cross sectional evidence of correlation between inventory investment and output volatility across a number of industries in the manufacturing and trade sector. Their results supported their hypothesis and found that changes in goods sector inventory behaviour accounted for about half of the overall decline in GDP volatility. One fourth of the reduction in GDP growth was found to be due to reduced covariance between output growth rates in the goods sector and other sectors. The change in covariance is felt to be possibly the indirect role of inventory management working through supply chains. Besides, improved management techniques were felt to be reflected as industry level data showed a cross-section correlation between reductions in output volatility and reductions in average in average inventory to sales ratio.

3. APPROACH TO THE STUDY

For over five decades now, scholars from operation research have been concerned with practical applications of inventory theory and not look at it from theory point of view alone (Robert Obermaier, 2012). As such inventory models and advanced inventory control systems are being applied so as to reduce excess inventories. As already seen in the previous section there are few inventory studies in India. In one of these studies (Seema Saggar, 2003), the author augments the production-smoothing with cash flows and monetary policy variables for a panel of Indian firms. Inventory ratio techniques have been used to study inventory management in selected Indian industries (Agarwal N.K., 1983). Inventories have also been analyzed in the organized manufacturing sector of the Indian Economy so as to see the trends in input-output ratios both industry-wise as well as component of inventories (Krishnamurthy K., Sastry D.U., 1970). Besides, in this study, the authors have estimated marginal inventory output coefficients for inventory and its components by using the "flexible accelerator model". The authors have used the data for the period 1946-58 (Krishnamurthy K., Sastry D.U., 1970).

According to one of the studies (Bridge J. L., 1971), inventories are difficult to handle because of the prevalence of uncertainty. These uncertainties relate to the supply chain facet which forces industries to hold stock of raw materials. Supply chain management points out that a closer cooperation and information sharing with producers and suppliers could help in reducing the stock of inventories (Robert

Obermaier, 2012). In order to achieve stockless production, there has been certain paradigms which have been adopted in different parts of the world such as "just in time" paradigm (Hall, R. W., 1983) and "lean production" paradigm (Robert Obermaier, 2012). According to a new management paradigm, inventory is said to be a waste and therefore to be eliminated and continue production with zero inventory (De Haan, J. Yamamoto M., 1999). Possibly, with globalization such sophisticated paradigms may be prevalent in Indian industries, however the study has not managed to source studies related to such paradigms in Indian industries. Besides, when exchange rate changes small open economies which depend heavily on imports of raw materials and semi-finished goods find inventory management difficult (Helen Louri, 1996).

In spite of various stochastic theories available, the concept of the "desired level of stocks" is the most extensively used device for inventory analysis. This is proportionate to the desired level of sales (Bridge J.L., 1971). The traditional accelerator theory is more appropriate to the study of inventories than to fixed investment because inventories are constantly varying. Further, it is well known that long run data cannot recover inventory fluctuations as these are prevalent only in the short-run (Bridge J.L., 1971). Therefore, the inventory study would be for the short-run and one could expect a partial adjustment to equilibrium. Thus, the "flexible accelerator model" is also called as "partial adjustment model" (PAM).

The model when used for a particular firm has been criticized for lacking proper definitions of independent variables (Bivin D.G., 1986). However, the same model has been used in this study, for it does not focus on a single firm but relates to a number of firms in each industry.

In one of the earlier papers (Swaminathan A.M., 2001), the author has used the flexible accelerator model and analyzed the public and private limited companies for the year 1982-83 to 1992-93 but has not involved the exchange rate into the model. Going by the same idea but with an enhanced thought of including exchange rate, this study modifies the flexible accelerator model of (Swaminathan A.M., 2001) by including exchange rate as an added independent variable. This is being done to see the impact of structural reforms on exports/imports for, though the reforms

process began in mid 1980s, the junk of the reforms was taken up only after early 1990s. It was here when India adopted a flexible exchange rate system (Pami Dua and Rajiv Rajan, 2010) and devaluated rupee.

Instead, of looking into the trend of inventories to sales ratio by sheer data the study plans to regress these ratios over time, thus it has tried to empirically test, whether inventories to sales ratio has decreased over time for the selected industries. These industries relate to both the public and private limited companies. This particular public and private limited company's data have been used because the available data are consistent over the period of time. This study has analyzed the data for non-government non-financial public limited companies from 1992-93 to 2008-09 and for non-government non-financial private limited companies from 1998-99 to 2008-09.

As already explained above, inventory fluctuation is a short-run phenomenon and during a short-run one could expect only partial adjustment or stock adjustment. Thus, for this study we make use of the partial adjustment model to examine the rate of change of inventories in relation to sales, interest rate, expected inflation and exchange rate, in Indian public limited companies during the year 1992-93 to 2008-09 and private limited companies during the year 1998-99 to 2008-09.

4. MODEL

The study plans to have a regression of the inventory-sales ratio over time. As such, the first model deals with a linear regression model with time (*i.e.*, year) as an independent variable, in order to investigate the rate of change of inventory to sales ratios over time. It is a known fact that inventory varies with variation in production and distribution levels. As such, inventory may increase (decrease) with sales having increased (decreased). Therefore, instead of using absolute inventory measures, the study uses inventory-sales ratio as a dependent variable as followed in the study by Robert Obermaier, 2012. Such ratios have also been used by Irvine, F.O., 2003.

