The Dynamic Inventory Problem of GM Dealers in the USA

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1 INTRODUCTION

The year 2008 is a very tough year for the US- and world-economy. The financial bubble that burst in the United States led to volatility in the stock-markets and the authorities are trying unusually drastic methods to prevent several financial institutes from collapsing. Fear of a major recession is going around as problems in the financial sector are beginning to have an effect on the rest of the economy and some forecasts predict a long-lasting recession.
The General Motors Company (GM), like the other two big motor-vehicle producers Ford and Chrisler, is struggling for a couple of years with several problems like loss in market-share, huge financial losses and increasing payments for its employees pension- and health-care shemes and the ongoing crisis seems to deepen these problems. As GM is the second biggest motor-vehicles manufacturer in the world, many companies are affected by GM's state and actions. Car dealers are in the special situation that they are the first to feel a change in demand but are also the last to react to this change. This slackness usually poses no economic threat when businesses go as usual. But in times of problems at GM and an ongoing financial crisis this can have negative impact on dealers. We want to show some of these problems the GM dealers might encounter in the near future if they are not already have so.

The specific problem we are dealing with in this paper is the rise of inventory numbers for GM cars in the last 6 years. In a first step we describe the problem dynamically and present the reference mode in a graph which shows the development of inventory unit numbers over a period of time. Then we go on presenting our hypotheses, what we think created the

problem and which underlying structure lead to this problematic behaviour. In a next step we test our hypotheses and examine whether our model can reproduce the reference mode and shows realistic behaviour. In the last part we give policy recommendations based on our findings in the previous sections.

2 PROBLEMATIC BEHAVIOUR

We present in this section the problematic behaviour we are trying to understand and explain why it is problematic. Figure 1 shows the development of quarterly inventory unit numbers over the last 6 years. One can see a rise in inventory numbers from 2003.This rise slowed down at the end of 2005 and dropped a little bit until the beginning of 2006, where it rose again until the beginning of 2007. From this point until now it is stabilizing. Why is this

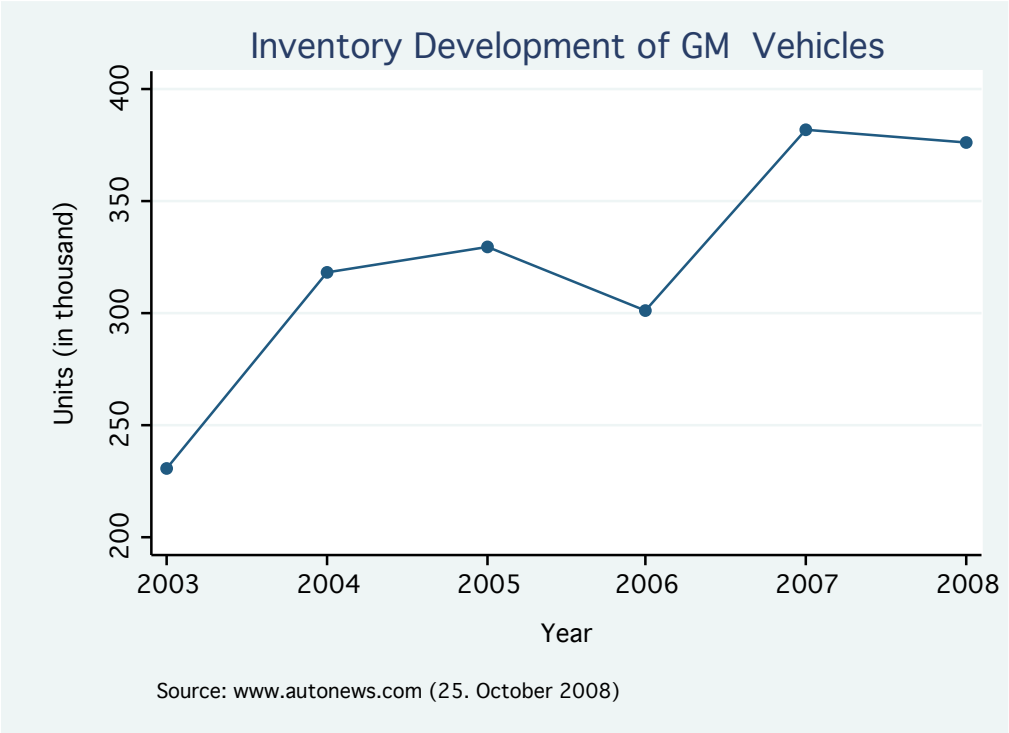

Fig. 1. **Notes:** Data is collected from certified GM dealers throughout the USA.

