that rather than minimising the sum of the squares of the residuals, the sum of some less rapidly increasing function of the residuals is minimised. In practice the algorithm for calculating the estimates is iteratively reweighted least squares. We will use the bisquare weight function. As with the heteroskedasticity consistent errors, we will omit reporting the results using robust regression except when robust regression produces qualitatively different results. In an attempt to maintain simplicity, we feel that it is preferable to use as simple a model as possible, but no simpler.

5.1 The effect of false announcements on expectations

Oh and Waldman (2005) demonstrate that measurement errors in initial announcement of some statistics can cause expectational shocks, but it doesn't directly address the topic of this thesis, the effect of measurement errors in GDP announcements. To address this question, we will take a similar approach as Oh and Waldman (2005) using different sets of data.

5.1.1 Forecasts: USA

First, we will test the effect of false announcements of aggregate output growth on professional forecasts in the United States. For the explanatory variables, we will use the GNP/GDP announcements from the real-time data set for macroeconomists introduced by Croushore and Stark (2001). The U.S. Bureau of Economic Analysis changed the headline aggregate output variable from GNP to GDP in 1991. Since we are interested in growth rates, the difference between the variables are small and for the most part we will ignore this change in definitions[4]. This data is available from 1965Q3 onwards, with 2008Q2 (released in 2008Q3) as the latest vintage. Since the data base includes only seasonally adjusted variables, we will use seasonally adjusted, quarter-to-quarter GNP/GDP growth as the measure of aggregate production. We will include the latest announced growth rate as the control variable and the revision to the initial announcement ($r_t^{final} = y_t^{final} - y_t^{initial}$) as the explanatory variable of interest. In

[4] Our tests indicate that the results are qualitatively similar when restricting the analysis to either variable.

order to allow for a sufficient number of revisions between the initial and "final" announcement, I will restrict the analysis to 2006Q2 and earlier.

As the dependent variable, following Oh and Waldman (2005), we will use forecasts from the Survey of Professional Forecasters, available from the Federal Reserve Bank of Philadelphia (2008). We will use both mean forecasts for growth in industrial production as well as GNP/GDP[5]. We will use the forecasts for quarter's t+1 through t+4. Forecasts are available from 1968Q3 onwards. [6]

Thus, the regression takes the form:

$$E_{t+1}\left[X_{t+j}\right] = \beta_0 + \beta_1 E_{t-1}\left[X_{t+j}\right] + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

where $E_{t+1}\left[X_{t+j}\right]$ is the forecast for quarterly growth in either GNP/GDP or industrial production for j quarters forward made after the initial announcement of GNP/GDP growth, while $E_{t-1}\left[X_{t+j}\right]$ is a similar forecast made before the announcement. We will run the regressions both with and without the previous forecast term included to test the robustness of the results. The results for these regressions are tabulated below:

[5] The results are qualitatively similar when using the median forecast.

[6] Forecasts for growth in real GNP/GDP are available only from 1981Q2, but using forecasts for nominal GNP and the GNP deflator it is possible to extrapolate the forecasts for real GNP/GDP starting from 1968Q3. We will use the extrapolated forecasts for real GNP/GDP growth.

Table 2. The impact of GDP/GNP announcements on professional forecasts of in the United States.

Forecasted variable	Forecasted quarter	Intercept β_0	Previous forecast β_1	'True' GDP/GNP growth β_2	Revision term β_3	Adj R-Sq	N
GNP/GDP	t+1	**0.012****		**1.875****	**-1.794****	0.425	152
	t+1	-0.001	**0.865****	**0.522****	**-0.674****	0.720	146
	t+2	**0.021****		**0.981****	**-1.090****	0.186	152
	t+2	**-0.004****	**1.052****	**0.235***	**-0.412****	0.791	146
	t+3	**0.027****		**0.331***	-0.298	0.022	152
	t+3	**-0.004***	**1.111****	0.041	-0.103	0.742	146
	t+4	**0.030****		-0.007	-0.071	-0.012	152
	t+4	**0.007****	**0.752****	0.019	0.034	0.544	146
Industrial production	t+1	-0.0002		**4.029****	**-3.618****	0.454	152
	t+1	**-0.015****	**0.863****	**1.922****	**-1.893****	0.704	146
	t+2	**0.025****		**1.305****	**-1.126***	0.084	152
	t+2	-0.004	**1.004****	0.214	-0.259	0.715	146
	t+3	**0.036****		0.089	0.216	-0.010	152
	t+3	-0.005	**1.059****	-0.033	0.310	0.762	146
	t+4	**0.044****		**-0.613****	0.543	0.038	152
	t+4	**0.007****	**0.889****	**-0.398****	**0.572****	0.737	146

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

From this table we can see that the parameter estimate for the revision term for forecasts one and two quarters ahead is negative in all eight cases and statistically significant in all but one. For forecasts further into the future the results are not conclusive. Interestingly, when controlling for the previous forecast, the revision term is positive and statistically significant for the four quarters ahead forecast of industrial production. This anomaly is interesting, but does not affect the conclusion that revisions to the initial announcements of GNP/GDP growth are negatively correlated with very short term professional forecasts of both industrial production and GNP/GDP growth in the United States. That is, falsely optimistic GDP announcements, which need to be revised downwards, are associated with higher short-term forecasts of growth. For longer term forecasts the measurement errors do not appear relevant. This finding is consistent with Table 1, where we found that in the US the initial announcement of GDP is useful for forecasts between one and two quarters forward.

The Quandt test for parameter instability indicate a possible break for GDP forecasts two quarters ahead around 1978, but the results are qualitatively similar in the suggested subperiods so this break is of no concern to us. The Durbin-Watson test indicates that the error terms are autocorrelated in the specifications without the previous forecast included as a regressor. With it included, the Durbin h-statistic indicates that there is no autocorrelation left in the residuals. Since the results are qualitatively similar with and without the previous forecast included as a regressor, we do not consider autocorrelation to be a problem.

To assess the economic significance of these results, we will compare the R-squared values of regressions both with and without the revision term included. We will focus on the one and two quarter ahead forecasts, since these are the specifications in which the revision term is found to be statistically significant.

Table 3. The explanatory power of the revision of GNP/GDP announcements on professional forecasts of GNP/GDP and industrial production growth in the United States.

<table>
<tr><td colspan="3"></td><td colspan="2">R-squared</td><td rowspan="2">Difference: the variability explained by the revision term</td></tr>
<tr><td>Previous forecast included as independent variable</td><td>Forecasted variable</td><td>Forecasted quarter</td><td>Without revision term</td><td>With revision term</td></tr>
<tr><td rowspan="4">No</td><td rowspan="2">GNP/GDP</td><td>t+1</td><td>0.286</td><td>0.433</td><td>0.147</td></tr>
<tr><td>t+2</td><td>0.112</td><td>0.197</td><td>0.085</td></tr>
<tr><td rowspan="2">Industrial Production</td><td>t+1</td><td>0.321</td><td>0.461</td><td>0.140</td></tr>
<tr><td>t+2</td><td>0.069</td><td>0.096</td><td>0.027</td></tr>
<tr><td rowspan="4">Yes</td><td rowspan="2">GNP/GDP</td><td>t+1</td><td>0.698</td><td>0.714</td><td>0.016</td></tr>
<tr><td>t+2</td><td>0.765</td><td>0.777</td><td>0.012</td></tr>
<tr><td rowspan="2">Industrial Production</td><td>t+1</td><td>0.671</td><td>0.705</td><td>0.034</td></tr>
<tr><td>t+2</td><td>0.706</td><td>0.708</td><td>0.002</td></tr>
</table>

Column 6 is defined as (column 5)-(column 4).

From this table we can see that the revision term explains over 14% of the variability of forecasts one quarter ahead when not controlling for the previous forecast. With the previous forecast included as a control, the revision term explains only 1-3% of the variability of forecasts one quarter ahead when controlling for the previous forecast, but only about 1% of the variability of forecasts two quarters ahead. This suggests that errors in GDP announcements affect mostly short-term forecasts, and that the economic significance of these expectational shocks is limited.

5.1.2 Forecasts: Finland

To determine whether GDP announcements affect expectations in Finland, we will now conduct the same regressions using Finnish data. As forecaster data, we have the forecasts for GDP growth for the current year and the next year by Finland's Ministry of

Finance, OECD and the Research Institute of the Finnish Economy ETLA. We will assess these forecasters individually, as well as with them all pooled into one group. These forecasts are available from 1970 onwards, so the limiting factor is the availability of GDP announcements. The Finnish real-time data set from Paavonen (2008) contains GDP announcements from 1978Q4 onwards. The latest vintage used is 2005Q2, to allow for sufficient number of revisions before the final vintage. As final values we will use the latest vintage in the Paavonen (2008) data set, which was released on 7.9.2007. We have attempted to match each forecast to the latest vintage of GDP data available at the time the forecast was devised[7]. We will run the regressions alternatively with announcements of seasonally adjusted quarterly growth and as real year-on-year growth of GDP as the independent variable of interest

As in 5.1.1, the regression takes the form:

$$E_{t+1}\left[Y_j\right] = \beta_0 + \beta_1 E_{t-1}\left[Y_j\right] + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

where $E_{t+1}\left[Y_j\right]$ is the forecast for growth in GDP for either the current or next year made after the release of the latest GDP vintage, while $E_{t-1}\left[Y_j\right]$ is a forecast for the same year made before the release of the latest vintage. For the current year forecasts we will run the regressions both with and without the previous forecast term included to test the robustness of the results. For the next year forecasts a previous forecast is not usually available, so the previous forecast term is not included. The results for these regressions are tabulated below:

[7] We used the timestamps from the ETLA database as well as expert help from Eija Kauppi (26.9.2008), ETLA, and Harri Kahkonen (25.9.2008), Ministry of Finance, to determine when the forecasts were made. The timestamps reflect when the forecast was input into the database, which generally happened some time after the initial publication of the forecast. The results presented here are based on our best judgement of when the forecasts were made. Blind faith in the timestamps produced qualitatively similar results.