The current study hypothesises that a declining (rising) inventory to sales ratio over time indicates a good (bad) inventory management. Let industry i's inventory be I_t in year t, achieving sales S_t, then inventory to sales ratio is

$$IS_i = I_{it}/S_{it} \quad \text{----------} \quad (1)$$

The study analyzes different components of inventory to sales ratio separately *i.e.* for total inventories, raw materials, work in progress and finished goods. This could possibly give a better understanding of how improvements develop at each of the different stages as well potential shifts between them (Robert Obermaier, 2012).
The regression model for the four inventory ratios is as follows:

$$\textit{MODEL 1}: IS_{it} = \alpha_i + \beta_{it}t + \varepsilon_{it} \quad \text{----------} \quad (2)$$

In the above equation, t represents time period (year), α represents the intercept and β the slope, *i.e.*, the trend coefficient of industry sector i.

In the second model (partial adjustment model) while considering finished goods inventories, it is hypothesised that there exist a 'desired or optimal level' of finished goods inventories. Since inventory stock is influenced by sales, rate of interest, rate of inflation and exchange rate, the study further hypothesised the desired or optimum level of finished goods inventories to be a function of the above variables. Here, sales is hypothesised to be directly related to desired inventory changes, short-term rate of interest and rate of inflation is said to be inversely related to desired inventory change. Exchange rate[2] is hypothesised to be directly related to desired inventory change in other words encouraging exports. The equation thus formed is as follows,

$$IF_t = \beta_0 + \beta_1 S_t^e + \beta_2 SI_t + \beta_3 P_t^e + \beta_4 ER_t + U_t \quad \text{----------} \quad (3)$$

Where,

IF_t = Aggregate level of finished goods inventories desired to be held by the industry at the end of period t, S_t^e = Expected aggregate sales of goods in period t, SI_t = Short-

term rate of interest in period t, P_t^e = Expected rate of inflation in period t, ER_t = Exchange rate in period t, U_t = Stochastic disturbance/error term during period t.

Depending on the situation there could be differences in the desired level of finished goods inventories from actual level of finished goods. It is well known that changes in production involve cost therefore the industry will make changes only partially. Thus, it is hypothesised that actual change in period t is some function of desired change for that industry *i.e.,*

$$IF_t - IF_{t-1} = \alpha(IF^d - IF_{t-1}) \quad \text{----------} \quad (4)$$

Where α is the coefficient of adjustment between 0 and 1 *i.e.,* $0 < \alpha \leq 1$.
Substituting Equation 3 into Equation 4 we get,

$$\textit{MODEL 2}: IF_t = \alpha\beta_0 + \alpha\beta_1 S_t^e + \alpha\beta_2 SI_t + \alpha\beta_3 P_t^e + \alpha\beta_4 ER_t + \alpha U_t + (1-\alpha)IF_{t-1} \quad \text{-------} \quad (5)$$

The above *MODEL 2* is not only worked out for finished goods inventories but other stages of inventories such as raw materials (IR_t) as a component of inventories and for total inventories (IT_t) as a whole. The models in the latter two cases are as follows:

$$\textit{MODEL 3:}\ IR_t = \alpha\beta_0 + \alpha\beta_1 PR_t^e + \alpha\beta_2 SI_t + \alpha\beta_3 P_t^e + \alpha\beta_4 ER_t + \alpha U_t + (1-\alpha)IR_{t-1} \quad \text{-----} \quad (6)$$

$$\textit{MODEL 4:}\ IT_t = \alpha\beta_0 + \alpha\beta_1 S_t^e + \alpha\beta_2 SI_t + \alpha\beta_3 P_t^e + \alpha\beta_4 ER_t + \alpha U_t + (1-\alpha)IT_{t-1} \quad \text{-------} \quad (7)$$

In *MODEL 3*, PR_t^e is the expected aggregate production of goods in period t. Unlike *MODEL 2* and *MODEL 4*, where finished goods and total inventories are a function of sales, short term rate of interest, expected rate of inflation, exchange rate, in *MODEL 3* sales are replaced by production.

Generally, it is believed that expected sales are some functions of past sales and on this basis the commonly used models are (a) the adaptive expectation model where it is assumed that expected sales equals the sales of the last period and (b) the expected sales is considered as distributed lag over sales in the last period. In this study, the first scheme (*i.e.*, the expected sales equals' sales of the last period) is used.

However, studies (Akhtar M.A, 1983) show that the two results are not significantly different.

Following, the same pattern for expected production in the raw material inventory model and expected rate of inflation in all the *MODELS 2-4*, the study considers expected production equals production of the last period and expected rate of inflation as the rate that prevails in the previous period.

Again, following Krishnamurthy K., Sastry D.U., the final equations in all the three models *i.e.* finished goods inventories (IF_t), raw materials of inventory (IR_t), total inventories (IT_t), are divided throughout by production.

A positive sign for the coefficient of the expected sales/production variable in the respective model would mean a correct anticipation. In the same manner, a negative sign for the co-efficient of the short-term rate of interest and the expected rate of inflation would mean correct anticipation in other words the hypothesis is accepted. A positive sign for the coefficient of the exchange rate would encourage exports and negative sign would indicate favourable environment for imports.

In the above models $\alpha\beta_1$ is the short-run response of inventories/its components to sales/production. Similarly, $\alpha\beta_2$, $\alpha\beta_3$, $\alpha\beta_4$ are respectively the short term rate of interest, rate of inflation and exchange rates.

5. DATABASE

The corporate data of the Reserve Bank of India (RBI) brings out data on non-government non-financial public limited companies and non-government non-financial private limited companies in regular intervals. These are available on the RBI website. All these data are in value term. The concerned data *i.e.* data on finished good, sales, inventories, raw materials, work in progress, *etc.* are used in this paper. Though the data selected are generally for a period of 3 years, they are overlapping and consistent and therefore the data have been used for analysis. Data related to inflation have been taken from different Economic Surveys from 1993-94 to 2008-09. Data on short term interest rate have been taken from the database on Indian Economy

(www.rbi.org.in). Data related to exchange rate are collected from the Statistical Appendix of the Economic Survey (Government of India, 2012).

