Microeconomic and Macroeconomic Systems

Macroeconomic Systems

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Abstract

I have divided the article into two parts: macroeconomics and microeconomics. We have used the least squares method and modelled GDP based on the most important variables: private consumption, private investment, public consumption, public investment, and exports minus imports. It is difficult to get the system to be controlled feedback except with the interest rate, which is difficult, because the system has a strong rising trend. Under these variables there are sub-variables that should be easier to regulate. The second part deals with microeconomics and deals with the energy market in the Nordic region and stock market prices in Nordpool and Nasdaq Nordic Elecrticy, as well as prediction of electricity prices for the years 2023 to 2025 using futures from Nordpool and Nasdaq. The task was difficult because of the war between Ukraine and Russia, which made electricity supply difficult, caused electricity prices to temporarily rise sharply and made the economy more difficult. I also developed a model for supply and demand, for example for electricity prices on the stock exchange. The model can be better than the fixed price on the stock exchange, which is based on many complicated aspects sometimes. In conclusion, I would like to say that there is still work to be done on regulating interest rates, inflation and unemployment. The economy can be somewhat predicted and controlled and stabilized if it succeeds in doing so. The war and the climate changes and more difficult economy can have an impact.

Introduction

Like the future in general in the world, the economy and macroeconomics can be divided into three-time perspectives[3,9]: I have also divided the article in microeconomics and macroeconomics aspects, with control theory, economics and engineering, with GDP modelled from several variables and given a microeconomic view from Nordic electricity market with Nasdaq Nordic Electricity and Nord pool as source of data and the central of statistic office for modelling of GDP. The future can be divided in:

1. The short-term (In the short term)
2. Medium term
3. Long term

Looking at the whole period, good management of the earth's resources is good management for the population, their well-being and development. Good financial planning and perhaps some regulations have been good in recent decades. The future and the present are also turbulent, yet stability must be maintained. In the past, we bartered and exchanged goods using squirrel skins, and agriculture and hunting played a central role in the so-called economy. Perhaps we will return to similar after a nuclear war[2] or when a long-lasting peace that was desired and promised is realized[5]. It is likely that stability will be preserved in the long term.[9]But it’s still to be shown.

As I said, it is monetary policy that regulates and preserves a fair system despite the turbulence at different stages in history and the present. barter and trade in squirrel skins regulate people's needs.

The future has already been predicted decades and perhaps 100 years[11] ahead in terms of resources such as food, raw materials, energy and population to be as concrete and as realistic as possible, you cannot study the economy thoroughly with theory and data than 10 years ahead. In the short term 1–2 years, the variations in production from year to year are mainly driven by variations in demand. Changes in demand due to changes in consumer confidence or other factors can lead to reduced output (review) or increased output (expansion). Here are references to Tom Forsman[9], James McKeever[5] and Oliver Blanchard[3]. During the 80s, there were great fears of nuclear war and its consequences in the United States. To this day, we do not know exactly how things will turn out.[2,3,5,9]

- In the medium term (3–10 years), the economy tends to return to the level of output determined by the availability and utilization of its factors of production: the size of the capital stock and labor, and the efficiency of production.

- In the long term, one or more decades, for example, one must understand why China achieves such high growth already in the 80s. We need to understand why capital and the technological level are increasing so rapidly. And to understand it, we need to see factors such as the education system, savings and the country's institutions.

In economics, the economy, the economic system, is mainly measured by gross domestic product or similar indicators, i.e. mainly by GDP.

GDP can be explained as the **sum** of (private consumption) + (private investment) + (government consumption) + (government investment) + (export-imports)[4]. The variables can be regulated and GDP improved. Export-imports can also be regulated by tariffs at EU level and by rules and restrictions at national level. GDP can also be regulated and stabilized with interest rates, as can inflation. Control theory is quite difficult to apply in these two problems as also general with data from economics where trends are only rising. Not all kinds of data have been studied, and although some variables in the data could be regulated, the total trend remains to rise consistently. But one can model using the least squares method. Inflation is a challenging problem that is topical now and I want to address it in a later work.

