Inventory control and forecasting

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Abstract

This paper provided a two-stage invertory system. Description its problem behavior and structure implement. Analysis the policy design: use inventory and backlog to absorb differences between production and demand, change production to match change in demand, change demand to match production abilities, finally, forecasting reslove permanat and temporory change and lag in production's responce to change.

1. Description of problem behavior

Many companies experience significant variations in production and inventory consumer goods. manufacturers experience similar variation: factory production often fluctuates more widely than consumer purchase rate,sometimes by factors of two and three. production and inventory instability is widespread in industry production and inventory variation impose cost on the company, its employees,and the economy. During boom periods the company works large amounts of overtime, experiences production inefficiencies because of parts inventory shortages,new employees, and fatigue, and potentially less business because of finished inventory shootages:
Employees experiences inflationary cost and demand pressures and growth is constrained by shortages.In bust periods the company has idle resources and excess inventory; employees and layed off; The economy bears the burden of high unemployment and growth below potential. policies that reduce the severity of these variations offer the potential for numerous cost savings.

A company can cope with demand change in three ways:

1.) Use inventory and backlogs to absorb differences between production and demand.
2.) Change production to match change in demand:short run changes can be accomplished with overtime, long-term change with change in resources.
3.) Change demand to match production abilities-change in product attractiveness affect market share and thereby company demand.

In all manufacturing industries physical goods flow through a series of production-inventory stages, consumer goods are produced and then shipped to distributors, wholesalers, and retailers. Each stage of the distribution system holds inventories, sends order to the previous stage, and awaits delivery.for industrial products, or for the production stage of consumer products,the flow proceeds from raw materials to basic items such as sheet and row steel, machined parts, subassemblies of parts, and finally complete assembly.

Each stage of the production system holds inventories, sends order to the previous stage, and awaits deliveries. while the length of delivery delays, the number of stages, the level of inventory,and so on.

2. The structure of a two-stage inventory system is shown in figure 1.

Shipment rate depletes finished inventory; production completions build finished inventory, work in process accumulates the difference between production rate and production completions. production rate depletes parts inventory, parts; parts arrival rate builds parts inventory; parts on order accumulates the difference between parts order rate and parts arrival rate.
The two- stage system is large enough to produce the instability observed in larger system, yet small enough for a modeler to understand the causes of such instability and design policies to lesson it, the conclusions drawn from an analysis of the simpler system apply equally well to other stages of the larger system.

the first feedback control is involve basing parts order rate on the level of parts invertory. as parts inventory fall, parts order rate increases, eventially enlarging parts inventory and feeding back to reduce parts order rate.
the second feedback control is involve the affect of parts invertory on production rate-as parts inventory fall, production rate is reduced by short-ages, thereby showing the decrease in part inventory.

Production completions PC are represented as a third-order delay of production rate PR, time to complete work in process TCWIP is set to 20 days.
parts arrival rate PAR is represented as a third-order delay of part order rate POR.
parts on order POO accumulates the difference between parts order rate POR and parts arrival rate PAR.
work in process correction WIPC is defined to equal work in process goal WIPG minus work in process WIP divided by time to correct finished

inventory TCFI
average customer order rate ACOR is represented as an exponential average of customer order rate TACOR is set equal to 60 days.
work in process goal WIPG equal time to complete work in process TCWIP multiplied by average customer order rate ACOR.
parts order rate POR equal average production rate APR multiplied by POP.
pop is a TABLE function of parts invertory PI divided by parts inventory goal pig. with the relationship added,as PI/PIG equal 1, POP equal 1. as PI/PIG higher than 1,POP less than 1, as PI/PIG less than 1, then POP high than 1.
work in process WIP accumulates the difference between production rate PR and production completions PC.work in process is initialized to its equilibrium value.time to complete work in process TCWIP multiplied by constant customer order rate CCOR.
COR equals constant customer order CCOR multiplied by a series of exogenous disturbances.

3. policy design and improve behavior
policy design builds on the understanding of the relationships between structure and behavior:
1) some pressure on parts ordering (feedback control) is essential to maintaining inventory near desired levels.
2) the stronger the pressure, the greater the swings in parts order rate.
3) with weak pressure parts inventory remains below it goal.
4) some drop in parts inventory is unavoidable because of delays introduced by averaging information and supplier delivery times. to avoid fluctuations in parts order rate and parts inventory, the company must suffer greater inventory shortages.

delay in physical flow channels causing inventory to decline in response to an increase in usage so that reorder rate must rise above usage rate to rebuild inventory.
delay in flow channels are relatively fixed.the information required to separate the initial disturbance from each stage's inventory correction order is very difficult to obtain.
consequently policy design must focus on parameters associated with the reorder rate policies.
reorder rate policy parameters affect stability and amplification in two ways. first, the averaging time determines how quickly the company establishes inventory goals. the longer the averaging time, the less the company responds to the short-term inventory correction orders of the preceding stage. second, the inventory correction time determines the magnitute of inventory correction orders.the longer the correction time

the lower the correction order and the amplification, policies with longer averaging and correction time should therefore improve stability.
figure2 and 3 give the behaviors of production rate and parts order rate (in the case of different value of TACOR,TCFI,TAPRPO,TCPI)

figure 4 and 5 give the behavior of POR,PR,PI,and FI for the different correction time. the shower the response, the greater the inventory decline, past a point, the benefits of shower responses are nearly offset by greater inventory losses.