behaviour a problem? Inventory is usually used as a buffer in order to cope with seasonal and structural change in production/ordering and/or sales, so the oscillatory behaviour seen in the graph is structurally given. The dealers face a trade-off by their decision how big their inventory should be. The more vehicles they have in the inventory the more they can cope with

changes in the market. But on the other hand is having an inventory costly. From the time the dealers receive the car from the manufacturer until they can sell it to a customer they have to finance it before they get any revenue. Rising inventory over six years is problematic for mainly three reasons: (1) Rising costs for the previously mentioned reasons; (2) Indication of falling sales; (3) Uncertainty whether inventory will fall in near future.
(1) Higher inventory numbers lead to higher costs as the upkeep is costly. The financial crisis made this situation worse as the banks are more reluctant[1] to finance inventory upkeep. (2) Car dealers Usually try to keep their inventory at certain levels, so when sales are low they order less in order to reduce inventory size. But actual sales figures show that they have been falling for the last 6 years.

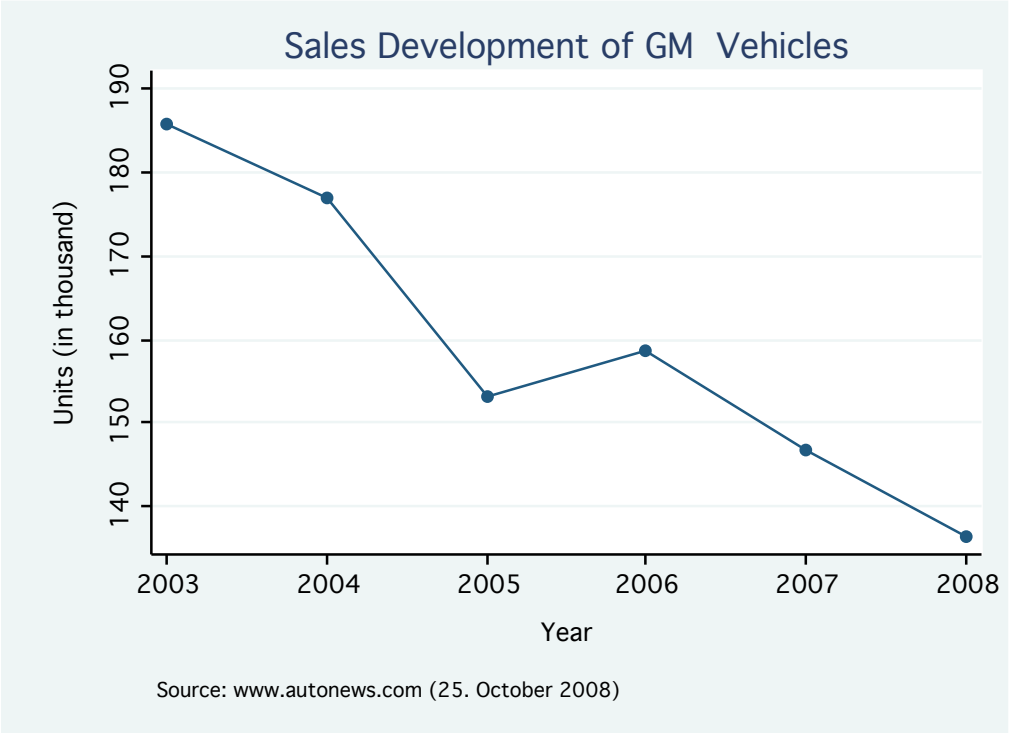

Fig. 2. **Notes:** Data is collected from certified GM dealers throughout the USA.