Demand for goods

Investments and savings

To understand the meaning of GDP and its variables, it is useful to get background of them and follow the derivation of the theoretical equations that analyze, more accurately and give a picture of demand, consumption and investment. Both doctors and engineers and leaders in companies, as well as politicians, can learn to think about the connections they can handle and benefit from.

We denote the total demand for raw materials by Z, if we assume the same position of GDP.

$$Z = C + I + G + X + IM \qquad (1.1)$$

If we assume that the economy is closed, i.e. $X = IM = 0$ ice

$$Z = C + I + G \qquad (1.2)$$

C= private consumption, $I =$ gross capital formation, = G public investment = X export and IM = import.

We can consider each of these more closely. Private consumption depends on many different factors. Mainly of disposable income Y_D. The income remaining when the consumer has paid his tax and received any subsidies. We can now describe consumption as a C function of Y_D. the disposable income;

$$C = C(Y_D)$$
$$+$$

The plus sign below Y_D shows that as disposable income increases, so does consumption. Let us assume in more detail that the relationship between consumption and disposable income is given by the function

$$C = c_0 + c_1 \text{x} Y_D \qquad (1.\ 4)$$

The function is linear, i.e. it can be depicted as a straight line. The relationship is determined by the two parameters c_0 and c_1. This parameter c_1 is called propensity to consume. An increase in available funds leads to an increase in private consumption. One limitation is that c_1 must be positive. Disposable consumption increases private consumption C . Another limitation is that c_1 must be less than 1: people likely consume only part of their increase in disposable funds and save the rest.

The parameter c_0 has a different interpretation. If the disable consumption is zero (0) in equation (1.4), then $C = c_0$ Even if the incomes are zero, people have to eat. How can people live without income? The answer is negative savings. They consume by taking out loans or selling. If parameter c_1 can be mentioned that people buy, consume and invest for various reasons. During the banking crisis in 2008, consumption segregation fell due to a poor situation in the financial world and economic events in the world and the banking sector. It was the propensity to buy that fell. Largely exaggerated – a domino effect.

Investments (I)

It is assumed here that investments I are exogenous, independent of other variables. Another definition is dependent or endogenous.

$$I = \bar{I} \qquad (1.5)$$

Public consumption(G)

The third component G, public consumption in the model is determined by fiscal policy – levels that policymakers determine on taxes and public spending. However, investments can be financed with loans. Changes in T taxes and G public consumption are determined by a decision of the parliament.

Balance function

If we assume that both exports and imports are zero, then the demand for goods is the sum of private consumption, investment and public consumption.

$$Z = C + I + G \qquad (1.6)$$

If we substitute and C and I in the equations (1.4) and (1.5), this gives

$$Z = c_0 + c_1 \text{x} (Y - T) + \bar{I} + G \qquad (1.7)$$

The demand for goods (Z) depends on the income (Y) and taxes (T)

When stocks are exactly as large as companies desire, production equals (Y) demand for goods (Z). In other words, there is a balance in the market.

$$(Y) = (Z) \qquad (1.8)$$

Substituting i (Z) by the expression in equation (1.6), we get

$$Y = c_0 + c_1 \text{ x } (Y - T) + \bar{I} + G \qquad (1.9)$$

Notice that the letter (Y) denotes both production and income. That's no coincidence! As we first saw earlier, GDP can be seen either from the production or income side: Production and income are identical.[3]

Investments equal to savings

Alternative approach to market equilibrium

It was John Maynard Keyes who first formulated the savings model presented in the highly influential book *The General Theory of Employment, Interest and Money, 1936.*

Economic savings

Private savings (S) , i.e., consumers savings by definition equal to their disposable income minus their consumption

$$S = Y_D - C \tag{2.0}$$

If we define disposable income as we defined private savings minus taxes minus consumption, we get

$$S = Y - T - C \tag{2.1}$$

Government savings by definition equal to taxes minus government consumption $T - G$. If taxes exceed public consumption, the state has a **budget surplus.** Public savings are negative. If taxes are below public consumption, the central government has a **budget excess**. Our previous condition for equilibrium in the goods market was that:

Production must equal demand, which in turn is the sum of private consumption, investments and public consumption.

$$Y = C + \bar{I} + G \tag{2.2}$$

Subtract (T) from both sides and shift private consumption to the left

$$Y - T - C = \bar{I} + G - T \tag{2.3}$$

The left joint of this equation is the saving (S). Therefore, we can write

$$S = I + G - T \tag{2.4}$$

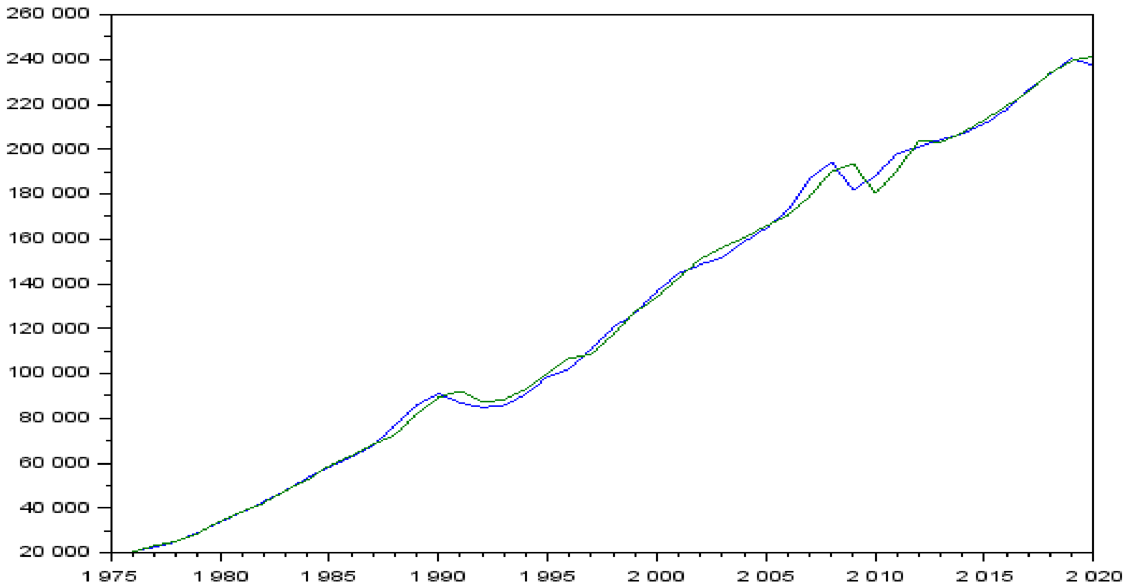
or shift investments to the left and savings to the right, we can write

$$\bar{I} = S + (T - G) \tag{2. 5}$$

On the left we have investments; on the right we have total savings and public savings. The equation (2.4) gives us an alternative for equilibrium in the commodity market. This equilibrium option for equilibrium in the commodity market is called the $\boldsymbol{IS}$ relationship.[3]