4. forecasting reslove permanat and temporary lag in production's response to changes

how might forecasting resolve the two behavior problems of a policy based on averages concerning trade-offs between permanent and temporary changes and lags in production's response to change?
A forecast is an assumption about the future, based on current and past information. in an average-based policy the forecast is the current average of past conditions.
the policy designed should respond slowly to short-term change but also anticipate long-term change once recognized.
many products are subject to strong seasonal variations in sales. by anticipating or forecasting these variations, and increasing production in advance of them, production will more nearly match shipments so that inventory will fluctuate.
figure 6 is using forrecasts in decision making for inventory control.
base customer order rate BCOR calculated incorporates trend extrapolation. BCOR equals 1.0 plus customer order rate forecasting time CORFT multiplied by observed customer order rate growth rate OCORGR. all multiplied by average customer order rate ACOR. customer order rate forecasting time CORFT is set to the sum of time to average customer order rate TACOR to complete work in process TCWIP.
observed customer order rate growth rate is calculated by a userdefined function, or marco, called TRND. the input to this macro are customer order rate COR, time to observe customer order rate growth TOCORG, and initial customer order rate growth rate ICORGR.

Figure 7 shows that a policy based on trend extrapolation is capable of adequately responding to growth in COR. in the figure, time to observe both COR and production growth rate equals 240 days. thus base production rate does not exceed production rate until approximately one year later, and base customer order rate does not exceed customer order rate for one year. as a result both finished and parts inventories initially decline.
after one year, however, base production rate leads production rate as the trend-forecasting procedure anticipates future values of production rate.

The situation is similar for customer order rate. finished and parts inventories increase and nearly equal their desired value by day 2400.

figure 8 shows that a 10 percent increase in customer order rate causes a 19 percent increase in parts order rate (amplification) and finished and parts inventories do not rise to thier desired values until day 740.

figure 9 shows the response of the TREND extrapulation policy to a NOISE variation in COR,as for STEP, amplification increases the shorter the observation time, Amplication is also greater for the parts stage because it has a longer forecasting time and is amplifying an already amplified disturbance.

5. Policy guideline

1).Response to GROWTH is improved with any trend observation time, but time between 240 and 700 days cause inventory to bottom and grow withen 480 days after the change in growth rate.
2). Response to STEP and NOISE is worsened because trend forecasting is an additional source of amplication, but the increased amplification is minimel for observation time greater than 480 days.

If a company does not experience the full range of demand variations, or if, for example, the cost of instability are far less than the cost of running short of inventory, then a company may choose a trend observation time other than that greater than 480 days.