Seasonal and business-cycle caused fluctuations are expected but an almost constant drop (with an interruption from 2005-2006) from 2003 until the end of 2008 is an indication of some major problems of GM and it's products. (3) There are two ways to reduce inventory; either by increasing

[1]See article in Forbes: *GM dealers say GMAC forcing inventory payoffs*. Link: http://www.forbes.com/reuters/feeds/reuters/2008/10/21/ last visit: 04. November 208

sales or reducing ordering of vehicles at GM. As the dealers have more direct control over the latter, this policy is often the first being implemented which also means that at some point fix-costs like salesmen, stores, etc. have to be cut. But the longer time period inventory rises the more uncertainty do dealers face whether sales might bounce back in the near future. This is a problem because it is costly and time consuming to hire and train new salesmen and acquire space to run business.

System Dynamics takes on a holistic approach and is useful to answer the main question whether the raising inventory should be tackled by changing some decision rules on desired inventory coverage, etc. or if one should wait and see what happens. In the next section we present a model we think that represents the real world system of inventory management.

3 HYPOTHESIS

There are different ways to convey a System Dynamics model. We start explaining ours first in a narrative manner. After this we go on presenting a causal loop diagram structure and explain each of the loops. In a last step we show the stock & flow structure our model is based on.

3.1 Narrative explanation

The main variable we are interested in is inventory because this stock can be managed autonomously by the car dealers. This variable is determined by two other variables: the order of cars which leads to the raise of inventory and the sales that has an reducing effect. These two variables are connected with each other as the dealers will depend their orders for cars on the sales so that they can keep the inventory at a *desired level*.

In our model the sales rate is very important as it captures actual demand and is a starting point for the decision how many orders have to be placed at GM. Let us first explain how demand affects sales and then turn to the order-decisive function of sales.

3.1.1 Connection between sales and demand

In a competitive market price will function to equalize the quantity demanded by consumers[2] and the quantity supplied by producers resulting in an economic equilibrium. The dealers will adjust the price of vehicles if they have excess inventory as this measure can stimulate demand. When do dealers know if they have excess inventory? Usually dealers use the concept of desired days supply as a goal for inventory size. It states that,

[2]In our model we call that *consumption*

if for some reason production should stop, the inventory had to be sufficient to supply market demand for a specific period of time based on last months sales. In the automobile industry this number is on average 60 days for cars[3]. The dealers evaluate if their actual inventory exceeds these 60 days and will change prices. This in return *can* have a desired effect on consumption. The reason why this is not imperative is because demand is also highly affected by actual performance of the economy, so in times of economic depression the stimulating effect of lower prices might be offset.

3.1.2 Corrective function of sales on orders

by the price of the cars as people demand more cars when the prices go down. The dealers can use this relation between price and demand by decreasing the price in order to clear excess inventory. Depending on the sales rate the dealers will decide what amount of cars they want to order from GM. The more sales they generate the more cars they have to order as they want to keep their inventory at a *desired level*. GM receives these orders and evaluates what has to be done in order to produce the demanded amount of vehicles. If they should realize that they cannot provide the demanded amount of cars in a reasonable time they will hire and train more people to increase production. In this process GM also evaluates whether any adjustments to production capacity has to be made because the workers need a proper environment to start producing. All this cannot happen immediately at order-receiving and needs time. When the production has started and the cars have been produced, they can be shipped to the dealers and this leads to a raise of dealers inventory.

3.2 Causal Loop Diagram

The causal loop diagram of this model is presented in figure 3.

We start by explaining the model loop by loop. The simulation model as it is, presents two major feedback loops:

- Counteracting Inventory Gap loop (C1)
- Reinforcing Orders loop (R1)

There are also four minor loops present, which are:

- Counteracting Price loop (C2)
- Reinforcing Expected Orders loop (R2)

[3]According to data from www.autonews.com (25. October 2008) average days supply for the period 2003-2008 has been 61.59 days.