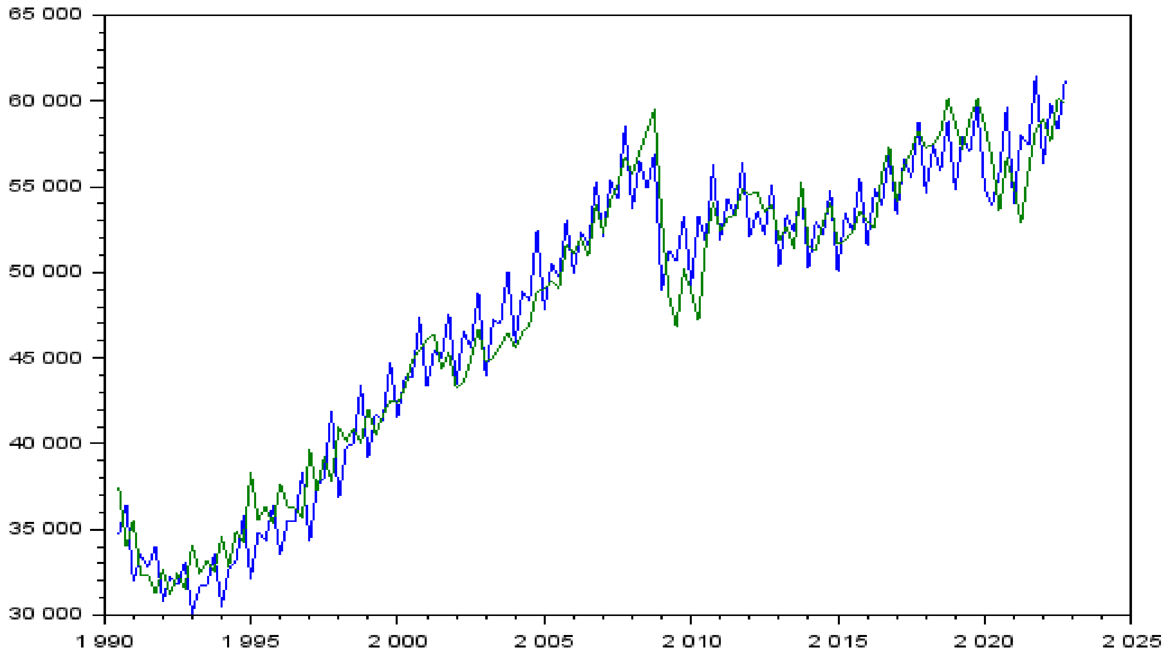
From this can be further developed *the **IS-LM*** relationship where inflation, unemployment and interest rates are included. We can do this in a later work using statistics in real values and our model that can be modified. What is interesting is inflation and interest rates today. Referred by Oliver Blanchard[3] and the author Tom Forsman.

We have previously modeled with our model by using the variables $C =$ private consumption, $I =$ gross investment $G =$ public investments $X =$ exports and $IM =$ imports. The model corresponds to the GDP curve almost exactly for the years 1975-2020.



Modelling of data for GDP and with the model for GDP for the years 1975 – 2020.

We used GDP data from 1975 to 2020 on the curve of GDP and the model. The years 2021 and 2022 are missing at the end, but show a consistent upward trend. There was an economic crisis around 1992 and a stock market crisis in 2008 where you can see downs in the curve. A decline in quarterly data modelling also shows a decline during the corona period in 2020 and 2021.



Modelling of GDP and real GDP using the least squares model with quarterly data for the years 1990–2023. The model is made using the least squares method with four input signals and one output signal, as well as for the years 1975–2020 plus prediction of on time. Tom Forsman and Jari Böling tried to regulate GDP with feedback regulation but the trend rose too sharply and data was only available for one year at a time so it was just modeling. Below is given the derivation of the least squares method for the sake of pedagogy and because it is elegant.

Because we consistently use automatic control and simulation in this series of articles, I want to give the background to the least squares method[2]:

Consider a system described by the difference equation

$$y(k+1) = a_1 y(k) + \cdots + a_{na} y(K+1-n_a) + b_0 u(k-L) + \\ \ldots b_n u(k-L-n_b) + e(k+1) \quad (2.5)$$

Introducing the signal vector

$$\varphi(k) = [y(k), \ldots, y(k+1-n_a), u(k-L), \ldots, u(k-L-n_b)]^T \quad (2.6)$$

and the parameter vector

$$\Theta = [a_1, \ldots, a_{na}, b_{0,}, \ldots., b_{nb}]^T \quad (2.7)$$

the system (2.6) can be written compactly as

$$y(k+1) = \varphi(k)^T \Theta + e(k+1) \tag{2.8}$$

We consider the problem of estimation the problem of estimating the parameters a_i, b_i of the system (2.5). Therefore, we introduce the model