6. EMPIRICAL RESULTS AND ANALYSIS

6.1 Inventory Management analysis

As already mentioned, since the study plans to regress the inventories to sales ratio over time for five public limited companies and four private limited companies, *MODEL 1* was solved by using OLS in Excel for each industry. In this *MODEL*, the OLS was run for four alternatives *i.e.*: - a) total inventories-sales ratio, b) finished goods-sales ratio, c) raw-materials-sales ratio, d) work in progress-sales ratio.

6.1.1 Results

Since *MODEL 1* was run for four different alternatives mentioned above and for five and four different industries under both the public and private limited companies respectively, the *MODEL* had 36 runs. Of which only 21 runs showing positively adjusted R^2 have been presented. A good inventory management expects inventory ratios *e.g.*: - inventory sales ratio, to decrease over time as output increases. Going by this, the regressions over time for these ratios show a clear decreasing trend for total inventories/sales ratio, in four out of the five industries belonging to the public limited companies. The OLS results for *MODEL 1* presented in Table 1 shows significant results. This behaviour continues for both finished goods/sales ratio as well as work in progress/sales ratio. In both the cases, three out of five selected industries in the public limited companies show significant results. Here it should be pointed out that the intensity with which they reduce differs from industry to industry and within the same industry the difference, is between the components of the inventories. However, the raw materials /sales ratio had no significant results. Among these public limited companies, while Basic Chemicals and Cement and Cement Products had significant results in three ratios, Paper and Paper Products and Chemical and Chemical Products industries had significant results for two ratios each. In the case of Tea Plantations, only the work in progress/sales ratio had significant results.

Like the public limited companies, in the case of private limited companies also it is seen from Table 2 that a decreasing trend is observed for the total inventory/sales ratio, finished goods/sales ratio as well as work in progress/sales ratio. However, the industries experiencing these are either one or maximum two. While decreasing trend, for the total inventory/sales ratio is observed only for Chemical and Chemical Products, the decreasing trend for finished goods/sales ratio is observed for both Paper and Paper Products and Chemical and Chemical Products. The same trend is observed for Tea Plantations for work in progress/sales ratio. Here again, it should be pointed out that the intensity with which they reduce differ from industry to industry and within the same industry the difference is between the components of the inventories. The OLS results for all the above ratios show significant results. Unlike, the public limited companies, which has totally insignificant results for all industries under raw materials/sales ratio; in the private limited companies the OLS results show that three out of the four industries have significant results. But, the trend indicated by OLS is rising rather than decreasing. All this is observed in the Basic Chemicals, Paper and Paper Products and Chemical and Chemical Products.

Though a desired decreasing trend is found in all the three ratios for most of the public limited companies in this study, the trend is not so clear for the private limited companies. Besides, the raw materials/sales ratio in both the public and private limited companies had problems with insignificant results for public limited companies and significantly increasing trend for private limited companies, which means that the private limited companies under study clearly have over investment of inventories. It should be pointed out here that, the data on raw materials sales ratio show an increasing trend for public limited companies during the second decade of reforms. Thus, it could be said that even after almost two decades of rigorous reforms, raw materials in industrial production of the industries under this study is not managed to expectations whether it is public or private limited companies. There could be several reasons, but, prominent should be the backward linkage *i.e*. the sectors supplying raw materials not doing well or no proper institutions to link the two (buying and selling) sectors *etc*. Thus, reforms solving the interdependencies between sectors should be strengthened.

6.2 Partial Adjustment Approach

The equations for the three models on total inventories (IT), finished goods (IF) and raw materials (IR) were solved by using OLS in Excel for each industry both under public and private limited companies. Under each of the three models, the OLS was run for six alternatives *i.e*. 1) all explanatory variables expected sales/production, short term rate of interest, expected rate of inflation and exchange rate, 2) all explanatory variables expected sales/production, short term rate of interest, expected rate of inflation excluding exchange rate, 3) without the explanatory variable short term rate of interest and exchange rate, 4) without the explanatory variable expected rate of inflation and exchange rate , 5) without the explanatory variable short term rate of interest and 6) without the explanatory variable expected rate of inflation. This is done to find out the extent of variations in results due to variations in the explanatory variables.

6.2.1 Results

As the three models using OLS was run for six different alternatives mentioned above and for five and four different industries under both the public and private limited companies respectively, each model had 54 runs *i.e*. a total of 162 runs for the three models. But of these, only significant results *i.e*. those runs having an adjusted R^2 of more than 0.49[3] are being presented *i.e*. 67 runs are being presented. Thus, for public limited companies, *MODEL 2* it was 15 runs, *MODEL 3* it was 3 runs and *Model 4* it was 26 runs and for private limited companies, *MODEL 2* it was 9 runs, *MODEL 3* it was 12 runs and *MODEL 4* it was 2 runs.

6.2.1.1 Sales/Production coefficients

The OLS results for public limited companies presented in Table 7(A), 7(B) and 7(C) shows that for the total inventories (*MODEL 4*), total inventories decreased by a maximum 0.49 units for Basic Chemical and by 1.03 units for the Cement and Cement Products and by 0.50 units in the case of Tea Plantation, all these for a unit increase in expected sales in the respective industry. Under the finished goods (*MODEL 2*), the OLS presented in Table 3(A) and 3(B) shows that the finished goods

decreased by 0.14 units for Basic Chemical for every increase of expected sales by 1 unit. Since these results are statistically significant at 5 % level, the hypothesis that the total inventories or finished goods inventories are directly related to expected sales is rejected.