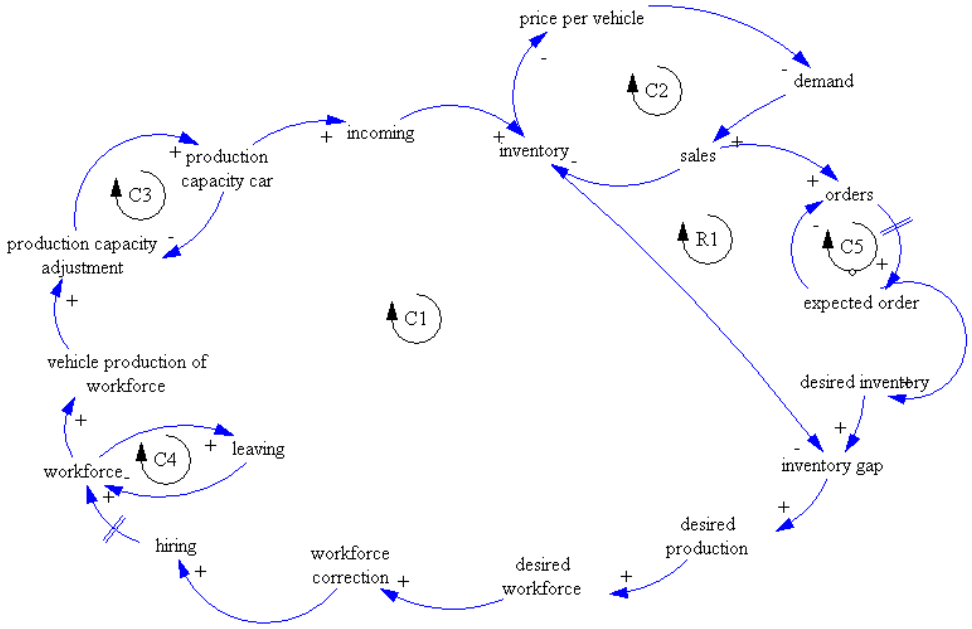

Fig. 3. Full causal loop diagram

- Counteracting Workforce loop (C4)
- Counteracting Production Capacity loop (C3)

R1 As shown in figure 4 an increase in inventory numbers increases, through the effect of higher demand triggered by inventory-clearing measures by the dealers, orders. This leads to a higher desired inventory and as a consequence to a greater inventory gap. This information goes to GM and they realise they have to increase the production. This results in an increase of the workforce. As a consequence the production capacity will be increased and the production grows. This will show up in higher incoming rates which leads to a higher inventory.

C1 The second major loop C1 has a balancing function. The main difference to R1 occurs in the beginning: A higher inventory has a negative effect on the inventory gap. The more cars the dealers have in their show-rooms the less they need to order at GM. So the production reduces, etc.

C2 The small counteracting loop C2 balances the effect of inventory regarding to demand. If the dealers have high inventory numbers