$$y(k) = \hat{a}_1 y(k) + \cdots + \hat{a}_1 y(k+1-n_a) + \hat{b}_0 u(k-L) + \\ \ldots + \hat{b}_{nb} u(k-L-n_b) \tag{2.9}$$

where the circumfix (^) denotes the estimate of parameter. For the moment we assume that the number of parameters; The problem of finding the correct number of parameters will be discussed later. In analogy with (2.8) the model (2.9) can be written in formn_a are known n_b

$$y(k+1) = \varphi(k)^T \hat{\Theta} + e(k+1) \tag{3.0}$$

were

$$\hat{\Theta} = [\hat{a}_1, \ldots., \hat{a}_{na}, \ldots. \hat{b}_{nb}]^T. \tag{3.1}$$

In order to construct a measure of the model accuracy we introduce the prediction error,

$$e(k+1) = y(k+1) - \varphi(k)^T \hat{\Theta} \tag{3.2}$$

$$= y(k+1) - \hat{y}(k+1 \mid k) \tag{3.3}$$

where is the known output at the time instant and is the predicted output of the model

$$y(k+1) k+1 \hat{y}(k+1 \mid k) = \varphi(k)^T \hat{\theta} \tag{3.4}$$

In the least-squares method the estimate $\hat{\theta}$ is defined by minimizing the sum of squares of prediction errors,

$$V(\hat{\theta}) = \sum_{i=1}^{N} \epsilon(i)^2 \tag{3.5}$$

$$= \sum_{i=1}^{N} [y(i) - \varphi(i-1)^T \hat{\theta}\,]^2$$

(3.6)

This gives the least-squares estimation

$$\phi_N^T \phi_N \theta\hat{}_N = \phi_N^T \boldsymbol{y}_N \tag{3.7}$$

from which it follows that the least-square estimate can be expressed explicitly as

$$\theta_N = [\ \phi_N^T \phi_N]^{-2} \phi_N^T \boldsymbol{y}_N \tag{3.8}$$

Microeconomic System

Supply and demand in practice in the Nordic electricity market

The Nordic electricity market has several characteristics that mean that supply and demand can have major effects on price. A far-reaching segment of the supply curve is horizontal. This segment corresponds to hydropower, nuclear power and district heating from industry, energy sources where the marginal cost of an additional megawatt hour is relatively low. However, supply from these energy sources is limited and additional energy must be produced from fossil energy sources that are significantly more expensive on the market. The supply curve slopes steeply upwards at quantities that are so high that the capacity of cheap energy sources is insufficient. In recent years, however, a lot of wind energy has been developed, which is cheap but in practice expensive for the system when it is not windy. Additional circumstances such as the import of electricity and price also have an impact[1]. The host market situation, natural disasters and other causes such as war can have a major impact and drive up the price. We will later look at curves in 2021–2025 for prices, where the Russian-Ukrainian war has affected the price.

Another important feature of the electricity market is that demand is price-sensitive, which means that electricity consumption does not decrease as many percent as the price increases. Both people and companies demand a lot of electricity even when the price is perceived as high. From time to time, the electricity market inevitably suffers two types of shock. A negative supply shock occurs, for example, when a nuclear power plant has to be shut down for repair or maintenance, which happens periodically. This means that part of the supply curve is pushed to the left because nuclear capacity is then limited.[1]