Table 4. The impact of GDP announcements on professional forecasts of annual GDP growth in Finland.

GDP measure	Forecaster	Year	Intercept β_0	Previous forecast β_1	'True' GDP growth β_2	Revision term β_3	Adj. R-Sq	n
Seas. adj. QoQ	OECD	Current	**0.019****		**1.386****	**-0.984***	0.341	48
		Current	**-0.006***	**1.061****	**0.616****	**-0.666****	0.849	47
		Next	**0.026****		**0.5838****	-0.191	0.197	46
	Ministry of Finance	Current	**0.017****		**1.303****	-0.268	0.431	76
		Current	**-0.005****	**1.088****	**0.318****	**-0.238***	0.877	76
		Next	**0.026****		**0.819****	-0.287	0.412	49
	ETLA	Current	**0.018****		**1.487****	**-0.721***	0.387	93
		Current	**-0.003***	**1.016****	**0.351****	-0.143	0.895	93
		Next	**0.027****		**0.575****	-0.313	0.173	93
	All	Current	**0.018****		**1.375****	**-0.571****	0.394	217
		Current	**-0.004****	**1.038****	**0.401****	**-0.256****	0.878	216
		Next	**0.026****		**0.628****	**-0.283***	0.236	188
Real YoY	OECD	Current	**0.011****		**0.660****	**-0.620****	0.747	48
		Current	-0.001	**0.728****	**0.344****	**-0.345***	0.870	47
		Next	**0.024****		**0.207****	-0.114	0.202	46
	Ministry of Finance	Current	**0.013****		**0.575****	**-0.438****	0.724	76
		Current	-0.003	**0.920****	**0.178****	**-0.206***	0.881	76
		Next	**0.025****		**0.199****	-0.183	0.236	49
	ETLA	Current	**0.011****		**0.645****	**-0.529****	0.721	93
		Current	-0.003	**0.902****	**0.169****	-0.037	0.897	93
		Next	**0.026****		**0.150****	-0.025	0.110	93
	All	Current	**0.012****		**0.623****	**-0.516****	0.730	217
		Current	-0.002	**0.850****	**0.220****	**-0.171****	0.884	216
		Next	**0.025****		**0.176****	-0.093	0.171	188

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

The parameter estimate for the revision term is negative for all model specifications. In 14 out of 24 specifications, the parameter estimate for the revision term is statistically significant. This suggests that measurement error in initial announcements of GDP growth is positively correlated with professional forecasts of GDP growth in Finland.

The Quandt test for parameter instability indicates possible breaks when using the seasonally adjusted quarterly growth as the measure of GDP. The timing of the suggested breaks varies depending on the forecaster and whether the previous forecast is included as a dependent variable. Breaks are suggested at 1981Q3, 1990Q4, 1993Q4, 2001Q1 and 1994Q4. As the results are qualitatively similar in all subperiods, these breaks are not of interest to us. Additionally, the fact that there is no unity in the timing of the suggested breaks indicates that these breaks are not of economic interest.

The Durbin-Watson and Durbin h-statistics suggest serial correlation in 19 of the above 24 regressions. To correct for this serial correlation, we will use an autoregressive error model in the specifications where serial correlation appeared to be a problem. That is, the model to be tested is of the form:

$$E_{t+1}[Y_j] = \beta_0 + \beta_1 E_{t-1}[Y_j] + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

where e_{t+1} is an autoregressive error term defined by

$$e_{t+1} = \varepsilon_{t+1} - \sum_{i \in K} \varphi_i e_{t+1-i}$$

The number of autoregressive parameters φ_i included in the model is determined by a stepwise procedure as described earlier, so that all the autoregressive parameters are statistically significant at the 5%-level. For the cases where no autoregressive term is found statistically significant, the estimates are ordinary least squares estimates. We will not run the autoregressions with all forecasters pooled together, because that does not produce a time series with observations at regular intervals as is required for autoregressions. Similarly, the Ministry of Finance forecasts for the next year are excluded, because they have been made at irregular intervals. Below are tabulated the results from the final specifications.

Table 5. The impact of GDP announcements on professional forecasts of annual GDP growth in Finland using autoregressive error models.

GDP measure	Forecaster	Year	Intercept β_0	Previous forecast β_1	'True' GDP growth β_2	Revision term β_3	R-Square	AR	n
Seas. adj. QoQ	OECD	Current	**0.023****		**0.639****	**-0.623***	0.620	1	48
		Current	**-0.006***	**1.061****	**0.616****	**-0.666****	0.859	none	47
		Next	**0.027****		**0.386***	-0.287	0.362	1	46
	Ministry of Finance	Current	**0.027****		**0.298***	**-0.309***	0.715	1, 2	76
		Current	**-0.005****	**1.088****	**0.318****	**-0.238***	0.882	none	76
	ETLA	Current	**0.025****		**0.274***	-0.236	0.751	1	93
		Current	**-0.003***	**1.016****	**0.351****	-0.143	0.899	none	93
		Next	**0.03****		**0.189***	**-0.246***	0.564	1	93
Real YoY	OECD	Current	**0.011****		**0.660****	**-0.620****	0.757	none	48
		Current	-0.001	**0.728****	**0.344****	**-0.345***	0.879	none	47
		Next	**0.025****		**0.177***	-0.139	0.370	1	46
	Ministry of Finance	Current	**0.013****		**0.575****	**-0.438****	0.732	none	76
		Current	-0.003	**0.920****	**0.178****	**-0.206***	0.886	none	76
	ETLA	Current	**0.015****		**0.481****	**-0.418****	0.789	1, 7	93
		Current	-0.001	**0.829****	**0.208****	-0.157	0.917	1, 3	93
		Next	**0.027****		**0.133****	-0.073	0.593	1, 6, 7	93

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level. The column AR denotes which autoregressive lags are included in the final model. For the models in which no autoregressive lags where found to be statistically significant, the results are identical to Table 4.

As in Table 4, all the estimated parameter coefficients for the revision term are negative, with ten out of sixteen statistically significant. This time only the models with current year forecasts by OECD as the dependent variable with the previous forecast included as a control exhibit serial correlation. Since the results in Table 4 and Table 5 are qualitatively similar, we feel confident that false announcements do affect forecasts in Finland.

Once again, to determine the economic significance of the error in the initial announcement, we will examine the R-squared values of regressions both with and without the revision term. We will use the regressions from Table 5, with the same number of autoregressive error terms as previously.

Table 6. The explanatory power of the revision of GDP/GNP announcements on forecasts in Finland.

GDP measure	Forecaster	Year	Previous forecast included	R-Square		Difference: the variability explained by the revision term
				Without revision term	With revision term	
Seas. adj. QoQ	OECD	Current	No	0.580	0.620	0.040
		Current	Yes	0.833	0.859	0.026
		Next	No	0.340	0.362	0.022
	Ministry of Finance	Current	No	0.695	0.715	0.020
		Current	Yes	0.874	0.882	0.008
	ETLA	Current	No	0.744	0.751	0.007
		Current	Yes	0.897	0.899	0.002
		Next	No	0.540	0.564	0.024
Real YoY	OECD	Current	No	0.691	0.757	0.066
		Current	Yes	0.861	0.879	0.018
		Next	No	0.358	0.370	0.012
	Ministry of Finance	Current	No	0.684	0.732	0.048
		Current	Yes	0.876	0.886	0.010
	ETLA	Current	No	0.770	0.789	0.019
		Current	Yes	0.914	0.917	0.003
		Next	No	0.591	0.593	0.002

Column 7 is defined as (column 6)-(column 5).

The explanatory power of the revisions varies between 0 % and 7 % for current year forecasts. For next year forecasts the revision term explains at most 2 % of the variability. Similar to the results from the United States, the explanatory power of the revision term is lower for longer term forecasts. Nonetheless, false announcements have a noticeable impact on next year forecasts as well. We can conclude that in the case of Finland, false announcements of GDP statistics cause shocks to expectations.

5.1.3 Consumer sentiment: USA

In addition to using professional forecasts as a measure of perceptions, we will also use consumer sentiment. To test the effect of false announcements on consumer sentiment, we will use the Index of Consumer Sentiment from the Reuters/University of Michigan Survey of Consumers as the dependent variable. This data is available at monthly frequency from 1978 onwards, so the first GNP announcement we include is that for 1977Q4. We will use the value of the Index of Consumer Sentiment whose interviews were conducted immediately after the initial announcement of GNP/GDP growth[8]. As the independent variables we will use the same ones as above. Now the regression takes the form

$$ICS_{t+1} = \beta_0 + \beta_1 ICS_{t-1} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

where ICS_{t+1} is the value of the Index of Consumer Sentiment after the initial announcement and ICS_{t-1} is the value of the ICS before the announcement. We will run the regressions both with and without the previous ICS term. The parameter estimates for these regressions are tabulated below:

Table 7. The impact of GNP/GDP announcements on the Index of Consumer Sentiment in the United States.