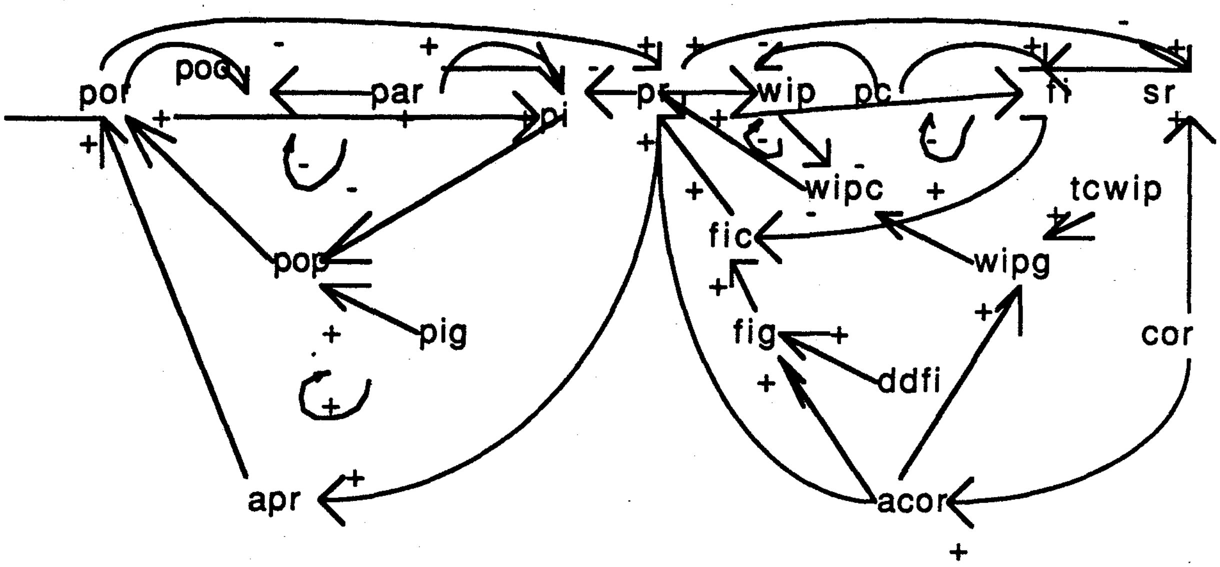
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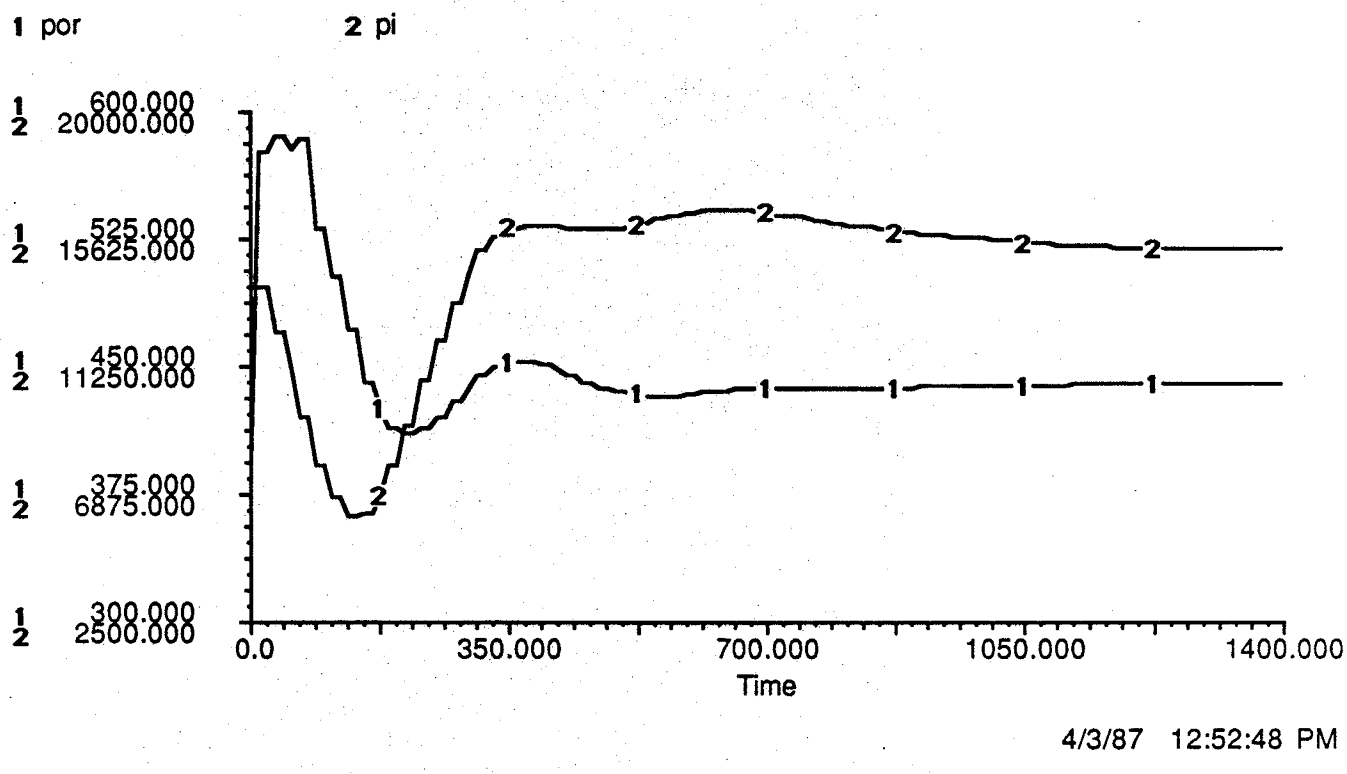
Figure 1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