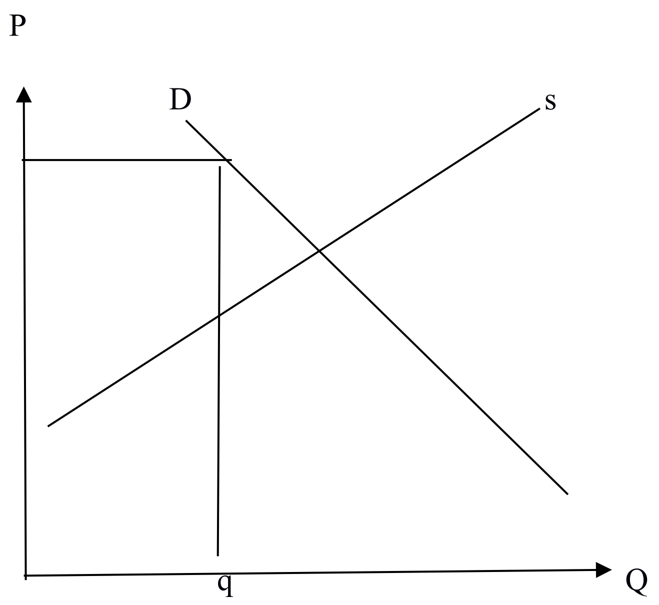


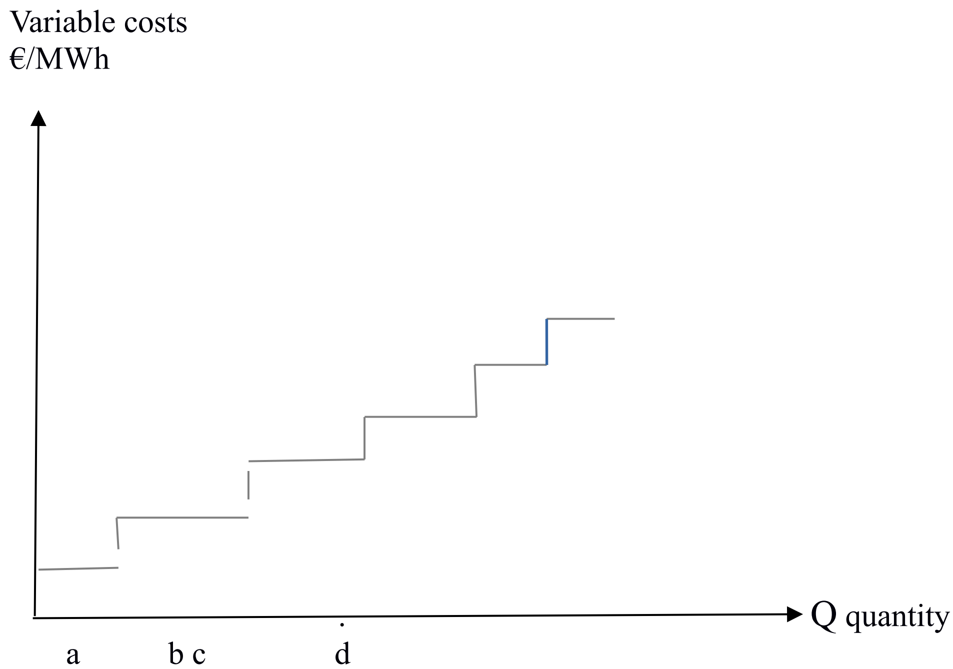
Figure 1.
When a regulation makes so the maximum q may be sold, a scarcity is c created that drives up the price of hose to be sold.