Intercept β_0	Previous ICS β_1	'True' GNP/GDP growth β_2	Revision term β_3	Adj R-Sq	n
82.22372**		**919.178****	**-1047.502****	0.235	114
4.70956	**0.94012****	49.783	-124.039	0.915	114

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

The parameter estimate for the revision term is negative in both model specifications. It is statistically significant in the first model specification, where the previous sentiment is not included as a control. With the previous ICS value included as a regressor, the GNP/GDP terms lose statistical significance.

The Quandt test for parameter instability indicates a possible break at 1982Q3 when the previous value of ICS is not included as a regressor. However, the results are qualitatively similar in both subperiods, so this break is not of interest to us. The Durbin-Watson statistic suggests that serial correlation is a problem in the model without the previous ICS value as a regressor. In an autoregressive error model the

[8] BEA makes the initial announcement of GDP/GNP growth for the previous quarter near the end of the first month of each quarter, so the first Consumer Confidence survey incorporating that new information is the survey for the second month of the next quarter. So the first survey after the initial announcement of Q1 GDP is in May; Q2 is August; Q3 is November; and Q4 is February of the next year.

revision term loses statistical significance but remains negative. These results are omitted for conciseness.

Since the parameter estimate for the revision term is not statistically significant in the correctly specified model, we do not find evidence that false announcements affect consumer sentiment in the United States. While the results from the first regression in Table 7 suggest that announcements do affect consumer sentiment, the results are not robust to adding lagged values of sentiment or autoregressive error terms to the model.

5.1.4 Consumer sentiment: Finland

We will also gauge the effect of false GDP announcements on consumer sentiment in Finland. Statistics Finland has conducted consumer confidence surveys since 1987. We will however restrict our analysis to start from 1991, after which the survey has been conducted at least quarterly. In 1995 the consumer confidence index was EU-harmonised and some new questions were added. As a result, the calculation of the index was changed in 1995. As a result, the new-style consumer confidence index is available from 1995 onwards. The old questions were retained as well, so it is possible to calculate the old-style index from 1991 onwards. We will use both in our analysis. We have attempted to match the GDP vintage to the consumer confidence survey whose interviews started immediately after the publication of the GDP vintage[9]. The independent variables are as previously.

Now, similar to section 5.1.3, the regression takes the form

$$ICS_{t+1} = \beta_0 + \beta_1 ICS_{t-1} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

with the terms defined as previously. Once again, we will run the regressions both with and without the previous ICS term included as a regressor. The parameter estimates for these regressions are tabulated below:

[9] Pertti Kangassalo (29.9.2008), Statistics Finland, provided us with information about when the surveys were conducted.

Table 8. The impact the revision of GDP announcements on consumer sentiment in Finland.

Measure of consumer sentiment	GDP measure	Intercept β_0	Previous ICS β_1	'True' GDP growth β_2	Revision term β_3	Adj R-Sq	n
New style index, 1995Q3-2007Q2	Real YoY	**10.366****		**96.080****	-95.948	0.220	41
		2.265	**0.812****	3.359	-31.968	0.649	40
	Seas. adj. QoQ	**10.638****		**314.904****	-54.118	0.261	41
		2.180	**0.758****	90.657	-30.224	0.662	40
Old style index, 1991Q1-2007Q2	Real YoY	**2.594****		**204.237****	-25.506	0.716	58
		1.046	**0.792****	28.876	30.887	0.861	58
	Seas. adj. QoQ	**3.086****		**669.071****	-14.304	0.615	58
		1.077*	**0.741****	**191.340****	-21.667	0.877	58

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

Once again, the parameter estimate for the revision term is negative for almost all model specifications. This time, however, none of the parameter estimates are statistically significant. The parameter estimate using real year-on-year growth rate and the new style index, without the previous ICS value included (first regression), is the closest to being statistically significant at the 5% level, with a p-value of 0.0602.

The Quandt test for parameter instability indicates possible breaks when the previous value of ICS is not included as a regressor and the old style index is used. The test indicates a break around 1993Q3. Restricting the analysis to the quarters after 1993Q3 increases the absolute value and statistical significance of the revision term, but the parameter estimate is still not statistically significant. The Durbin-Watson and Durbin-h statistics imply serial correlation in the models without the previous consumer sentiment term included as a regressor. With autoregressive error terms included to correct for serial correlation, the revision terms remains statistically insignificant.

Similar to the results achieved using data from the United States, we are not able to demonstrate a relationship between GDP announcements and consumer sentiment in Finland. While we can not rule out such a relationship, we have not found significant evidence of consumer sentiment being affected by GDP announcements.

5.1.5 Business confidence: Finland

As a final measure of sentiment, we will take surveys of business sentiment. The Confederation of Finnish Industries EK has conducted a quarterly survey of business sentiment since 1976. For our purposes, we will use the composite confidence index measuring economic outlook expectations for the near-term future. We will use the composite index for individual industries, as well as for all industries combined. We attempted to match each business sentiment survey to the GDP vintage released immediately before the beginning of the survey[10]. Now, similar to previously, the regression takes the form

$$PS_{t+1} = \beta_0 + \beta_1 PS_{t-1} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

where PS_{t+1} is the value of the producer sentiment index after the initial announcement of GDP growth and PS_{t-1} is the value of the index before the announcement. We will run the regressions both with and without the previous sentiment term. The results for these regressions are tabulated below.

[10] Penna Urrila (17.10.2008), EK, provided us with information about when the surveys were conducted.

Table 9. The impact of the revision of GDP announcements on producer sentiment in Finland.

Industry	GDP measure	Intercept β_0	Previous sentiment β_1	'True' GDP growth β_2	Revision term β_3	n	Adj R-sq
Food	Real YoY	**-7.160****		91.519	74.581	98	0.027
		-2.703	**0.543****	18.578	125.504	98	0.295
	Seas. adj. QoQ	**-6.556****		**371.444****	-244.269	98	0.063
		-2.825	**0.514****	179.965	-157.833	98	0.303
Textile, cloth and leather	Real YoY	**-10.382****		26.317	194.466	98	-0.010
		-1.762	**0.758****	-62.518	**275.684***	98	0.626
	Seas. adj. QoQ	**-11.351****		**407.563***	-173.170	98	0.025
		-2.889	**0.744****	33.604	189.048	98	0.611
Wood	Real YoY	-4.714		-144.307	**899.394***	98	0.040
		0.949	**0.784****	**-158.881***	**606.329****	98	0.685
	Seas. adj. QoQ	-6.652		338.132	-374.025	98	-0.010
		0.292	**0.802****	-139.978	-76.571	98	0.652
Chemical	Real YoY	-0.258		22.992	324.718	98	0.001
		1.689	**0.631****	-38.720	95.356	98	0.381
	Seas. adj. QoQ	-1.436		**513.147***	-208.561	98	0.038
		-0.130	**0.609****	217.149	-177.471	98	0.388
Metal and machine shop	Real YoY	-2.738		73.502	-4.253	98	-0.011
		1.228	**0.853****	-71.202	236.181	98	0.690
	Seas. adj. QoQ	-3.644		**511.052***	-405.105	98	0.045
		0.556	**0.831****	-43.845	-4.409	98	0.675
Clay, glass and stone	Real YoY	**-26.592****		**280.651***	300.528	98	0.046
		-0.145	**0.847****	-88.740	335.846	98	0.659
	Seas. adj. QoQ	**-24.513****		**1120.258****	-600.046	98	0.085
		-1.798	**0.821****	80.234	-301.590	98	0.652
Construction	Real YoY	**-28.829****		**534.781****	75.459	98	0.256
		-4.115	**0.782****	53.923	125.844	98	0.637
	Seas. adj. QoQ	**-22.465****		**1328.936****	-455.280	98	0.193
		-2.807	**0.796****	216.602	-450.476	98	0.644
All	Real YoY	**-7.044***		60.035	323.397	98	0.011
		1.082	**0.879****	**-91.399***	**324.143****	98	0.767
	Seas. adj. QoQ	**-7.453****		**573.800****	-357.530	98	0.057
		0.040	**0.859****	-15.333	-51.479	98	0.739

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

At first glance, these results seem quite anomalous. In the very few model specifications where the revision term is statistically significant, the parameter estimate is positive. This finding is counterintuitive and anomalous when considering the previous results using professional forecasts as a measure sentiment. In other cases the sign of the parameter estimate is almost evenly divided between positive and negative values. However, when grouping the results by the GDP measure used, we can see that in 15 out of 16 cases the parameter estimate for the revision term is negative when using the quarterly measure of GDP growth. Conversely, when the real year-on-year GDP growth is used, in 15 out of 16 cases the parameter estimate for the revision term is positive. This suggests that it might be useful to test model specifications in which both measures of GDP growth are included. Thus the model becomes:

$$PS_{t+1} = \beta_0 + \beta_1 PS_{t-1} + \beta_2 y_{SA\ QoQ}{}_t^{final} + \beta_3 r_{SA\ QoQ}{}_t^{final} + \beta_4 y_{real\ YoY}{}_t^{final} + \beta_5 r_{real\ YoY}{}_t^{final} + e_{t+1},$$

where $y_{SA\ QoQ}{}_t^{final}$ and $r_{SA\ QoQ}{}_t^{final}$ are growth and revision to seasonally adjusted quarterly GDP, while $y_{real\ YoY}{}_t^{final}$ and $r_{real\ YoY}{}_t^{final}$ are growth and revision to real year-on-year GDP.

The results for this alternative specification are tabulated below:

Table 10. The impact the revision of GDP announcements on producer sentiment in Finland when considering both annual and quarterly GDP simultaneously.