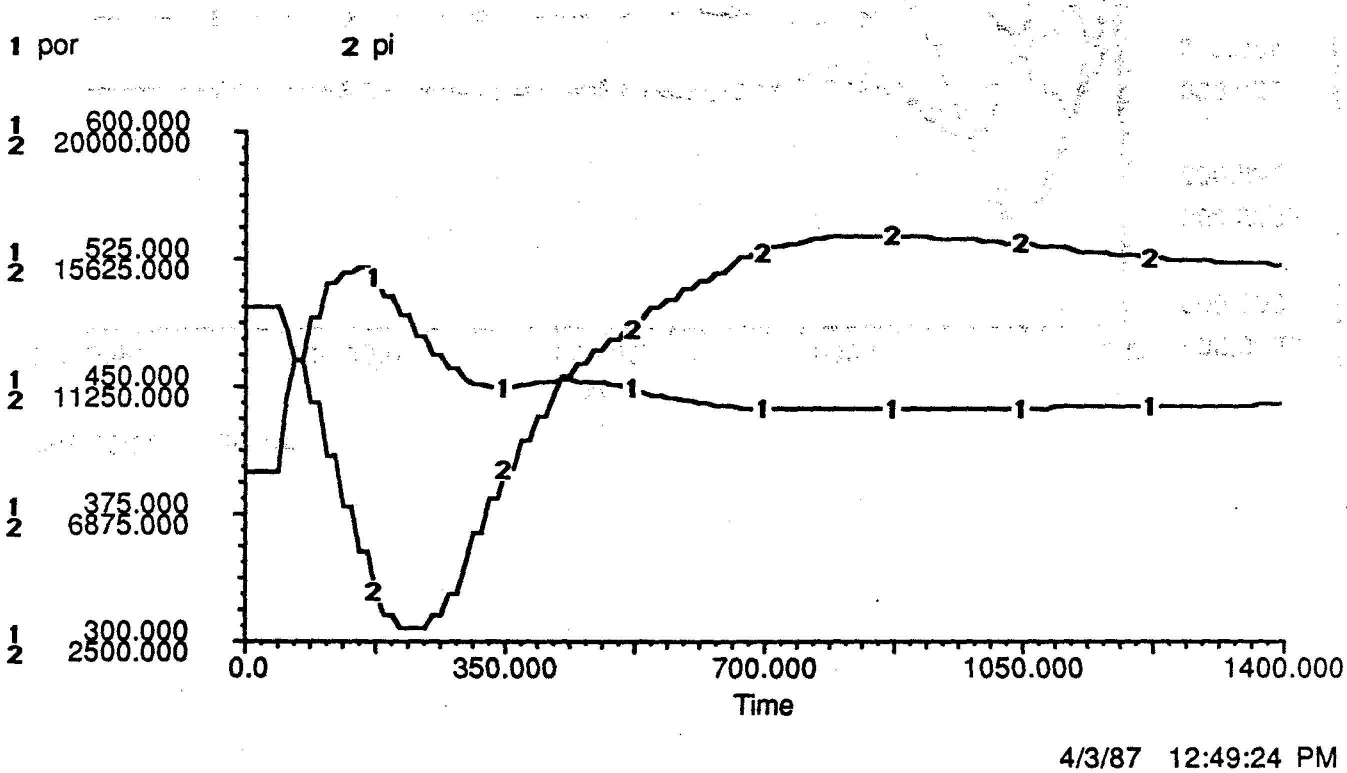
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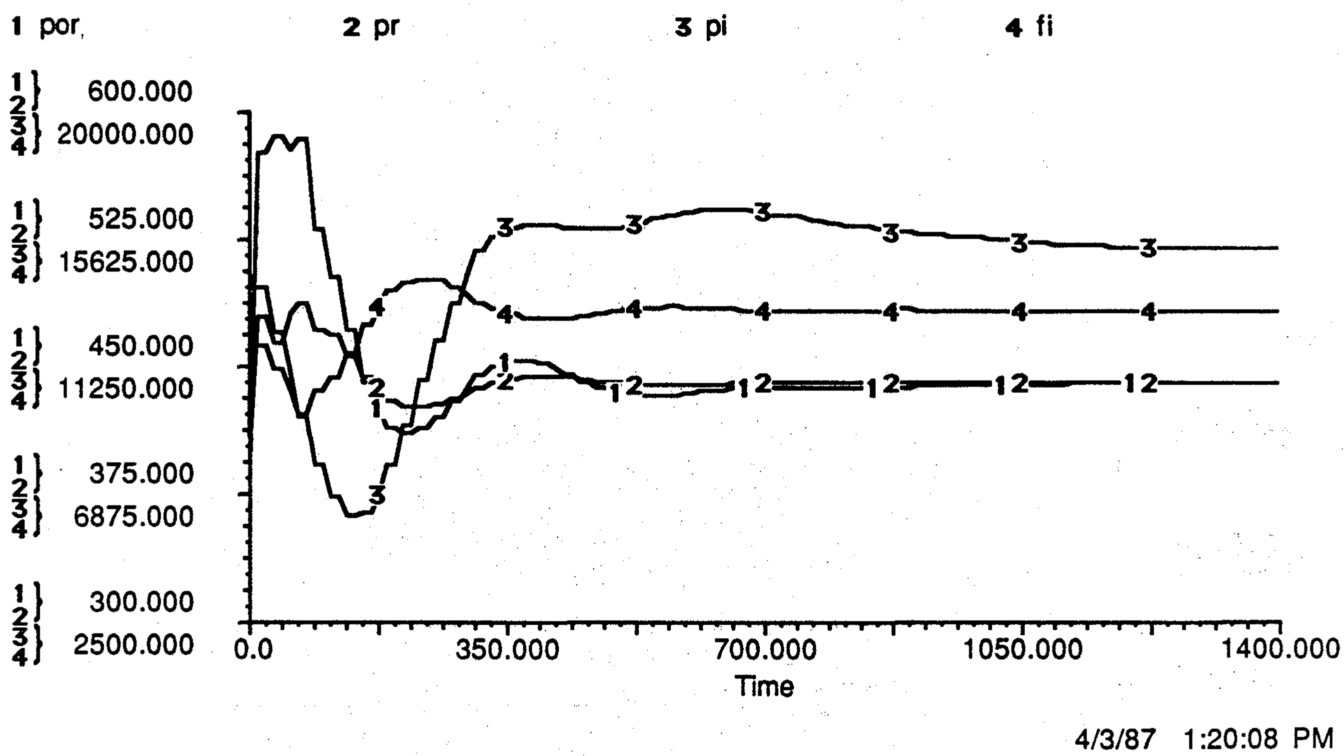
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