Explaining Large Inventories: the Case of Iran

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TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

GDP   Gross Domestic Product
GNE   Gross National Expenditure
CPI   Consumer Price Index
PPI   Producer Price Index
OSF   Oil Stabilization Fund
USD   United States Dollar
UN   United Nations

EXPLAINING LARGE INVENTORIES: THE CASE OF IRAN

Anton Dobronogov and Ahmad R. Jalali-Naini[1]

ABSTRACT

According to the national accounts of Iran, during the period of 1988-2003 the annual change in inventories in this economy was highly variable and averaged 7.3 percent of GDP if calculated at current prices. In an ideal economy with no distortions, change in inventories should be zero on average for a sufficiently large period. Because of inefficiencies and statistical errors, in developing countries it typically falls in a range between one and two percent of GDP. The figure for Iran exceeds not only this range, but also economy's real GDP growth, which averaged 4.3 percent for this period. In this paper **we** argue that variation in the change in inventories in Iran could be explained by a number of factors including: impact of cost of capital effect and supply shocks expectations in a context of high dependency on the oil revenues and imports of capital/intermediary goods; periodical softening and hardening of budget constraints of the public enterprises; variations in statistical errors related to differentials between PPI and CPI inflation; and possibly shifting financial constraints which may bind on private purchases of goods and services. Further, there is evidence to suggest that high average change in inventories could be explained by capital flight hidden in the imports statistics, by wasting some of the over accumulated inventories under the soft budget constraint, and by statistical errors and omissions.

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Ahmad R. Jalali-Naini   Anton Dobronogov

2003‑1988

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(CPI)   (PPI)

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Anton Dobronogov et Ahmad R. Jalali-Naini

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Selon les comptes nationaux de l'Iran, au cours de la période 1988-2003 le changement annuel dans les inventaires de l'économie a été très variable et s'est situé en moyenne à 7,3 pour cent du PIB, sur base d'un calcul aux prix actuels. Dans une économie idéale libre de toute distorsion, le changement dans les inventaires se situerait en moyenne à zéro sur une période de temps suffisamment longue. En raison d'inefficacités et d'erreurs statistiques, dans les pays en développement ce changement est généralement de l'ordre de 1 à 2 pour cent du PIB. Le chiffre pour l'Iran non seulement excède cette fourchette mais également la croissance du PIB réel de l'économie qui a été en moyenne de 4,3 pour cent au cours de la période. Le présent document avance l'argument selon lequel cette variation dans le changement des inventaires de l'Iran pourrait s'expliquer par un certain nombre de facteurs dont : l'impact du coût du capital et les anticipations de chocs sur le front de l'offre dans un contexte de forte dépendance vis-à-vis des recettes pétrolières et des importations de biens d'équipement/intermédiaires ; l'assouplissement et le durcissement périodiques des contraintes budgétaires des entreprises publiques ; les variations dans les erreurs statistiques liées aux écarts entre l'inflation de l'indice des prix à la production et l'indice des prix à la consommation ; et éventuellement les fluctuations au niveau des contraintes financières qui peuvent influer sur les achats privés de biens et services. Par ailleurs, l'expérience montre qu'un changement moyen important dans les inventaires pourrait s'expliquer par la fuite de capitaux masquée dans les statistiques d'importation, par le gaspillage de certains inventaires sur-accumulés dans le contexte de contraintes budgétaires plus libérales, et par des erreurs et omissions statistiques.

1.   Introduction

According to the national accounts of Iran, during the period of 1988-2003 the annual change in inventories in this economy averaged 7.3 % of GDP if calculated at current prices. In an ideal economy with no distortions, change of inventories should be zero on average for a sufficiently large period. In developing countries it typically falls in a range between one and two percent of GDP, as some of the produced goods are never sold, some of the capital goods purchased by the firms are never put to use. In addition, a portion of this statistic represents errors and omissions since change in inventories is a residual item in the system of national accounts. For the 1990s, the average change in inventories in the lower-middle income countries was 1.2% of GDP, in the countries of Middle East and North Africa – 1.7%, and in the world economy – 0.6%[2]. The figure for Iran is much higher. Moreover, it exceeds the economy's real GDP growth which averaged 4.3% for this period, while coefficient of correlation between these two variables (Figure 1) is positive and stunningly high (0.82). Therefore, evidence of post-war economic growth in Iran, which is generally abundant, is less clearly presented in the national statistics.