Industry	Intercept β_0	Previous sentiment β_1	True GDP QoQ β_2	Revision QoQ β_3	True GDP YoY β_4	Revision YoY β_5	n	Adj. R-sq
Food	**-7.312****		**396.447***	-418.779	-6.104	241.085	98	0.064
	-3.029	**0.522****	282.605	-359.276	-46.913	265.502	98	0.314
Textile, cloth and leather	**-10.405****		**752.967****	-504.068	-166.079	399.694	98	0.047
	-1.854	**0.738****	**354.887***	-76.613	**-154.705***	308.923	98	0.635
Wood	-5.399		**1334.090****	**-1596.916****	**-468.316****	**1531.216****	98	0.125
	0.231	**0.756****	443.286	**-840.690***	**-258.572***	**945.194****	98	0.698
Chemical	-0.328		**995.239****	-709.019	**-230.284***	**612.275***	98	0.091
	1.509	**0.586****	**616.778***	-436.947	**-191.311***	289.094	98	0.409
Metal and machine shop	-2.860		**748.734***	-608.407	-115.243	240.660	98	0.041
	1.008	**0.836****	194.388	-276.384	-114.481	**340.102***	98	0.691
Clay, glass and stone	**-26.949****		**1191.528***	-1148.391	-15.396	758.943	98	0.094
	-1.211	**0.828****	479.696	**-820.581***	-191.040	**656.124***	98	0.671
Construction	**-29.007****		587.537	-568.406	**388.852****	302.316	98	0.263
	-4.407	**0.790****	248.975	**-749.087***	-0.568	416.150	98	0.649
All	**-7.303***		**960.312****	**-893.407***	-179.335	**680.610***	98	0.112
	0.554	**0.846****	**354.483***	**-466.146***	**-170.741****	**507.935****	98	0.783

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

Now the parameter estimates for the quarterly growth revision terms are all negative, and the parameter estimates for the annual growth revision terms are all positive. As expected, the true growth terms are all opposite in sign compared to the revision term. In 13 out of 32 cases the revision term is statistically significant. At least in one specification a revision term is statistically significant for all industries, except the food industry and the textile, cloth and leather industry. This could be because these industries are comparatively business-cycle resistant, which might imply that their sentiment does not fluctuate strongly due to macroeconomic conditions.

The fact that the annual GDP growth terms take opposite signs compared to the seasonally adjusted quarterly growth terms is interesting. As noted previously, quarterly growth rates are a more timely measure, since they measure only the growth in the previous quarter, while annual GDP growth rates measure the growth of the previous four quarters. The difference in timeliness and the cyclical nature of aggregate output might account for the opposite signs. Holding the growth in the previous quarter constant, higher growth in the previous year might suggest that the cyclical peak has been passed, while lower growth in the previous year might suggest that the cyclical trough has passed. However, for our purposes it suffices to note that revisions to both annual and quarterly GDP growth rates clearly affect business sentiment in Finland.

The Quandt test indicates that the parameter estimates are stable over time. The Durbin-Watson statistic suggests that serial correlation is a problem in the models without the lagged value of producer sentiment included as an independent variable. With it included, however, the Durbin h-statistic finds no serial correlation. Since the results are qualitatively similar with and without the lagged value of sentiment as a control, we find that these findings are robust to serial correlation and parameter instability.

To assess the economic significance of this finding, I will focus on the composite sentiment of all industries. As before, we will compare R-squared values both with and without the revision terms included.

Table 11. The explanatory power of the revision of GDP announcements on producer sentiment in Finland.

	R-squared		Difference: the variability explained by the revision term
Previous sentiment included as independent variable	Without revision term	With revision term	
No	0.075	0.149	0.075
Yes	0.760	0.794	0.034

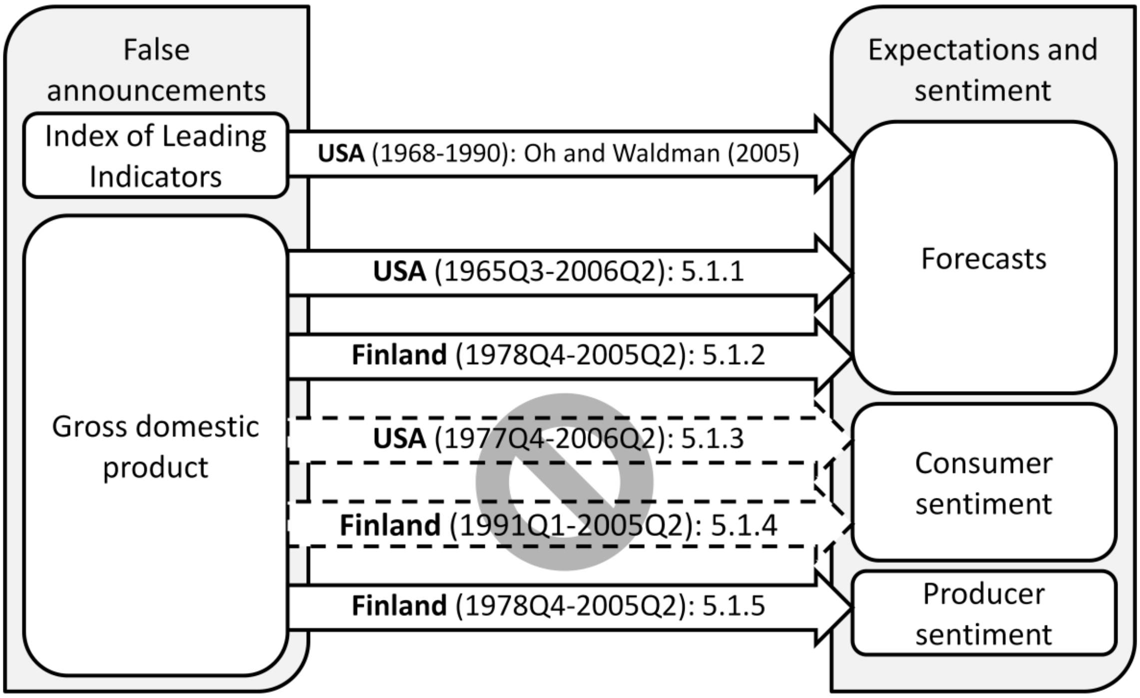
Column 4 is defined as (column 3)-(column 2).

The revision terms explain about 5% of the variability of producer sentiment. While it is not a huge amount, it certainly is a noticeable amount.

5.1.6 Conclusion

We have found that false announcements of GDP growth affect expectations in Finland and the United States. This finding is robust for various different measures of expectations. These findings are summarised in Figure 4.

Figure 4. The effect of false announcements on expectations.



We find that false announcements of aggregate production growth affect professional forecasts in both Finland and the United States. Additionally, we find that false announcements affect producer sentiment in Finland. The results using consumer confidence are inconclusive. Recalling that Oh and Waldman (2005) found that false announcements in the Index of Leading Indicators affect professional forecasts, we are confident in our finding that false announcements do affect expectations.

Specifically, the measurement error in the initial announcement of quarterly growth of GDP is positively correlated with sentiment. That is, falsely optimistic GDP announcements cause optimism, while falsely pessimistic GDP announcements cause pessimism. Recalling the results from previous empirical studies from section 3.2, we can conclude that both steps of the propagation path of the noise shock are now empirically verified. That is, we have found that false announcements affect sentiment and that sentiment affects output. From this it logically follows that false announcements cause output fluctuations.

5.2 The effect of false announcements on output fluctuations

As noted at the start of this chapter, the propagation of a noise shock caused by statistic announcements can be studied either step-by-step or directly by measuring the relationship between errors in announcements and future output. Previously we studied each step individually. In this section we take the second approach, and directly examine the relationship between false announcements and future output.

5.2.1 United States

As noted earlier, Rodríguez Mora and Schulstald (2007) studied the relationship between measurement error in initial announcements of GNP growth and future GNP growth. Their results are interesting, but it is now possible to use longer time series. The Rodríguez Mora and Schulstald (2007) study was done in 1994, which explains why they chose to not use GDP announcements as part of their data. Since GNP and GDP growth announcements are for our purposes similar, it is possible to study them simultaneously[11]. Including GDP growth announcements in the time series lengthens the time period available to study by 15 years. Our data on GNP/GDP announcements is

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[11] Restricting the analysis to either GNP or GDP data exclusively does not qualitatively change our results.

from Croushore and Stark (2001) while the GDP component time series are from St. Louis Fed (2008). Our data covers 1965Q3 to 2002Q2. The regression takes the form:

$$y_{t+1}^{final} = \beta_0 + \beta_1 y_t^{final} + \beta_2 r_t^{final} + e_{t+1},$$

with the variables defined as previously.

Additionally, we will test the effect on individual components of GDP, with the lagged value of the dependent variable included as a dependent variable:

$$X_{t+1}^{final} = \beta_0 + \beta_1 X_t^{final} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+1},$$

where X_{t+1}^{final} and X_t^{final} is alternatively growth in real consumption, investment and government expenditure.

The results from Rodríguez Mora and Schulstald (2007) and our own tests using the longer time series are tabulated below.

Table 12. The impact of GNP/GDP announcements on next quarter aggregate output in the US.

Dependent	Intercept β_0	Lagged dependent β_1	True GNP/GDP β_2	Revision β_3	n	Adj. R-sq	Note
GNP	**0.004****		**0.380****	**-0.363****	100	0.126	RM&S
GNP/GDP	**0.005****		**0.365****	**-0.373****	163	0.110	
Consumption	**0.005****	**0.254****		-0.008	100	0.045	RM&S
	0.006**	**0.224***	0.024	0.039	163	0.045	
Investment	0.003	**0.269****		**-1.569***	100	0.068	RM&S
	-0.010*	**-0.317****	**3.554****	**-2.841****	163	0.193	
Government spending	**0.003****	**0.219***		-0.102	100	0.027	RM&S
	0.004**	**0.171***	0.024	-0.210	163	0.014	

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level. The rows labelled RM&S are results from tables 3 and 6 of Rodríguez Mora and Schulstald (2007).