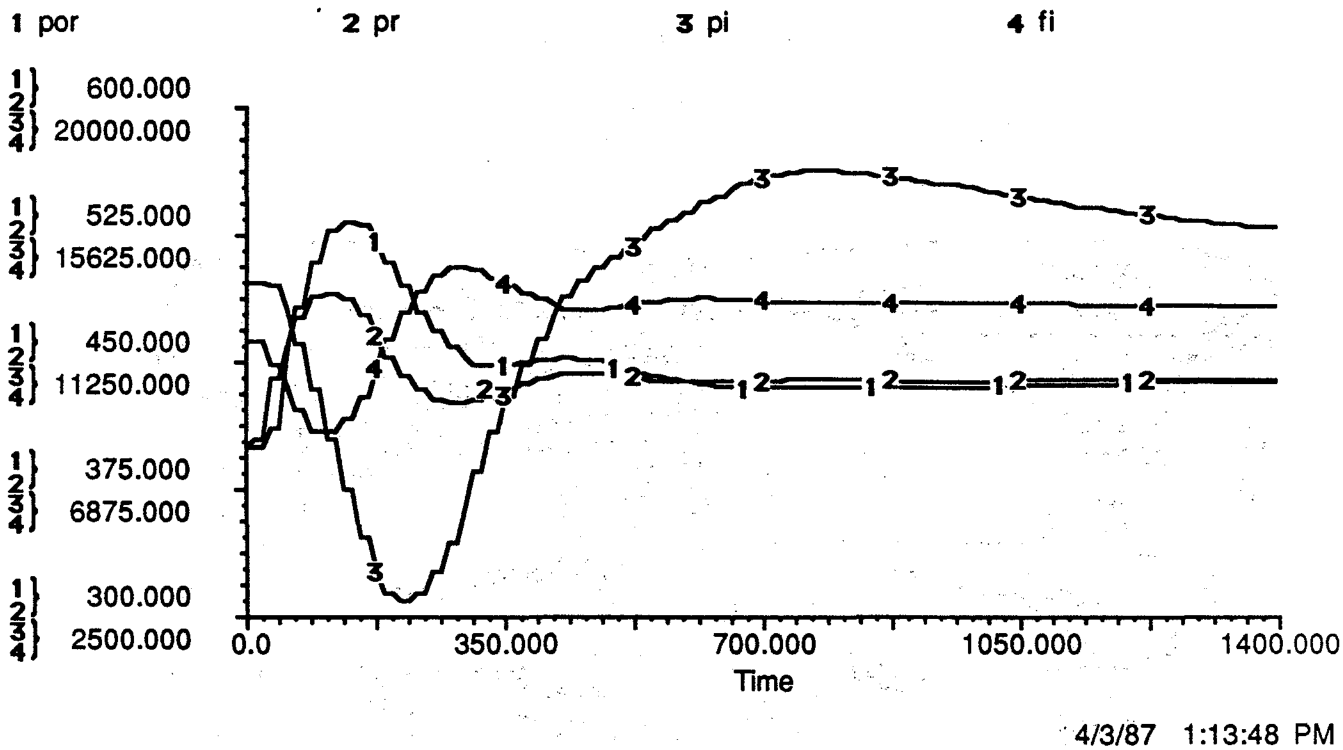
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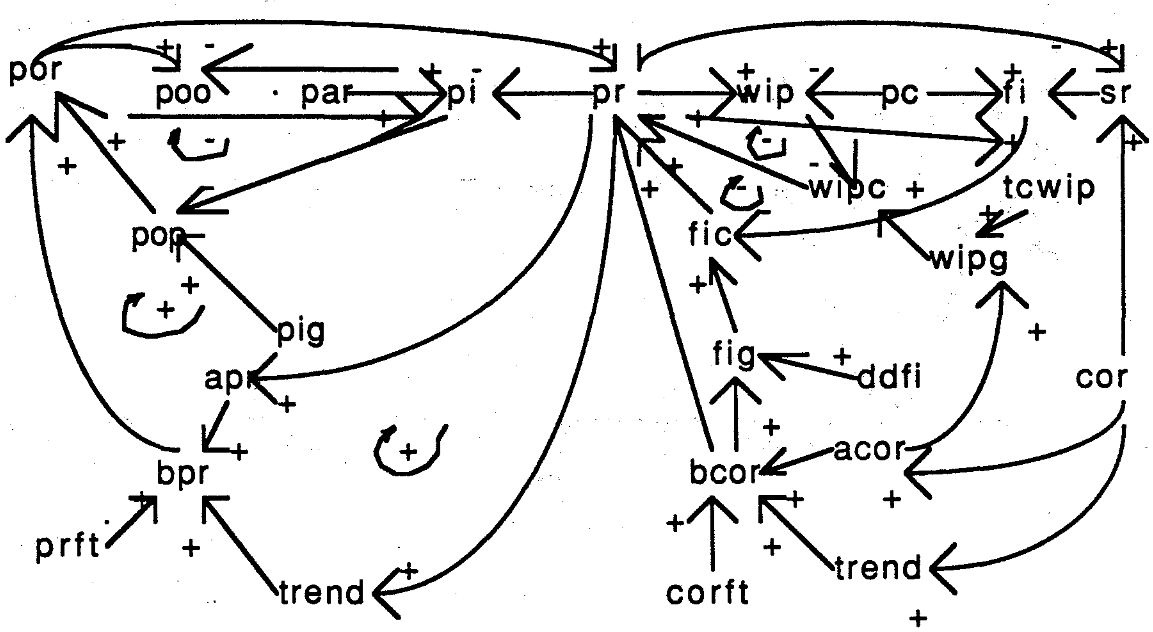
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