The OLS results for private limited companies presented in Table 8 shows that for total inventories (*MODEL 4*), total inventories decreased by a maximum of 1.59 units for Basic Chemical for a unit increase in expected sales. Under raw materials (*MODEL 3*) the OLS presented in Table 6 shows that the raw materials decreased by 0.02 units for Chemical and Chemical Products and by 0.04 units for Tea Plantation, for a unit increase in expected production. Under the finished goods (*MODEL 2*) the OLS presented in Table 4 shows that the finished goods increased by a maximum of 1.05 units for Paper and Paper Products for every increase of expected sales by 1 unit. Since these results for *MODEL 3* and *MODEL 4* are statistically significant at 5 % level the hypothesis that the raw materials or total inventories are directly related to expected production/sales is rejected. However, since there is a positive relationship between finished goods inventories and expected sales under the private sector only for Paper and Paper Products, we accept the hypothesis that the finished goods inventories are directly related to expected sales at 5 % level significance.

Thus, while most of public and private limited companies under the study experience a negative relationship between total inventories or raw materials inventories or finished goods inventories and expected sales/production, and only one industry (Paper and Paper Products) under private limited companies experience a direct relation to expected sales, it could be said that in general most of the industries under study have a negative relationship between inventories and expected sales.

6.2.1.2 Short term rate of interest coefficients

The OLS results for public limited companies presented in Table 3(A) and 3(B) shows that for finished goods inventories (*MODEL 2*), finished goods decreased by around 1149.71 units for Basic Chemicals but increased by a maximum of 510.71 units for the Paper and Paper Products, all these for a unit increase in short-term rate of interest in the respective industry. Under the raw materials (*MODEL 3*), the OLS in

Table 5 shows that the raw materials increased by 4556.30 units for Chemical and Chemical Products industry for every increase of short-term rate of interest by 1 unit. Under total inventories (*MODEL 4*), the total inventories (presented in Table 7(B)) increased by a maximum of 1425 units for Paper and Paper Products and by a maximum of 14079.89 units for Chemical and Chemical Products for every increase of short term rate of interest by 1 unit. It is observed that only for the Basic Chemicals under *MODEL 2* shown in Table 3(A); the hypothesis of a negative relationship between short term rate of interest and finished goods inventories is accepted at 5% level of significance. In the rest of the cases, since there is a positive relationship between total inventories or raw materials inventories and the short term rate of interest the hypothesis is rejected at 5 % level significance

The OLS results for private limited companies presented in Table 4 shows that for finished goods inventories (*MODEL 2*), finished goods decreased by around 111.64 units for Paper and Paper Products but increased by 11050.26 units for the Chemical and Chemical Products industry all these for a unit increase in short-term rate of interest in the respective industry. Under the raw materials (*MODEL 3*), the OLS in Table 6 shows that the raw materials increased by 27860 units for Chemical and Chemical Products but decreased by 688.92 units for Tea Plantation industry for every increase of short term rate of interest by 1 unit. Under total inventories (*MODEL 4*), the total inventories in Table 8 increased by a maximum of 25621.94 units for Basic Chemicals industry for every increase of short term rate of interest by 1 unit. It is observed that only for the Paper and Paper Products under *MODEL 2* and Tea Plantation under *MODEL 3*, the hypothesis of a negative relationship between short term rate of interest and finished goods inventories or total industries is accepted at 5% level of significance. In the rest of the cases, since there is a positive relationship between total inventories or raw materials inventories or finished goods inventories and the short-term rate of interest, the hypothesis is rejected at 5 % level significance

Thus, while some of public and private limited companies under study experience a positive relationship between total inventories or raw materials inventories or finished goods inventories and short term rate of interest, and one industry under public limited companies, two under private limited companies

experience an indirect relation to short term rate of interest, it could be said that in general there is a mixed picture of the industries under study.

6.2.1.3 Expected rate of inflation

The OLS results for public limited companies in Table 3(A) and 3(B) shows that for finished goods inventories (*MODEL 2*), finished goods inventories increased by a maximum of 678.78 units for Cement and Cement Products for a unit increase in expected rate of inflation. It is observed that except for the Cement and Cement Products industry under *MODEL 2* no other industry has significant results in any of the models. Added to this, the 5% level significant result is against the hypothesis of a negative relationship between expected rate of inflation and finished goods inventories and thus rejected.

The OLS results for private sector in Table 6, shows that for raw materials (*MODEL 3*), raw materials inventories decreased by 820.69 units for Tea Plantations for every increase of expected rate of inflation by 1 unit. It is observed that only Tea Plantations under *MODEL 3* has significant results in all the models. The hypothesis of a negative relationship between expected rate of inflation and raw materials inventories is accepted at 5% level of significance.

Thus, while one of the public limited companies under study experiences a positive significant relationship between expected rate of inflation coefficients and finished goods inventories, one of the private limited company experience a negative significant relationship between expected rate of inflation coefficients and raw materials inventories. It could be concluded that, expected rate of inflation has limited influence on the inventories for most of the industries under study.

6.2.1.4 Exchange rate

The OLS results for public limited company in Table 3(A) and 3(B) shows that for finished goods inventories (*MODEL 2*), finished goods decreased by 255.28 units for Basic Chemical for a unit increase in exchange rate in the respective industry. Under the raw materials (*MODEL 3*) the OLS in Table 5 shows that raw

materials decreased by a maximum of 3359.88 units for Chemical and Chemical Products industry for every increase of exchange rate by 1 unit. Under total inventories (*MODEL 4*), the total inventories in Table 7(B) decreased by a maximum of 158.23 units for Chemical and Chemical Products and the same total inventories in Table 7(C) decreased by around by 329.12 units for Tea Plantations for every increase of exchange rate by 1 unit. It is observed that, all the above industries show significant result at 5% level in each of the models. The hypothesis of a negative relationship between exchange rate and finished goods, raw materials and total inventories indicates a favourable environment to imports.