From this table we can see that the results of Rodríguez Mora and Schulstald (2007) are robust to using more recent data. The estimated coefficient for the revision term is negative and statistically significant for the model with GNP/GDP as the dependent variable. This implies that falsely optimistic announcements of aggregate production growth are correlated with higher growth in the next quarter. The GDP component through which the announcement effect is transmitted is investment. The strength of these findings is only increased with the longer time series compared to the original results of Rodríguez Mora and Schulstald (2007).

The Quandt test for parameter instability indicates that the parameter estimates are stable over time. The Durbin h-statistic shows no signs of serial correlation being a problem.

Next, to assess the persistence of this announcement effect, we will run the regression with later quarters as the dependent variable. That is, the regression takes the form:

$$y_{t+i}^{final} = \beta_0 + \beta_1 y_t^{final} + \beta_2 r_t^{final} + e_{t+i}.$$

The results are tabulated below.

Table 13. The impact of GNP/GDP announcements on future aggregate output in the US.

Dependent	Intercept β_0	True GDP β_1	Revision β_2	n	Adj. R-sq
t+1	**0.005****	**0.365****	**-0.373****	163	0.110
t+2	**0.006****	**0.231****	-0.142	162	0.034
t+3	**0.007****	0.062	-0.040	161	-0.009
t+4	**0.007****	0.065	-0.028	160	-0.009

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

From this table we can see that the announcement effect is statistically significant only in the quarter immediately following the quarter which the announcement concerns. For later quarters the sign of the parameter estimates are as expected, but they are not even close to being statistically significant. Next we will assess the economic significance of the results from Table 12, by comparing the R-squared values of models both with and without the revision term included.

Table 14. The explanatory power of the revision of GDP announcements on aggregate output in the next quarter.

Dependent variable	R-squared: Without revision term	R-squared: With revision term	Difference: the variability explained by the revision term
GNP/GDP	0.074	0.121	0.047
Consumption	0.062	0.063	0.001
Investment	0.110	0.208	0.099
Government spending	0.022	0.032	0.010

Column 4 is defined as (column 3)-(column 2).

From this we can see that false announcements of GDP growth explain over 4% of the variability of quarterly GDP growth. Of the variability of investment growth, false announcements explain almost 10%.

5.2.2 Finland

Next we will conduct the similar tests as in 5.2.1 using data from Finland. As noted previously, our data on GDP announcements comes from Paavonen (2008). Data on individual components of the GDP come from Astika. The data ranges from 1978Q4 through 2005Q2.

The timeliness of the initial GDP announcements warrants some discussion. Initial announcements of GDP growth are made with a longer delay in Finland than in the US. In the US the initial announcement of GDP growth in quarter t is made near the end of the first month of quarter t+1, so it is reasonable to expect that the announcement has an impact in quarter t+1, since the announcement is known for most of the quarter. In Finland, however, the initial announcement is made with a longer lag. Before 2001, the initial announcement was made around the end of quarter t+1. Since 2001, the initial announcement is near the end of the second month of quarter t+1. Thus, it seems impossible that the initial announcement would have had an impact in quarter t+1 before 2001, and quite unlikely it would have had a significant impact even after 2001. However, in reality much of the information contained in the initial announcement of GDP growth has been included in previously released monthly aggregate production statistics since the early 1990s. These monthly indicators are based on largely the same data as the quarterly GDP announcements, so the measurement error in the initial announcement of GDP is also included in these previously published monthly statistics[12]. While it would be ideal to use these earlier indicators directly, the limited availability of real-time data forces us to use the measurement error in initial GDP announcements as a proxy for the measurement error in all early aggregate production announcements.

Thus, we will focus on the effect of the GDP announcement on GDP growth in quarters t+1 and t+2. Thus, the regression takes the form:

$$X_{t+i}^{final} = \beta_0 + \beta_1 X_t^{final} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+i}.$$

Since we have both seasonally adjusted quarterly growth rates and real year-on-year growth rates available, we will use both GDP measures alternatively.

Table 15. The impact of GDP growth rate announcements on aggregate output in Finland.

Quarter	GDP measure	Dependent	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
t+1	Seasonally adjusted quarterly growth	GDP	**0.006****		0.107	0.021	106	-0.006
		Consumption	**0.003****	**0.283****	0.160	0.161	106	0.209
		Investment	0.0001	-0.022	**0.961***	-0.109	106	0.040
		Government spending	0.001	**0.604****	0.041	0.074	106	0.375
	Real year-on-year growth	GDP	**0.006***		**0.831****	-0.267	106	0.664
		Consumption	0.002	0.120	**0.125****	0.112	106	0.293
		Investment	**-0.015****	**-0.287****	**0.908****	-0.570	106	0.298
		Government spending	0.0003	**0.519****	**0.052***	0.114	106	0.435
t+2	Seasonally adjusted quarterly growth	GDP	**0.004****		**0.318****	0.122	105	0.113
		Consumption	**0.003****	**0.476****	0.088	0.131	105	0.311
		Investment	-0.006	0.049	**1.623****	0.156	105	0.243
		Government spending	0.002	**0.415****	0.121*	0.148	105	0.266
	Real year-on-year growth	GDP	**0.007***		**0.744****	0.014	105	0.552
		Consumption	**0.002***	**0.432****	0.050	0.041	105	0.305
		Investment	**-0.011***	0.077	**0.563****	0.117	105	0.226
		Government spending	0.0005	**0.316****	**0.074****	**0.143***	105	0.325

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

[12] Discussion with Samu Hakala (23.1.2009), Statistics Finland, and our tests using data from 2004-2008 suggest that the monthly announcements of aggregate production includes similar measurement error as the later initial announcement of GDP.

In these regressions the revision term is statistically significant only with government spending in quarter t+2 as the dependent variable and real annual growth rates as the independent variable. Considering the strong evidence that false announcements cause expectational shocks in Finland, and the results using US data in the previous section, these results seem anomalous.

The Quandt test for parameter instability indicates a possible break at around 1993Q1. This break coincides with the end of the Finnish depression. It seems reasonable to expect that the depression, and the large structural changes related to it, would have changed this structural relationship as well. This break also coincides closely with the introduction of the monthly released aggregate production index by Statistics Finland. This increase in the availability of timely aggregate economy statistics might have increased their role in decision-making, so for this reason as well this suggested break seems appropriate. In the next table we will present the results for the regressions when restricted to quarters after 1993Q1.

Table 16. The impact of GDP growth rate announcements on aggregate output in Finland after 1993Q1.

Quarter	GDP measure	Dependent	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
t+1	Seasonally adjusted quarterly growth	GDP	**0.01022****		-0.060	-0.267	48	0.032
		Consumption	**0.00669****	0.165	0.052	-0.105	48	0.009
		Investment	0.00644	0.120	0.844	-1.089	48	0.057
		Government spending	**0.00355****	**0.347****	-0.108	0.175	48	0.153
	Real year-on-year growth	GDP	**0.0206****		**0.548****	**-0.683****	48	0.541
		Consumption	**0.00702****	0.065	0.035	-0.093	48	0.069
		Investment	-0.00121	-0.225	**0.704****	**-1.245****	48	0.298
		Government spending	**0.00456****	**0.344****	-0.052	0.039	48	0.141
t+2	Seasonally adjusted quarterly growth	GDP	**0.00754****		0.171	0.015	47	-0.013
		Consumption	**0.00698****	0.214	-0.024	-0.014	47	-0.003
		Investment	0.00693	0.087	0.659	0.072	47	-0.020
		Government spending	**0.00302****	**0.473****	-0.073	-0.004	47	0.270
	Real year-on-year growth	GDP	**0.0242****		**0.416****	**-0.418***	47	0.267
		Consumption	**0.00686****	0.181	0.008	-0.024	47	-0.0001
		Investment	0.0021	-0.051	0.420	-0.367	47	0.029
		Government spending	**0.00373****	**0.498****	-0.050	0.048	47	0.323

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

In this sub-sample, with real year-on-year GDP growth as the independent variable, the revision term is statistically significant and negative for both quarters t+1 and t+2. With investment growth in quarter t+1 as the dependent variable, the parameter estimate for the revision term is negative and statistically significant, suggesting that the announcement effect acts through the investment component, similar to the results using US data. Thus, since 1993Q1 overly optimistic aggregate output announcements have predicted higher investment growth in the next quarter and higher aggregate output in the following two quarters.

Using seasonally adjusted quarterly growth as the independent variable, the revision term is statistically insignificant in all specifications. However, in the specifications with GDP and investment growth in quarter t+1 as the dependent variable, the parameter estimates for the revision terms are similar to those with real year-on-year growth. This suggests that measurement errors in seasonally adjusted quarterly growth might have a similar effect, though these results are quite inconclusive.

In this sub-sample the Durbin h-statistic shows no signs of serial correlation being a problem.

Using robust regression the results are broadly similar. Using seasonally adjusted quarterly growth as the GDP measure, the revision term is negative and statistically significant at the 5% level with next quarter GDP as the dependent variable. Using investment growth in the next quarter as the dependent and real year-on-year growth as the GDP measure, the revision term loses statistical significance. While the results using ordinary least squares and M-estimation differ to some degree, in broad terms both methods show that false announcements affect future output. For conciseness and simplicity, we will omit the results using robust regression.