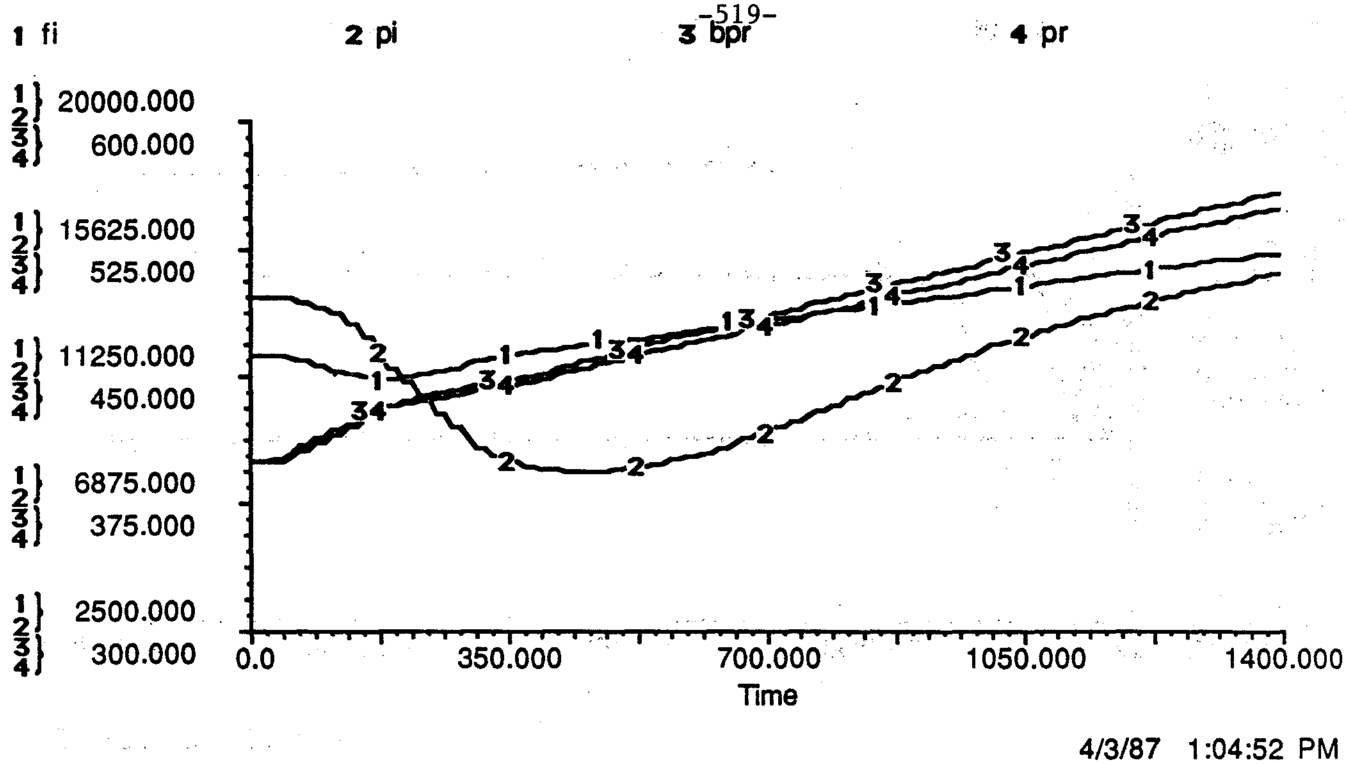
Figure 6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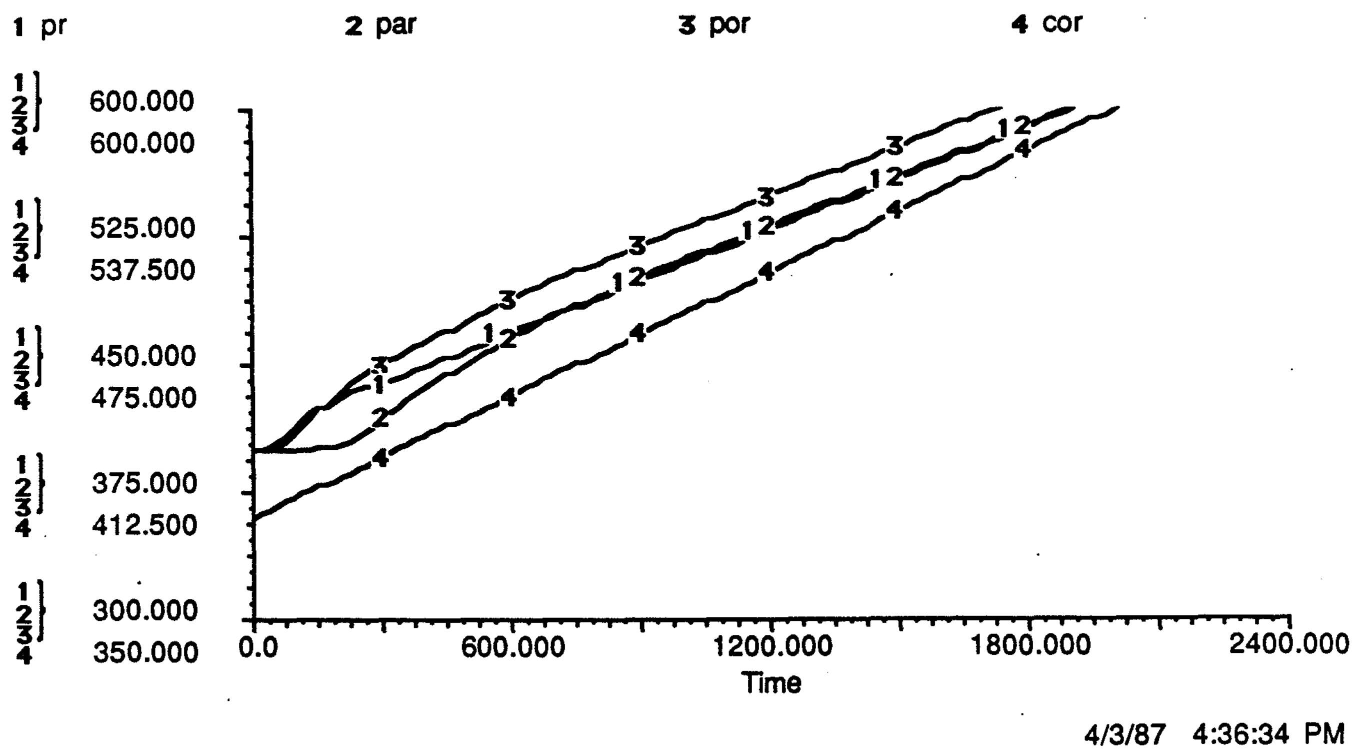
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Figure 7