The OLS results for private limited company presented in Table 4, shows that for finished goods inventories (*MODEL 2*), finished goods increased around 29.05 units for Paper and Paper Products and by 3040.50 units for the Chemical and Chemical Products, all these for a unit increase in exchange rate in the respective industry. Under the raw materials (*MODEL 3*) the OLS in Table 6 shows that the raw materials decreased by a maximum of 10610 units for Chemical and Chemical Products and by 196.05 units for Tea Plantation for every increase of exchange rate by 1 unit. Under total inventories (*MODEL 4*), the total inventories in Table 8 decreased by a maximum 6097.51 units for Basic Chemicals for every increase of exchange rate by 1 unit. It is observed that, only for the Paper and Paper Products and Chemical and Chemical Products under *MODEL 2* in Table 4, the hypothesis of a positive relationship between exchange rate and finished goods inventories is accepted at 5% level of significance. In the rest of the cases, since there is a negative relationship between exchange rate and total inventories or raw materials inventories, the hypothesis is rejected at 5 % level significance. It could be said that a negative relationship implies that the results are favouring imports.

Though, both Paper and Paper Products and Chemical and Chemical Products under private limited companies favour export of finished goods inventories, Basic Chemicals and Tea Plantations under the same group of companies favour import of total inventories and raw materials inventories respectively and Chemical and Chemical Products also favour import of raw materials. On the other side, Basic Chemicals under public limited companies favour import of finished goods, Chemical and Chemical Products favour import of both raw materials and total inventories and

Tea Plantation favour import of total inventories. Factually, all the three industries (Basic Chemicals, Chemical and Chemical Products and Tea Plantation) showing significant negative relationship are importers too. Thus, while all the three public and three private limited companies showing significant results under study experience a negative relationship between total inventories or raw materials inventories or finished goods inventories and exchange rate, two under private limited company experience a direct relation to exchange rate, it could be said that in general there is an indication favourable for imports rather than exports for the industries under study.

6.2.1.5 Coefficients of lagged variables

In the case of adjustment[4] of inventories and its components in the public limited companies it is seen in Table 3(A) that there is a maximum of 45% and 36% adjustment of finished goods respectively to the desired level in the Basic Chemicals and Cement and Cement Products industry. Adjustment of total inventories to the desired level presented in Table 7(A) and 7(B) shows that it was a maximum of 30%, 54%, 41% and 16% for Basic Chemical, Cement and Cement products, Paper and Paper Products and Chemical and Chemical Products industries respectively. There were no significant raw material adjustments to the desired level, under the chosen public limited companies.

In the case of adjustment of inventories and its components in the private limited companies, it is seen in Table 4 that there is a maximum of 14% adjustment of finished goods to the desired level in the Paper and Paper Products industry. There were no significant results[5] under raw material or total inventories adjustments to the desired level, for the chosen private limited companies.

As all the adjustments to the desired level are below 55%, it could be concluded that adjustments are very slow and that too private limited companies are far slow as compared to public limited companies. But among them also, the total inventories adjust faster than finished goods inventories. Added to this while 4 out of 5 public limited companies show adjustments to desired level, in the case of private limited companies it was only 1 out of 4 industries showing adjustment to the desired level. Besides, the lack of adjustment of raw materials inventories to the desired level

could possibly be the prevalence of overinvestment both in the public and private limited companies. Thus, so far as adjustment is concerned the chosen public limited companies are performing better than their corresponding private limited companies.

Overall it is observed that out of the total five industries, Paper and Paper Products either under public or private limited companies shows decreasing inventory-sales ratio, positive finished goods-sales relationship, negative finished goods-short term interest rate relationship, positive finished goods-exchange rate relationship and an adjustment of total inventories to the desired level at 41% relationship and an adjustment of finished goods inventories to the desired level at 14%. Basic Chemicals industry either under public or private limited companies shows a decreasing inventory-sales ratio, negative finished goods-short term interest rate relationship and an adjustment of total inventories and finished goods inventories to the desired level at 30% and 45% respectively. Cement and Cement Products under public limited companies shows decreasing inventory-sales ratio and an adjustment of total inventories and finished goods inventories to the desired level at 54% and 36% respectively. Chemical and Chemical Products either under public or private limited companies shows decreasing inventory-sales ratio, positive finished goods-exchange rate relationship and an adjustment of total inventories to the desired level at 16%. Tea Plantation either under public or private limited companies shows decreasing work in progress-sales ratio and negative total inventories-short term interest rate relationship. Observing the results of the five industries, it could be concluded that Paper and Paper Products industry seem to be doing better than all other industry.

Observing the total results, it is seen that four out of the five industries belonging to the public limited companies show a clear decreasing trend for total inventories/sales ratio and finished goods/ sales ratio. Three out of five selected industries in the same group show a decreasing finished goods-sales ratio and work in progress-sales ratio. One industry shows negative finished goods-short term rate of interest relationship. Two out of five industries show adjustment of finished goods to the desired level and four out of five show adjustments of total inventories to the desired level.

In the private limited companies, only one out of four industries show a clear decreasing trend for total inventories/sales ratio. Two out of four industries show a decreasing finished goods-sales ratio and one out of four industries show a decreasing trend for work in progress-sales ratio. One industry shows positive finished goods-sales relationship, negative finished goods-short term interest rate relationship and negative raw material-short term interest rate relationship. Two out of four industries show positive finished goods-exchange rate relationship and one industry adjust to the finished goods to the desired level.