As before, we will assess the economic significance of these results by comparing R-squared values in models with and without the revision term included. We will assess only the models with real year-on-year GDP growth, since the results using seasonally adjusted quarterly growth were statistically insignificant.

Table 17. The explanatory power of the revision of real, year on year GDP growth rate announcements on aggregate output in Finland after 1993Q1.

Dependent variable		R-squared		Difference: the variability explained by the revision term
Quarter	Variable	Without revision term	With revision term	
t+1	GDP	0.390	0.561	0.171
	Consumption	0.065	0.128	0.063
	Investment	0.163	0.342	0.180
	Government spending	0.187	0.196	0.009
t+2	GDP	0.233	0.299	0.066
	Consumption	0.061	0.065	0.005
	Investment	0.077	0.092	0.015
	Government spending	0.354	0.367	0.013

Column 5 is defined as (column 4)-(column 3).

We find that after 1993Q1, false announcements of real year-on-year GDP growth account for about 17% of the variability of GDP growth for quarter t+1 and 6% of the variability of GDP growth in quarter t+2. Of the variability of investment growth in quarter t+1, the false announcements account for 18%. It seems as if after 1993Q1 false announcements of aggregate production account for a statistically and economically significant part of output fluctuations. The fact that the effect is strongest in quarter t+1, largely before the initial announcement of GDP growth, suggests that the effect is transmitted by some earlier statistics which contain largely the same information and error. The amount of variance explained by the revision term is significantly higher than was in section 5.2.1 using data from the United States. It should be remembered, however, that in this case we are using real year-on-year growth, rather than seasonally adjusted quarterly growth, as the GDP measure. This difference in definitions might account for the difference in variance. It should also be remembered that we are not attaching any confidence intervals to these numbers, so we cannot with any confidence determine in which countries the explanatory power of the revisions is greater. The purpose of these analyses of explanatory power is merely to give a general idea of the economic importance of this effect.

The fact that the relationship is not statistically significant using seasonally adjusted quarterly growth is interesting, but does not affect our conclusion. Previously we found that announcements of both seasonally adjusted quarterly growth and real year on year growth of GDP affect professional forecasts and producer sentiment in Finland. While we failed to demonstrate that announcements of seasonally adjusted quarterly growth affect future output, we can not rule this out.

5.2.3 United Kingdom

Next we will examine the relationship between false announcements of GDP growth and future GDP growth in the United Kingdom. Our data comes from the Gross Domestic Product Real-time Database maintained by the Bank of England. The data ranges from 1975Q4 to 2007Q1. The last quarter we will include in our analysis is 2005Q1, in order to allow for sufficient number of revisions between the initial and final announcement. Initial announcements for quarters 1981Q1 through 1981Q4 are missing for some reason, so those quarters are also excluded from the sample studied. This database includes only seasonally adjusted numbers.

As in Finland, the initial announcements of GDP growth in the United Kingdom are made with almost a one quarter lag. However, similar to Finland, monthly production indices are released earlier, which should include much of the same information and error as the initial GDP announcements. Thus, we can use the error in the initial announcement of GDP growth as a proxy for the error in early aggregate economy announcements. As with the Finnish data, we will use growth in the two quarters immediately following the quarter the GDP announcement concerns as the dependent variables. The regression is once again of the form:

$$X_{t+i}^{final} = \beta_0 + \beta_1 X_t^{final} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+i}.$$

The results are tabulated below.

Table 18. The impact of seasonally adjusted, quarterly GDP growth rate announcements on aggregate output in United Kingdom.

Dependent	Quarter	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
GDP	t+1	**0.006****		0.054	-0.154	114	0.012
	t+2	**0.005****		**0.265****	-0.077	113	0.050
Consumption	t+1	**0.008****	-0.070	-0.073	0.070	114	-0.014
	t+2	**0.006****	-0.016	0.309	-0.148	113	0.024
Investment	t+1	0.003	-0.050	**0.904****	-0.215	114	0.036
	t+2	0.002	-0.016	**0.838***	0.169	113	0.047
Government spending	t+1	**0.005****	**-0.218***	-0.128	0.017	114	0.040
	t+2	**0.004****	0.007	-0.124	0.065	113	-0.015

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

Using the full sample the revision term is statistically insignificant in all specifications. However, the Quandt test for parameter instability indicates several breaks. The regression with GDP growth in t+1 as the dependent variable breaks at 1980Q2. The regression with growth in quarter t+2 as the dependent variable breaks at 1979Q1, 1983Q1 and 1992Q1. We will focus on the latest subsamples suggested by the Quandt tests. The results for the regression on these subsamples are tabulated below.

Table 19. The impact of seasonally adjusted, quarterly GDP growth rate announcements on aggregate output in United Kingdom after 1980Q2 (for t+1) or 1992Q1 (for t+2).

Dependent	Quarter	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
GDP	t+1	**0.004****		**0.452****	-0.106	96	0.207
	t+2	**0.006****		0.181	-0.054	50	-0.011
Consumption	t+1	**0.006****	-0.043	**0.441****	-0.019	96	0.086
	t+2	**0.006***	0.115	0.247	-0.170	50	-0.035
Investment	t+1	0.0001	-0.083	**1.745****	-0.562	96	0.107
	t+2	0.003	-0.132	1.501	-1.630	50	0.005
Government spending	t+1	**0.006****	**-0.226***	-0.138	-0.027	96	0.031
	t+2	0.005	-0.136	-0.258	**1.043***	50	0.076

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

Once again, the parameter estimate for the revision term is statistically insignificant, except for government spending in quarter t+2. Though statistically insignificant, the negative parameter estimates for the revision terms in the regressions with GDP or investment growth as the dependent variable suggest that false announcements cause output fluctuations as suggested by the strategic complementarity theory.

An examination of the United Kingdom GDP revisions database reveals that the magnitude of the revisions has decreased dramatically after 1990. The Quandt test indicates the mean absolute revision changed in 1990Q1. Before this, the revisions were on average 1%, after this they were 0.3%. This change may have made the initial announcement of the aggregate production a more accurate, and thus useful, macroeconomic indicator after 1990. Because of this, we will run the regressions using the subsample following 1990Q1. The results for this subsample are tabulated below.

Table 20. The impact of seasonally adjusted, quarterly GDP growth rate announcements on aggregate output in United Kingdom after 1990Q1.

Dependent	Quarter	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
GDP	t+1	**0.002****		**0.644****	-0.185	59	0.362
	t+2	**0.004****		**0.472****	-0.073	58	0.254
Consumption	t+1	**0.003***	-0.008	**0.514***	0.200	59	0.121
	t+2	**0.003***	0.083	**0.534****	0.054	58	0.176
Investment	t+1	-0.003	0.093	**1.991****	**-1.548***	59	0.221
	t+2	-0.001	-0.061	**1.899****	-1.358	58	0.139
Government spending	t+1	**0.005****	0.025	-0.160	0.265	59	-0.036
	t+2	**0.005***	-0.111	-0.078	0.590	58	0.004

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

In this subsample the revision term is statistically significant in explaining investment growth in quarter t+1. The parameter estimate is negative, signifying that falsely optimistic GDP announcements predict high investment growth in the next quarter.

With this data robust regression produces qualitatively different results than ordinary least squares regression. This is probably because this data is dominated by a few outliers, whose inclusion or exclusion affects dramatically the statistical significance, if not the sign, of the parameter estimates. For example, omitting quarter 1990Q1 from the time period studied in Table 20 would have made the revision term statistically significant at the 1% level, with a parameter estimate of -0.42, in the regression with GDP growth in quarter t+1 as the dependent variable. Similarly in Table 19, by including just four earlier quarters, the same term would have been statistically significant at the 1% level, with a parameter estimate of -0.23.

The previously found breaks were apparently related to outliers rather than true structural changes, so we will use the full sample for the robust regressions. The results for these robust regressions are tabulated below.

Table 21. The impact of seasonally adjusted, quarterly GDP growth rate announcements on aggregate output in United Kingdom, using M-estimation.

Dependent	Quarter	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
GDP	t+1	**0.005****		**0.357****	**-0.238****	114	0.088
	t+2	**0.004****		**0.405****	**-0.152****	113	0.094
Consumption	t+1	**0.007****	-0.044	**0.246***	0.117	115	0.046
	t+2	**0.007****	0.119	0.097	-0.073	115	0.024
Investment	t+1	0.004	0.007	**0.838****	-0.239	115	0.050
	t+2	0.002	0.032	**0.837****	0.096	115	0.073
Government spending	t+1	**0.005****	**-0.187***	-0.112	0.020	115	0.049
	t+2	**0.004****	-0.012	-0.001	-0.060	115	0.003

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

Using M-estimation the parameter estimate for the revision term is negative and statistically significant in the specifications with GDP growth as the dependent variable. In the other specifications the revision term is statistically insignificant.

The results using the United Kingdom data depend on the subsample analysed and the estimation method, but some general conclusions can be drawn. In all four sets of regressions, the parameter estimate for the revision term is consistently negative when GDP growth in quarter t+1 or t+2 or investment growth in t+1 is used as the dependent variable. For each of these dependent variables, the revision term is statistically significant in one specification. The results with the other dependent variables are less consistent. This gives us some confidence that false announcements of aggregate production do cause fluctuations in output and investment in the UK.

To assess the economic significance of these results, we will compare the R-squared values with and without the revision term using the M-estimation as in Table 21.

Table 22. The explanatory power of the revision of seasonally adjusted, quarterly GDP growth rate announcements on aggregate output in United Kingdom.