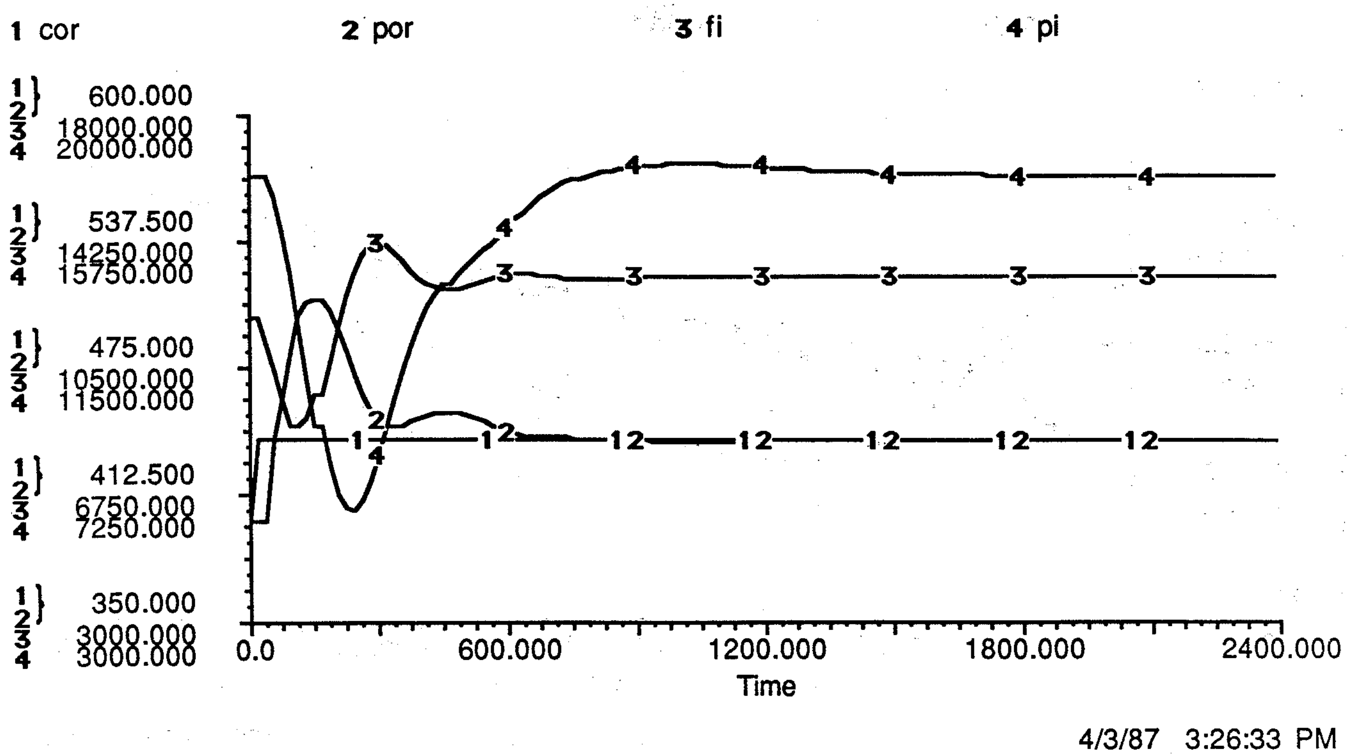
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Figure 8