7. POLICY IMPLICATIONS

The results clearly indicate that some of the Indian industries still continue to have over investment of inventories especially raw materials even after two decades of rigorous reforms. This indicates a supply chain mismanagement calling for strengthening the existing reforms on industrial linkages or introducing new reforms to see a high degree of coordination between sectors such that interdependencies between sectors are solved in the best manner possible.

The results of partial adjustment approach showed that adjustments to desired level was very poor among the chosen public limited companies and even among the one private limited company (finished goods in Paper and Paper Products) that adjust, it is very slow. Though the adjustment in the chosen public limited companies is better than the corresponding private limited companies, the adjustment here is not very fast. Raw materials adjustment to desired level, are neither prevalent in the public limited companies nor in the private limited companies. The paradox here is on one side there seems to be over investment in inventories especially raw materials and on the other side the adjustment of raw materials to the desired level are neither prevalent in the public limited companies nor in the private limited companies of the study. This indicates problems at the intermediate stage *i.e*. co-ordination between demand and supply of raw materials as well as other financial requirements of individual industries. Here demand and supply is an institutional issue which calls for interference of the government so as to smoothen the intermediate problems.

Though the impact of structural reforms (devaluation of rupee) on exports were positive during the initial period of the reform process, these do not seem to be continuing in the latter decade for the results show trends favourable to imports for the industries under study. This again calls for boosting the reform process as suggested by experts.

However, the overall results seem to be better for the public limited companies. This could mainly be due to the reform process which brought about liberalization and competition among industries. But, sustained improvement in inventory management could only be possible provided the reform process is continued consistently.

8. CONCLUSIONS

The study finds that there is prevalence of over investment in raw material inventories in some of the public and private limited companies. Besides, the results of partial adjustment approach show a slow adjustment of total inventories and finished goods inventories to desired level in both these companies. The adjustment of raw materials inventories to the desired level did not prevail for the public limited companies but for the private limited companies though there were some significant results, these were unusually slow. The adjustments of inventories under the public limited companies under study were better than the private limited companies. Of the five industries under study, Paper and Paper Products industry seemed to be the best performer. Thus it is felt that there is a strong need to strengthen the ongoing reform process so as to improve interdependencies between sectors.

NOTES

1. The data available for public limited companies is for a period of 17 years while for private limited companies it is available for a period of 11 years. Although the comparison might not be ideal, an attempt has been made to look at the degree of impact for the factors influencing the public and private limited companies by comparison.
2. Since rupee value against the dollar is used as the exchange rate in the model, any increase in the rupee value is said to increase the exchange rate. However, theoretically, it means that the exchange rate has depreciated and therefore it is said to be favourable to exports.
3. Though we planned to present results which had adjusted R^2 of 50 and above, there was only one result with adjusted R^2=0.4923 as such we have considered this too and presented all results above 0.49.
4. Adjustments figures are calculated as one minus the coefficient and then multiplied by 100 to get the percentage.
5. Though it was observed under Table 6 and Table 8, that partial adjustments to the desired level are prevalent under Chemical and Chemical Products, Tea Plantation (*MODEL 3*) and Basic Chemicals (*MODEL 4)*, the same has not been pointed in the text for the partial adjustment to the desired level is more than 100%.

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Appendix

Table 1: Results of Model 1: OLS with inventory-sales ratio as dependent variable (public limited companies)

Industry	IT/Sales	A R^2	IF/Sales	A R^2	IW/Sales	A R^2
1	-0.007*	0.51	-0.0031*	0.63	-0.001*	0.35
2	-0.004*	0.68	-0.0007*	0.10	-0.0009*	0.36
3	-0.0032*	0.55	-0.0013*	0.54		
4	-0.0039*	0.80	-0.0028*	0.48		
5					-0.0003*	0.60

1: Basic Chemicals, 2: Cement and Cement Products, 3: Paper and Paper Products, 4: Chemical and Chemical Products, 5: Tea Plantation.

*p<0.01, **p<.05, A R^2: Adjusted R^2

Table 2: Results of Model 1:OLS with inventory-sales ratio as dependent variable (private limited companies)

Industry	IT/Sales	A R^2	IR/Sales	A R^2	IF/Sales	A R^2	IW/Sales	A R^2
1			0.003**	0.42	-0.001	0.008		
2			0.001**	0.31	-0.002*	0.52	0.001	0.16
3	-0.002**	0.30	0.002*	0.66	-0.002*	0.62	0.0004	0.17
4							-0.0002*	0.55

1: Basic Chemicals, 2: Paper and Paper Products, 3: Chemical and Chemical Products, 4: Tea Plantation.

*p<0.01, **p<.05, A R^2: Adjusted R^2

Table 3(A): Results for Model 2 (finished goods):OLS with IF_t as dependent variable (public limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	(1-a)$(IF)_{t-1}$	A R^2	F-Stats
1	0.048	-0.032	-1166.826	1493.895	3.962	0.775*	0.638	6.284
	0.633	-0.421	-0.380	1.287	0.006	2.470		
	0.112*	-0.083	286.423		-193.01	0.556*	0.616	7.022
	1.863	-1.244	0.097		-0.276	2.049		
	0.052	-0.032		1331.709	-255.2*	0.676*	0.666	8.478
	0.713	-0.431		1.283	-1.903	4.018		
	0.048	-0.032	-1149.710*	1492.444		0.773*	0.671	8.640
	0.664	-0.448	-1.958	1.3824		4.347		
	0.116*	-0.089	-517.437			0.618*	0.646	10.116
	2.069	-1.491	-1.354			4.312		
	0.162*	-0.142*		-153.672		0.649*	0.593	8.287
	3.347	-2.925		-0.204		3.511		
2	0.045	-0.043	-247.276	622.887*	126.348	0.727*	0.692	7.739
	0.217	-0.204	-0.692	2.599	0.835	3.727		
	0.009	-0.002	-309.179		200.521	0.644*	0.531	5.242
	0.035	-0.009	-0.703		1.093	2.712		
	0.049	-0.048		633.947*	28.480	0.796*	0.707	10.029
	0.241	-0.237		2.716	0.5410	4.881		
	0.068	-0.067	31.399	660.622*		0.824*	0.700	9.768
	0.332	-0.330	0.250	2.847		5.337		
	0.042	-0.039	143.231			0.795*	0.523	6.485
	0.165	-0.151	0.952			4.092		
	0.081	-0.081		678.781*		0.829*	0.724	14.106
	0.431	-0.428		3.207		5.658		