Dependent	Quarter	R-squared		Difference: the variability explained by the revision term
		Without revision term	With revision term	
GDP	t+1	0.046	0.088	0.042
	t+2	0.059	0.094	0.035
Consumption	t+1	0.035	0.046	0.011
	t+2	0.026	0.024	-0.002
Investment	t+1	0.042	0.050	0.008
	t+2	0.065	0.073	0.008
Government spending	t+1	0.057	0.049	-0.008
	t+2	0.000	0.003	0.003

Column 5 is defined as (column 4)-(column 3).

From this we can see that the false announcements explain about 4% of the variation of GDP growth one and two quarters ahead.

5.2.4 Sweden

Next we will test the effect of false GDP announcements on GDP growth in Sweden. We have final and initial announcements of real year-on-year GDP growth data from 1980Q1 to 1998Q4 courtesy of Öller and Hansson (2002). This source included year-on-year growth in GDP components as well. Additionally, to maintain consistency with the earlier results, we will use the quarter-on-quarter growth in GDP components from OECD Key Economic Indicators. These are available from 1981Q1 onwards. As before, the regression is of the form:

$$X_{t+i}^{final} = \beta_0 + \beta_1 X_t^{final} + \beta_2 y_t^{final} + \beta_3 r_t^{final} + e_{t+i},$$

The results are tabulated below, first using the Öller and Hansson (2002) data exclusively, and then with Öller and Hansson (2002) data for the announcements and newer OECD data for the final values.

Table 23. The impact of real, year-on-year GDP growth rate announcements on aggregate output in Sweden data.

Data source	Dependent	Quarter	Intercept β_0	Lagged dependent β_1	True GDP β_2	Revision β_3	n	Adj. R-sq
Öller and Hansson (2002)	GDP	t+1	**0.005***		**0.712****	**-0.494***	74	0.428
		t+2	**0.007***		**0.639****	-0.207	74	0.357
	Consumption	t+1	0.004	**0.657****	0.035	-0.127	74	0.427
		t+2	0.004	**0.451****	0.194	-0.180	74	0.278
	Investment	t+1	-0.014	**0.513****	**1.305****	-0.836	74	0.563
		t+2	**-0.022***	**0.249***	**2.173****	-1.537	74	0.494
	Government spending	t+1	**0.005***	**0.553****	0.026	-0.064	74	0.275
		t+2	**0.007****	**0.366****	0.065	-0.249	74	0.101
Öller and Hansson (2002) and OECD	GDP	t+1	**0.007****		**0.830****	**-0.469****	72	0.589
		t+2	**0.008****		**0.733****	-0.334	72	0.460
	Consumption	t+1	0.002	-5.2E-05	0.090	0.008	72	-0.009
		t+2	0.001	-0.023	0.123	0.001	72	0.017
	Investment	t+1	-0.006	-0.031	**0.663****	-0.046	72	0.205
		t+2	-0.001	0.202	0.341	-0.072	72	0.135
	Government spending	t+1	**0.005****	**-0.303****	-0.015	-0.047	72	0.060
		t+2	**0.004***	-0.147	0.024	-0.094	72	-0.017

Note: Bolded and starred coefficients are significant at the 5% level; double-starred coefficients are significant at the 1% level.

We find that the revision term is negative and statistically significant for GDP growth in quarter t+1 as the dependent variable. This finding is consistent using either data source. In the other model specifications the revision term is not statistically significant. This suggests that falsely optimistic announcements of GDP growth predict higher GDP growth in the next quarter.

The Quandt test for parameter instability indicates possible breaks around 1990, the start of the major depression in Sweden. Before the break the results are similar to using the full sample, but after the break the revision term is statistically insignificant. The data covers only a few years after the end of the depression, so it is impossible to determine whether the announcement effect changed in 1990 permanently or only for the duration of the depression. Nonetheless, the strong results using the full sample and the pre-1990 subsample give us confidence that false announcements of GDP growth do affect future growth. The Durbin h-statistic shows no signs of serial correlation being a problem.

Next we will assess the economic significance of these results.

Table 24. The explanatory power of the revision of real, year-on-year GDP growth rate announcements on aggregate output in Sweden.

Dependent variable			R-squared		Difference: the variability explained by the revision term
Data	Quarter	Variable	Without revision term	With revision term	
Öller, Hansson (2002)	t+1	GDP	0.406	0.444	0.038
		Consumption	0.448	0.450	0.002
		Investment	0.574	0.581	0.008
		Government spending	0.304	0.305	0.001
	t+2	GDP	0.369	0.375	0.007
		Consumption	0.304	0.308	0.004
		Investment	0.489	0.514	0.025
		Government spending	0.122	0.138	0.017
Öller, Hansson (2002) and OECD	t+1	GDP	0.556	0.600	0.045
		Consumption	0.033	0.033	0.000
		Investment	0.238	0.238	0.000
		Government spending	0.098	0.099	0.001
	t+2	GDP	0.453	0.475	0.022
		Consumption	0.059	0.059	0.000
		Investment	0.171	0.172	0.001
		Government spending	0.021	0.027	0.006

Column 6 is defined as (column 5)-(column 4).

From this we can see that the false announcements explain about 4% of the variation of GDP growth one quarter ahead.

5.2.5 New Zealand

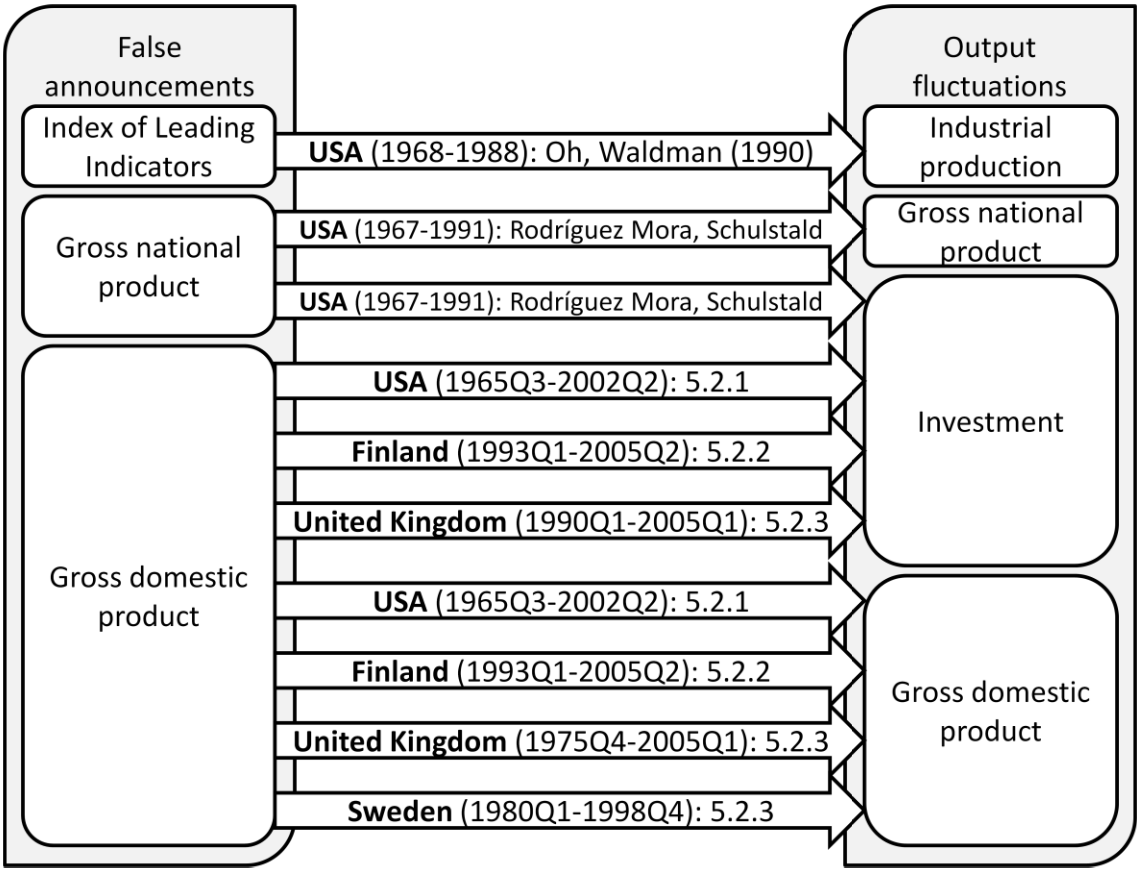
To test the effect of false announcements of GDP growth on output in New Zealand, we will use the data from the real-time database made available by Reserve Bank of New Zealand. This data set ranges from 1984Q2 onwards. To allow for sufficient revisions, the last quarter we will consider is 2004Q4. As was found in section 4.4, the initial announcement of seasonally adjusted quarterly growth of GDP does not help predict future GDP growth in New Zealand. The Quandt test for parameter instability suggests a break at 1992Q4, but in both subsamples the initial announcement is not a statistically significant predictor of future true GDP growth. Since the initial announcement is not useful for forecasting the future, it seems obvious that the errors in the initial announcement would not matter either. This was found to be the case. The results of the regressions are omitted for conciseness.

The reason why the initial announcement of GDP growth does not help predict future GDP growth New Zealand is beyond the scope of this thesis. This serves as a useful reminder that false announcements of GDP growth do not necessarily have any effect on the economy. For these announcements to cause expectational shocks, they must be useful for forecasting purposes. Since in New Zealand, at least with the rather simplistic methods we use, these announcements do not help in forecasting, the errors in these announcements do not matter either.

5.2.6 Conclusion

The results of the empirical studies regarding the effect of false announcements on output fluctuations are summarised in Figure 5.

Figure 5. The effect of false announcements on output.