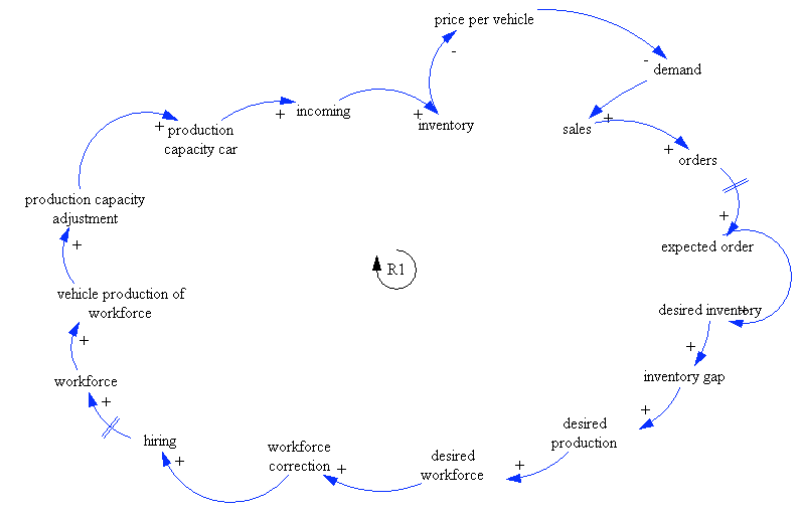

Fig. 4. Orders loop R1

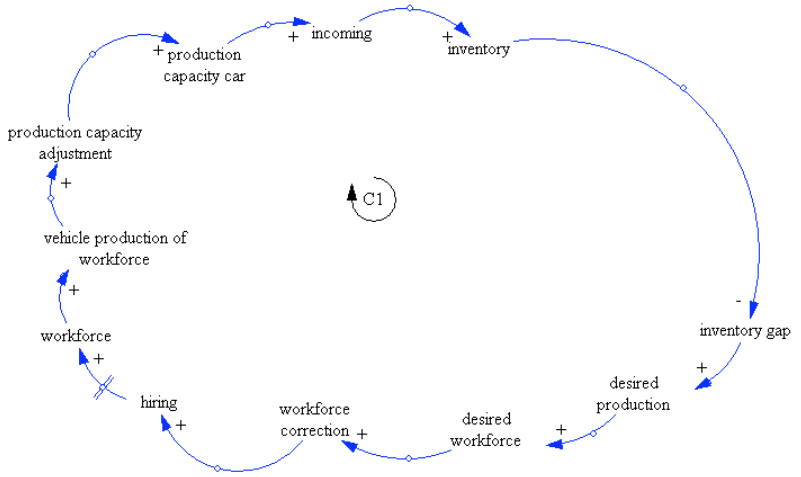

Fig. 5. Inventory gap loop C1

they try to reduce the price of the vehicles in order to stimulate demand. They do that through simple price-cuts or equivalent incentive-programs like offering additional items (tires, gas-bons, better car-radios). They are often aided by GM. By stimulating demand the sales figures go up and as a consequence lead to a decrease in inventory.

C4 The C4 loop is straightforward and has a balancing effect on workforce. The more people GM has the more will leave due to retirement, job-change, injuries, etc.

C3 The production capacity loop describes the relationship between pro-

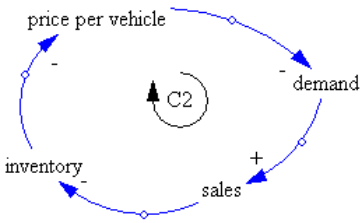

Fig. 6. Price loop C2

Fig. 7. Workforce loop C4

duction capacity and the adjustment of it. The more workers GM hires to build cars the more production capacity like factories, assembly lines, etc. has to be created. If GM's production capacity is growing the less adjustment has to be made.

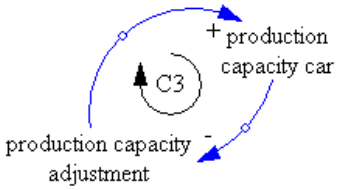

Fig. 8. Production capacity loop C3

C5 The expected orders loop is a balancing one. The more orders (that the dealers want to place at GM) are coming in due to increasing sales, the more will our expectation of orders increase. But if our perception of future orders is increasing, the discrepancy to the actual orders in the future will be lower.

3.3 Stock & flow structure

The stock & flow structure can be seen in figure 11. This representation reveals the *systemic* nature of our model. It reveals the focal points where accumulation processes occur; in other words it visualizes where and how delays happen.