1: Basic Chemicals, 2: Paper and Paper Products, 3: Chemical and Chemical Products, 4: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 3(B): Results for Model 2 (finished goods):OLS with IF_t as dependent variable (public limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	(1-a)$(IF)_{t-1}$	A R^2	F-Stats
3	0.108	-0.079	461.525*		41.3424	-0.206	0.515	4.973
	0.612	-0.458	2.2732		0.6340	-0.599		
	0.122	-0.095	479.558*	78.194		-0.098	0.503	4.792
	0.621	-0.486	2.304	0.366		-0.287		
	0.090	-0.062	510.715*			-0.134	0.539	6.838
	0.532	-0.371	2.793			-0.424		

1: Basic Chemicals, 2: Paper and Paper Products, 3: Chemical and Chemical Products, 4: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 4: Results for Model 2 (finished goods):OLS with IF_t as dependent variable (private limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	(1-a)$(IF)_{t-1}$	A R^2	F-Stats
2	-1.045*	1.052*	-111.64*	11.734	29.045*	0.732	0.781	7.436
	-2.297	2.331	-2.914	0.435	2.935	1.379		
	-1.010*	1.015*	-108.22*		28.80*	0.867*	0.817	11.037
	-2.464	2.502	-3.154		3.184	2.198		
	-1.087	1.096	-5.888			0.861	0.538	4.493
	-1.673	1.703	-0.308			1.374		
	-0.900*	0.911*		1.532		0.653	0.531	4.394
	-2.939	3.035		0.043		0.944		
3	0.175	-0.115	2403	-5648	2466	-0.063	0.567	3.354
	0.534	-0.369	0.181	-0.854	0.713	-0.111		
	0.194	-0.129	-1891.46		3159.83	-0.159	0.590	4.238
	0.609	-0.426	-0.159		0.967	-0.295		
	0.173	-0.112		-5192.47	3040.50*	-0.085	0.651	5.187
	0.588	-0.400		-0.946	2.438	-0.170		
	0.120	-0.073	11050.26*	-6754.96		0.139	0.609	4.508
	0.399	-0.250	2.189	-1.107		0.299		
	0.125	-0.076	8695.120			0.089	0.593	5.399
	0.407	-0.255	1.864			0.191		

1: Basic Chemicals, 2: Paper and Paper Products, 3: Chemical and Chemical Products, 4: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 5: Results for Model 3 (raw materials):OLS with IR_t as dependent variable (public limited companies)

Industry	A	PR_t^e	SI_t	P_t^e	ER_t	(1-a)$(IR)_{t-1}$	A R^2	F-Stats
4	0.073*	-0.008	6840.1452	-1747.769	-3359.88*	0.036	0.588	5.288
	3.304	-0.602	1.6810	-0.673	-2.269	0.115		
	0.066*	-0.005	4556.304*		-2851.13*	0.099	0.609	6.837
	3.453	-0.426	2.0833		-2.298	0.340		
	0.047*	-0.007		1895.585	-1170.41	0.386	0.520	5.063
	2.741	-0.478		1.226	-1.54	1.506		

1: Basic Chemicals, 2: Cement and Cement Products, 3: Paper and Paper Products, 4: Chemical and Chemical Products, 5: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 6: Results for Model 3 (raw materials):OLS with IR_t as dependent variable (private limited companies)

Industry	A	PR_t^e	SI_t	P_t^e	ER_t	(1-a)$(IR)_{t-1}$	A R^2	F-Stats
3	0.175*	-0.025*	27860*	-6330	-10610*	-1.243*	0.906	18.26
	4.962	-2.226	2.819	-1.750	-3.487	-2.694		
	0.144*	-0.013	18340		-8447*	-0.936	0.867	15.62
	3.969	-1.236	1.870		-2.557	-1.845		
	0.092*	-0.012		-712.20	-2329.51	-0.185	0.774	8.72
	3.049	-0.754		-0.153	-1.901	-0.446		
	0.066*	-0.014	-5414	-1208		0.216	0.695	6.12
	2.251	-0.712	-1.169	-0.203		0.617		
	0.064*	-0.011	-6042.29			0.218	0.744	9.70
	2.523	-0.785	-1.910			0.680		
	0.059*	-0.026		-5842.07		0.444	0.676	7.26
	1.994	-1.566		-1.281		1.487		
4	0.058*	0.005	-430.372	264.415	-97.032	0.057	0.857	11.78
	2.540	0.245	-0.997	0.504	-0.765	0.105		
	0.068*	0.011	-358.261		-138.534	-0.168	0.878	17.23
	7.487	0.855	-0.953		-1.555	-0.595		
	0.059*	0.006		91.321	-196.049*	-0.001	0.857	14.49
	2.625	0.335		0.185	-2.486	-0.002		
	0.048*	-0.005	-688.92*	524.535		0.321	0.869	15.90
	2.661	-0.360	-2.678	1.373		0.802		
	0.069*		0.003	-820.68*		-0.064	0.849	17.93
	6.861		0.233	-3.211		-0.209		
	0.014	-0.039*		906.582		1.195*	0.734	9.27
	0.769	-4.830		1.795		3.632		