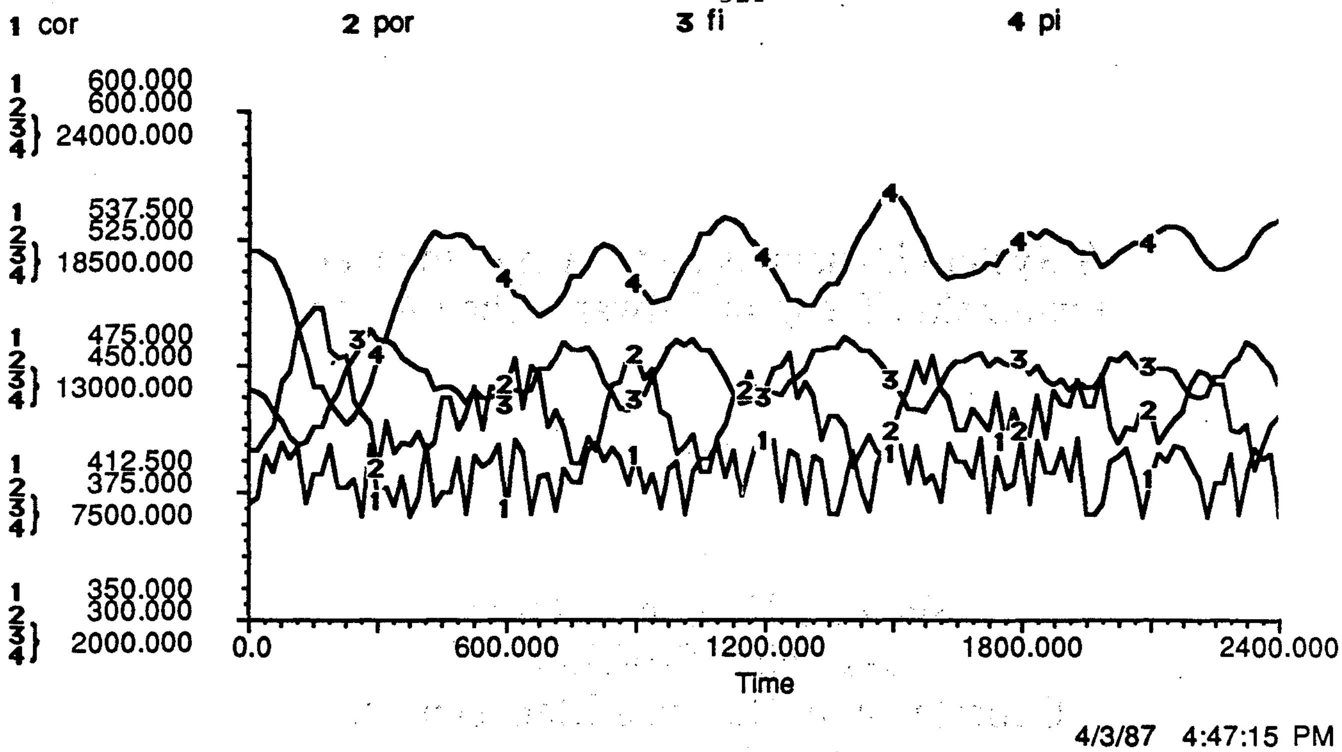
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Figure 9