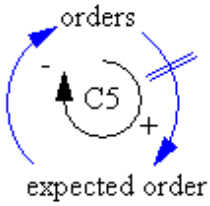

Fig. 9. Expected orders loop C5

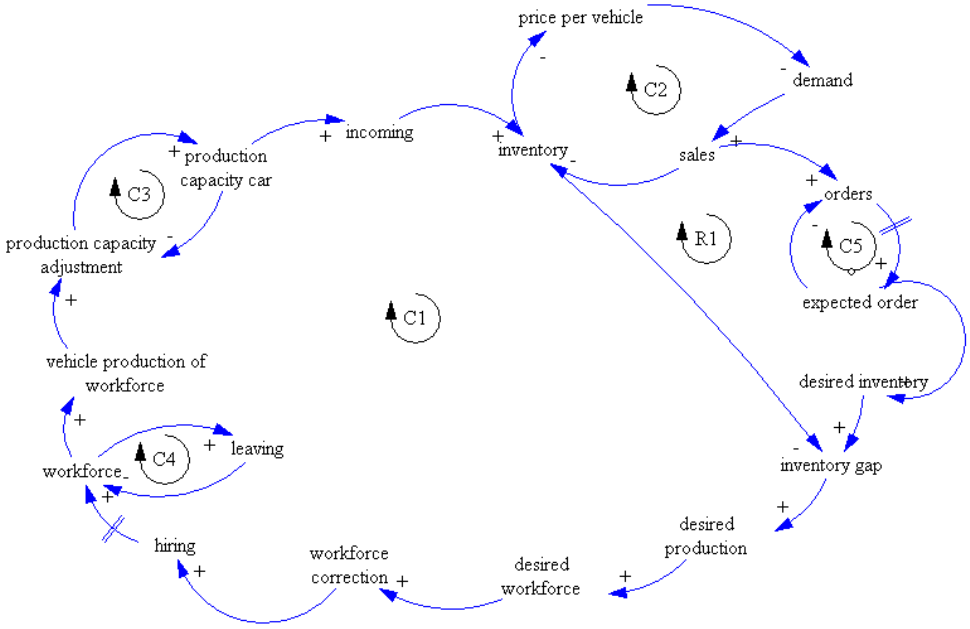

Fig. 10. Full causal loop diagram

The main stock and flows are inventory as a level and incoming and sales rate as the according flows. As stocks only can change through its connected flows, let's pay our attention first to the sales rate. This rate is changed by the demand for cars. The dealers can to a certain amount change this demand to their favour by decreasing the price for vehicles. But this price is an information stock. That means a change of price cannot happen over night. There are several reasons:

- Cost of rewriting advertising.
- Uncertainty of demand in the future as they don't want to lower the prices and see demand bouncing back anyways.
- Competition from other companies.
- The dealers simply can't afford to lower the price.

The sales rate is the most important factor that determines future orders. The dealers have a certain perception how much cars they have to order from GM. This stock of expected orders will also change only gradually as they won't place orders each and everyday but will wait and see how sales develop over a certain period of time. This level of expected orders will be evaluated under two points; the first is the number of orders to keep the actual inventory. The second is more important for us, it calculates the desired inventory based on the expected orders (by multiplying expected orders and desired days supply). We then get the information how much we have to correct the orders in order to keep the inventory at a desired level.

The dealers can then place their order at GM and the company can start producing. But before it can do so an evaluation has to be done if the actual workforce is capable of producing the ordered amount in reasonable time. So the received orders determine a change in workforce figures. As hiring and training (or firing as in the case of low orders) takes some time the workforce is a level. The same evaluation process has to be done for production as new capacity has to built up or scrapped depending on the existing workforce. The production can start now and the ordered vehicles can be shipped to the dealers.

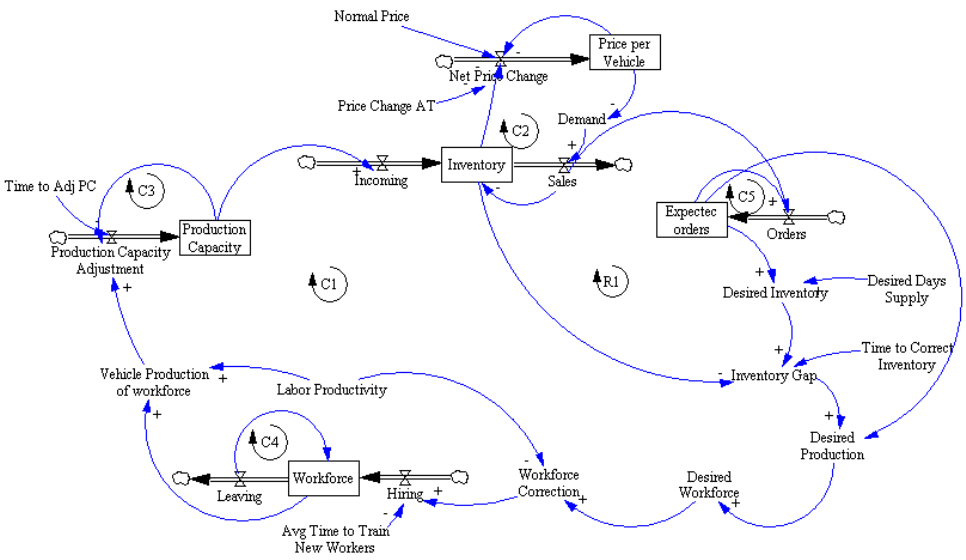

Fig. 11. Stock & flow diagram