P = price, Q = quantity, s = the supply line, D = demand line

Fig. 2

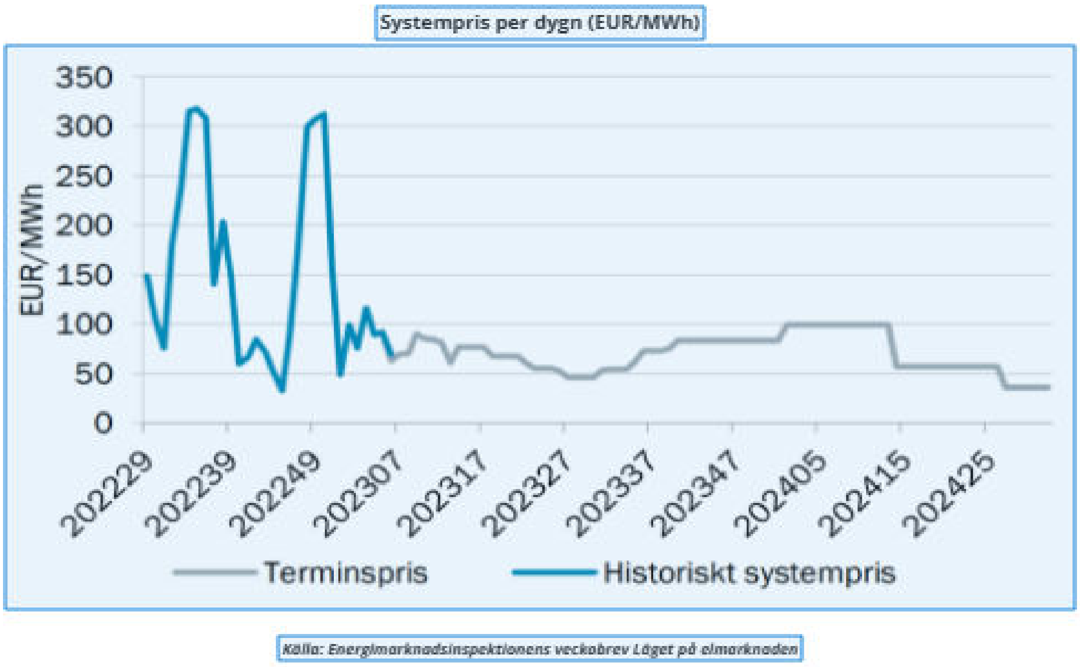
Conceptual sketch of the Nordic electricity market. Electricity from different energy sources has different capacities and marginal costs[1]:

a = wind power
b = hydropower
c = nuclear power
d = miscellaneous fossil energy sources



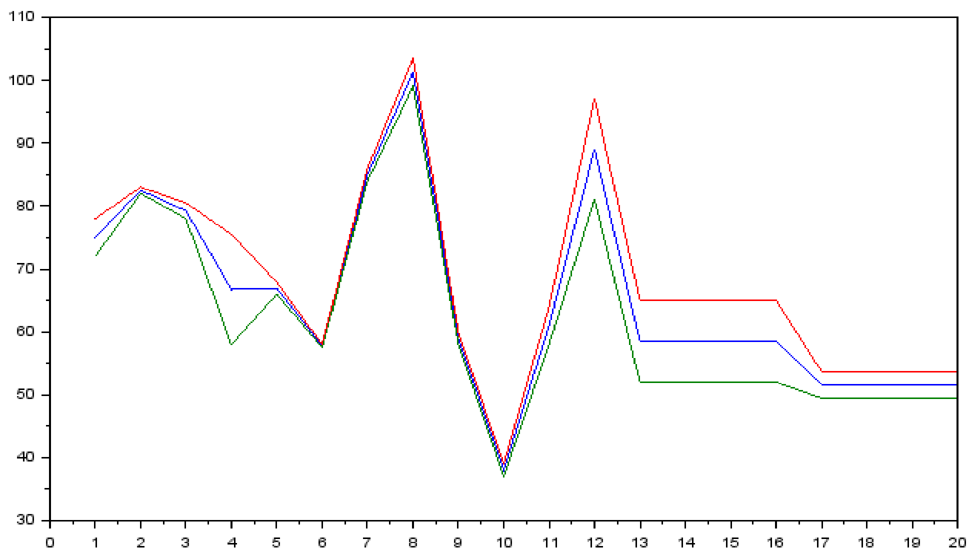
If the market is exposed to both shut down nuclear power plants and cold winters at the same time, i.e., a negative supply market, the price of electricity rises sharply[1]. If the supply becomes further limited for serious reasons, it is only a matter of saving energy and electricity. This may also be the case if the general price rises above the ability to pay. In the Nordic countries, the price of electricity is determined for each day through an auction on the electricity exchange. You can follow curves for a small period, for a day at different times or for a day at different times or from historical data where you can guess longer trends. Ordinary people follow the price of electricity daily day by day, hour after hour to try to save costs with exchange electricity contracts. Fixed contracts make it easier to live and one can save by using less electricity or buying preferential fixed contracts at low prices as large electricity buyers are interested in assets and price in the future. This can be done by following futures on the electricity exchange in Nasdaq. Nordpool has also started to predict its prices based on future prices on Nasdaq. But it can also be on profit and loss for the buyer. The supplier must commit to an agreed price/capacity margin to cope with price and consumption fluctuations. Nasdaq predicts futures purchased for different time periods that Nordpool also end-turned. We have a figure from Sweden.