1: Basic Chemicals, 2: Paper and Paper Products, 3: Chemical and Chemical Products, 4: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 7(A): Results for Model 4 (total inventories):OLS with IT_t as dependent variable (public limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	$(1-a)(IT)_{t-1}$	A R^2	F-Stats
1	0.384*	-0.335	-2192.51	1405.759	125.101	0.779*	0.686	7.57
	1.967	-1.603	-0.274	0.490	0.066	2.319		
	0.437*	-0.373*	-957.144		-40.901	0.700*	0.708	10.09
	2.767	-2.000	-0.131		-0.023	2.463		
	0.379*	-0.319		1158.163	-381.35	0.703*	0.713	10.31
	2.039	-1.658		0.444	-1.108	3.951		
	0.381*	-0.329*	-1670.70	1371.479		0.761*	0.715	10.40
	2.104	-1.806	-1.146	0.509		4.179		
	0.43*	-0.375*	-1123.28			0.706*	0.732	14.68
	3.164	-2.454	-1.177			4.979		
	0.54*	-0.489*		-901.265		0.713*	0.707	13.08
	4.781	-4.152		-0.489		3.972		
2	1.037*	-0.932	557.881	1227.531	137.035	0.168	0.624	5.99
	1.882	-1.703	1.109	1.500	1.263	0.595		
	0.792	-0.715	595.176		52.073	0.422	0.582	6.22
	1.426	-1.283	1.123		0.534	1.768		
	1.114*	-1.032*		1272.398	91.165	0.356	0.617	7.03
	2.018	-1.891		1.541	0.899	1.558		
	0.858	-0.776	315.559	687.569		0.393	0.604	6.72
	1.569	-1.418	0.661	0.959		1.740		
	0.754	-0.683	459.993			0.481*	0.607	8.71
	1.4126	-1.2720	1.0186			2.343		
	0.9487*	-0.8762		836.8949		0.467*	0.623	9.25
	1.8373	-1.7069		1.2606		2.449		

1: Basic Chemicals, 2: Cement and Cement Products, 3: Paper and Paper Products, 4: Chemical and Chemical Products, 5: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 7(B): Results for Model 4 (total inventories):OLS with IT_t as dependent variable (public limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	$(1-a)(IT)_{t-1}$	A R^2	F-Stats
3	0.066	0.078	1425.007*	-258.448	-92.493	-0.026	0.703	8.114
	0.170	0.193	2.889	-0.577	-0.818	-0.096		
	0.214	-0.085	1281.329*		-97.525	0.061	0.721	10.709
	0.772	-0.298	3.106		-0.893	0.282		
	0.582	-0.529		394.492	69.599	0.594*	0.505	4.828
	1.321	-1.176		0.790	0.549	2.836		
	0.055	0.084	1224.884*	-286.681		-0.012	0.712	10.285
	0.146	0.209	2.905	-0.652		-0.045		
	0.221	-0.098	1052.409*			0.086	0.726	14.254
	0.802	-0.348	3.284			0.404		
	0.665	-0.619		514.198		0.667*	0.534	6.729
	1.655	-1.526		1.180		4.239		
4	0.065	0.154	14079.890*	-1490.08	-158.23*	-0.288	0.911	31.686
	0.276	0.709	3.897	-0.933	-3.103	-0.957		
	0.069	0.138	13136.262*		-150.01*	-0.232	0.912	39.859
	0.302	0.642	3.809		-3.005	-0.792		
	-0.271	0.302		251.632	-27.959	0.839*	0.796	15.643
	-0.827	0.936		0.109	-0.479	6.649		
	-0.122	0.224	6728.304*	-633.979		0.373	0.841	20.847
	-0.404	0.779	1.846	-0.302		1.315		
	-0.115	0.216	6481.939*			0.383	0.853	30.041
	-0.399	0.783	1.898			1.411		
	-0.275	0.299		235.111		0.862*	0.809	22.205
	-0.866	0.961		0.1048		7.6092		

1: Basic Chemicals, 2: Cement and Cement Products, 3: Paper and Paper Products, 4: Chemical and Chemical Products, 5: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 7(C): Results for Model 4 (total inventories):OLS with IT_t as dependent variable (public limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	$(1-a)(IT)_{t-1}$	A R^2	F-Stats
5	0.728*	-0.570	306.674	85.871	-329.115*	-0.088	0.492	3.91
	2.144	-1.757	1.339	0.342	-2.918	-0.371		
	0.656*	-0.502*	334.155		-328.547*	-0.058	0.533	5.28
	2.573	-2.049	1.625		-3.037	-0.274		

1: Basic Chemicals, 2: Cement and Cement Products, 3: Paper and Paper Products, 4: Chemical and Chemical Products, 5: Tea Plantation. (*Statistically Significant at 5% level)
Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

Table 8: Results for Model 4 (total inventories):OLS with IT_t as dependent variable (private limited companies)

Industry	A	S_t^e	SI_t	P_t^e	ER_t	$(1-a)(IT)_{t-1}$	A R^2	F-Stats
1	1.590*	-1.313*	25621.943*	-3700.899	-6097.506*	-0.949*	0.876	13.67
	3.264	-2.690	4.751	-1.322	-5.397	-3.731		
	1.827*	-1.588*	19905.64*		-5005.969*	-0.717*	0.857	14.49
	3.759	-3.353	5.760		-6.055	-3.640		

1: Basic Chemicals, 2: Paper and Paper Products, 3: Chemical and Chemical Products, 4: Tea Plantation. (*Statistically Significant at 5% level) Excluding the first row, odd rows show coefficients and even rows show t-Statistics.

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