We have found some evidence that false announcements of GDP growth affect future production in the United States, Finland, Sweden and United Kingdom. The relationship is in some cases is not stable over time, and the results depend to some degree on the methods used, but in general we find that falsely optimistic announcements of GDP growth are associated with higher GDP growth in the following quarter and vice versa.

The measurement error of GDP growth explains between 3% and 4% of the variability of next quarter GDP growth in the United States, Sweden and United Kingdom. In Finland the measurement error accounts for 16% in the post-1993 subsample. Of the variability of two quarters ahead GDP growth, the measurement error accounts for between 3% and 5% in Finland and United Kingdom. The announcement effect is apparently transmitted through investment, with the measurement errors explaining between 10% and 17% of the variability of its quarterly growth in the United States and Finland. These findings are clearly of economic significance. This evidence is consistent with the theory of strategic complementarity discussed earlier.

6 CONCLUSIONS

6.1 Summary of results

In this paper we outlined the theoretical justifications and empirical evidence of output fluctuations caused by noisy announcements regarding the aggregate economy.

The overview of theoretical models demonstrated that the theoretical basis for the significance of noisy announcements is plausible. We showed that there exists a variety of features of an economy which would imply strategic complementarity, resulting in self-fulfilling forecasts and output fluctuations caused by noisy announcements. For the purposes of this study it was neither necessary nor useful to select which theoretical model is most compelling. The purpose of the overview of theoretical studies was merely to motivate and guide the empirical part of the study, rather than construct a viable model of the macroeconomy. The theoretical models suggested that false announcements could cause noise shocks in the economy which are propagated through consumer or producer sentiment.

The review of previous empirical studies showed that measurement errors in some statistics can affect sentiment and future output. Additionally, we saw several studies suggesting that sentiment affects future output. This finding motivates us to study the effect of announcements on sentiment.

The empirical evidence for these noise shocks was convincing. We saw that false announcements of GDP growth affect macroeconomic forecasts in the United States and

Finland. Similarly, we saw that false announcements affect producer sentiment in Finland. These results, combined with the finding that sentiment affects future output, imply that false announcements of GDP growth affect future output. Apparently the announcement effect is transmitted through producer, rather than consumer, sentiment. It is of course possible that false announcements affect consumer sentiment, though we did not find convincing evidence of this, but it seems likely that the effect on producer sentiment is stronger. Since we have now established that announcements affect sentiment and sentiment affects future output, it seems obvious that announcements indirectly affect output.

To verify this relationship, we examined this relationship directly as well. We found that in the United States, United Kingdom, Sweden and Finland false announcements of GDP growth have been associated with output fluctuations. Though the relationship was not entirely stable, especially in the cases of United Kingdom and Finland, in broad terms we are confident of the relationship between false announcements and output fluctuations. In most cases the announcement effect was most pronounced in investment growth, suggesting that the effect is transmitted through investment. This seems logical, since investment is by its nature a forward looking variable. This also suggests that the announcement effect is transmitted through producer, rather than consumer, sentiment.

In some cases the announcement effect is evident before the initial announcement of GDP growth, suggesting that the announcement effect is at least in some cases actually transmitted by a related, timelier statistic. For example indices of industrial or aggregate production are often compiled monthly, based on largely the same data as the later quarterly announcement of GDP growth. This means that the effect we ascribe to the initial announcements of quarterly GDP, may in fact be caused by related monthly announcements. In broad terms this distinction is trivial. Our finding remains that false announcements of aggregate production growth affect sentiment and, through that, future output.

Clearly the importance of the false announcements can vary in place and time. It appears that the false announcements became more significant in Finland after the depression of the early 90s. This may be related to the structural changes of the early

90s, or to the introduction of a monthly aggregate production index. This new statistic increased the usefulness of aggregate production statistics in forecasting the near-term future, which might explain the heightened importance of the false announcements. We also found that in New Zealand, where initial announcements of GDP growth do not help predict future GDP growth, the false announcements of GDP growth have no effect on future output. The importance of the false announcements depends on the importance of the underlying statistic. We do not believe that false announcements matter everywhere, but our results suggest that in many cases they are a source of sentiment and output fluctuations.

6.2 Practical implications

It is clear that in many cases false announcements of aggregate production growth cause output fluctuations. These output fluctuations are undesirable, but it is not immediately obvious how to react to them. It is tempting to think that postponing the release of aggregate production growth statistics until they are subject to less noise would reduce the output fluctuations. This is not necessarily the case, since economic agents have alternative ways of observing the economy as well. If official statistics were unavailable, economic agents might use informal means of evaluating the macroeconomy, such as barometers or word-of-mouth. Though early announcements of aggregate production growth are subject to noise, it is likely that they are subject to less noise than these alternative sources of information. Thus, postponing the release of aggregate production growth data forces economic agents to use even less reliable sources of information, potentially resulting in even larger expectational shocks.

A more appropriate reaction would be to attempt to minimise the noise in the initial announcements. Though this is obviously costly, this finding demonstrates that having noisy initial announcements has economic implications as well. It is necessary to balance the cost of more comprehensive initial announcements with the costs associated with increased variability in GDP and investment growth. Aruoba (2004) estimated that noisy data causes welfare losses of $33 billion in the United States. Compared to the $2.3 billion currently spent on data collection, Aruoba (2004) concluded that any additional money spent on data collection would be worthwhile.

While we have not made any attempt of estimating the size of the welfare losses caused by the output fluctuations induced by the false announcements, we think our results demonstrate that national statistics offices have good reason to ensure that their initial announcements of aggregate production are as timely and accurate as possible. In this case measurement errors have real, tangible effects on the economy, rather than being mere inconveniences to researchers.

6.3 Theoretical implications

These findings suggest that perceptions do matter. Expectations are subject to fluctuation caused by the random measurement errors in statistics, and these random fluctuations in sentiment result in fluctuation in output. These fluctuations in sentiment, not based on the real economy, are reminiscent of the “animal spirits” and “spontaneous optimism” Keynes (1936) considered to be the cause of business cycles. These changes in sentiment are obviously not strictly spontaneous, since they are based on statistics announcements. However, they can be thought of as spontaneous, since the errors in the initial announcements which cause them are random. While we do not find evidence that business cycles, or even a large part of the variance of output growth, are traceable to these false announcements, it seems evident that at least some part of output fluctuations is traceable to the “animal spirits”. If errors in statistics announcements cause fluctuations in sentiment and future output, it seems possible that there are other sources of random fluctuations in sentiment as well. While we do not think that these “animal spirits” are by any means the most important feature of the economy, they seem to be a feature worthy of consideration when constructing macroeconomic models.

6.4 Direction for future research

There are multiple possibilities for future research available around this subject.

Attempting to replicate these studies using data from other countries is an obvious possible venue of future research. In particular, the effects of false announcements on sentiment in Sweden and United Kingdom could be studied. The effect on business confidence in countries besides Finland is also so far left unexplored. The effect of false announcements on consumer sentiment could also be studied further. Additionally, studying the effects of measurement errors in earlier indicators, such as monthly production indices, could be interesting. It is clear that the GDP announcements are not entirely new information, since earlier announcements of monthly aggregate production are based on largely the same data. Thus, using announcements of monthly production as the source of expectational shocks would allow us to pinpoint with greater accuracy when the announcement effect should be visible in sentiment. Additionally, the greater frequency would potentially give us three times as many data points to work with.

Considering several sources of measurement error simultaneously would be interesting. It could give a fuller picture of what portion of fluctuations are traceable to measurement errors in general. In particular, the Index of Leading Indicator studied by Oh and Waldman (1990) combined with an aggregate production statistic is a potential pair, but the initial announcements of the Leading Indicator are not publicly available. The OECD real-time database includes announcements of a monthly composite leading indicator which can also be used in conjunction with a monthly production index, but the time series available is so far too short. As the OECD real time database matures, it should provide an excellent source of data for related research.

It would also be instructive to study under what circumstances these false announcements matter. A comparison of countries with comparable data available could suggest in which types of economies the announcement effect is most pronounced. Determining during what part of the business cycle the effect is strongest would also be interesting. It is plausible that the significance of the announcements depends on the current business cycle situation. For example, it is possible that during recessions statistics announcements are keenly analysed for an indication of a recovery, while during good times they are not paid attention to as much. The breaks around the depression of the 90’s we uncovered using Finnish and Swedish data give some hint that the announcement effect might change during depressions.

Attempting to estimate the welfare cost of the output fluctuations caused by false announcements is an important question. The work of Aruoba (2004) is a good starting point, but more work remains to be done, especially in relation to economies besides the United States.

Recalling the studies of Bomfim (1999a, 1999b), the significant decrease in the magnitude of the revisions to the initial announcement of GDP in United Kingdom in 1990 provides a possibility to study whether agents use efficient or simple bounded rational signal extraction. Studying the influence of the announcements on a measure of expectations might be the simplest way to test whether the weight agents place on the statistic changed after its noisiness decreased.

Additionally, studying the effects of false announcements on government policy would be interesting. It is conceivable that both fiscal and monetary policies are guided in part by statistical announcements, suggesting that false announcements would affect them as well. The results from Tables 15 and 19 provide some very limited evidence that in Finland and United Kingdom the government might practice counter-cyclical fiscal policy guided in part by false announcements. Studying the effect of noisy announcements on government policy, both theoretically and empirically, would be interesting.

Finally, studying decision making at a less aggregated level might be desirable. While studying individual firm or consumer decision making might be impractical or impossible, studying individual industries should be feasible. This could give us a clearer indication of what industries are most affected by noisy announcements.

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