Figure 3 System price per day and prediction of prices for the years 2023 and 2024.



I myself have made a simple model based on starting data from supply data and demand data from Nasdaq Nordic Electricity. The model is simple C= (A+ B)/2, where A is the supply price and B is the demand price which may give a more real buying curve over time than fixed price or completed purchases.

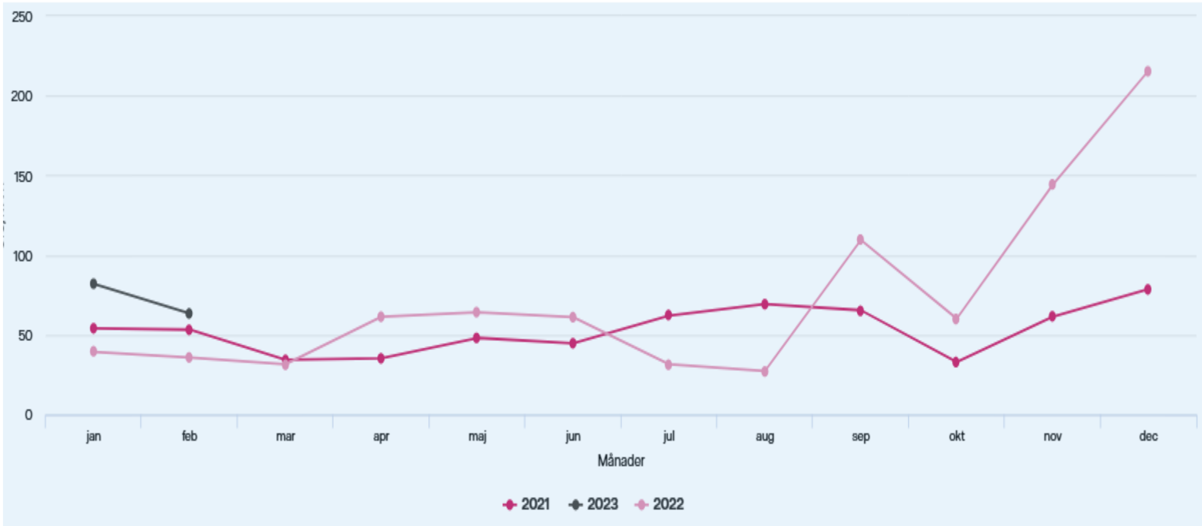
Figure 4: The x-axis is €/MWh and y-axis are quarters from for the years 2022 to 2025. The



curves are bought and supply curves as well as the curve of the model in the middle. The points quarters 8, 10 and 13 are a bit cool, due to little access to data, but for the years 2023, 2024 and 2025, the prediction seems calm and probably calmer in reality than historical data from the years 2022 and 2023.

We can still compare with historical spot prices from Nordpool. Nordpool's historical prices can also be compared to figures made with scilab from futurdata and Nasdaq. In all figures, it can be seen that electricity prices have been in autumn 2022 and winter 2022. In conclusion, it can be said that it seems that prices will drop and calm down. Nordpool has chosen rather calm prospects based on futures from Nasdaq Nordic Electricy[6,7].

The y-axis is kronor per kWh which is almost like € per MWh. In all figures, the fluctuations in autumn are high and large.



Conclusions

I have written an issue about microeconomics and macroeconomics with economics control, modelling and engineering aspects in macroeconomics whit GDP modelling from 5 input variables with an approach to control the output variable GDP. It was difficult because the high rising trend. But it can be possible in some times and lower levels so least square modelling without feedback was reached. A view for the Nordic electric market with the difficult circumstances like Russian-Ukrainian war and high rising prises was to come out with a microeconomic model and content. The futures from Nasdaq and Norpool promises a calm future and lower prices.

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