Figure 1. GDP growth and change in inventories in Iran
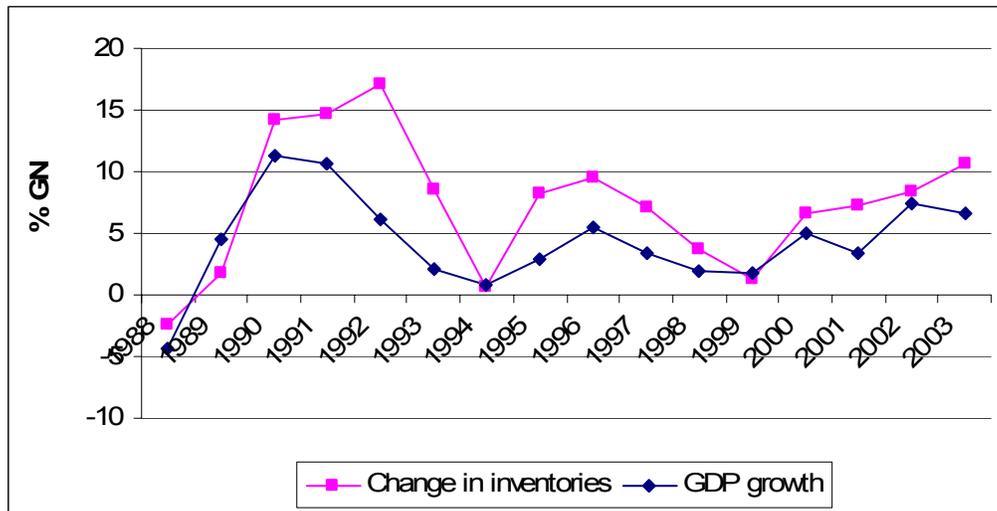
Source: Central Bank of Iran, the 2005 revision of the national accounts

This paper attempts to understand the puzzle of large inventories in Iran. As it will be discussed in the paper, due to the structure of the Iranian economy, the dominating economic role of government, competitive general equilibrium models of inventory accumulation may not be very applicable. Available evidence suggests that average change in inventories is very high in Iran due to certain behavioral patterns reflecting the economy's proneness to supply shocks which cannot be mitigated by underdeveloped

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[2] Source: World Development Indicators

financial sector, budgetary rent seeking and a soft budget constraint. Public enterprises facing soft budget constraints often fail to use over-accumulated inventories efficiently, making them "chronic". In an economy that imports a large share of its investment goods, volatile oil prices and exchange rates produce large variations in the effective costs of capital. Moreover, the external political risks tend to raise uncertainties and cause over-accumulation of imported inventories by risk-averse economic agents. Hidden capital flight through over-invoicing of imports serves as an alternative means for insurance against these risks, also contributing to high change in inventories statistic.

The paper is organized as follows. Section 2 discusses a definition of the change in inventories statistic. Section 3 provides a brief overview of economic theories of the inventories accumulation and presents available international evidence on the cases when average change in inventories statistic is high. Section 4 provides background information on the relevant economic developments in Iran during the post-war period. Section 5 presents and discusses the results of the econometric analysis of change in inventories. The final section is reserved for concluding remarks.

2. "Change in inventories" statistic in the national accounts: a definition

Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." In the system of national accounts, the "change in inventories" identity is defined as follows:

$$\Delta Inv = GNE - (C + I + X - M) + error \qquad (1)$$

Change in inventories is a balancing item on the total expenditures (uses) side and is equal to the difference between total supply and demand. To the extent that there is discrepancy between the actual and estimated values of sources and uses of output, its value is reflected in the inventory numbers. The error term in (1) refers to this discrepancy.[3]

3. Economics of inventories and their accounting

This section will provide an overview of the insights of economic theory on the factors affecting accumulation of inventories by firms and present some international evidence

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[3] To better understand its nature, consider the following identity:

TS (sources) = TE (uses)   (I)

TS stands for total supply and TE stands for total expenditures (demand). In a disaggregated form:

Total output + net indirect taxes + M = Cp + Cg + Ip + Ig + Δ Inv + X   (II)

Total supply aggregates domestic supply of consumer goods, intermediate goods, and investment goods, as well as imported goods (M) of the same variety (consumer, intermediate, and investment), and net indirect taxes. Total expenditure consists of private consumption Cp, government consumption Cg, private investment Ip, government investment Ig, exports X, and Δ Inv. Note that Ip + Ig = GFCF, gross fixed capital formation.

on other cases when average change in inventories is high. The latter helps us, *inter alia*, to hypothesize possible causes of large errors and omissions in the national accounts.

3.1.   Why and when firms accumulate inventories? Choice-theoretic and cost of capital explanations

Inventories are one of the most volatile components of aggregate demand.[4] Business cycles studies show that inventories have significant co-movements with GDP and over the business cycle inventories are pro-cyclical with sales. Normally, change in inventories is large and positive during business cycle peaks; it is large and negative during the troughs.[5]

Firms hold inventories in presence of frequent unforeseen demand and supply shocks because modern "just-in-time" inventory management techniques cannot always deal with such shocks satisfactorily. The choice-theoretic approach to inventory investment suggests that the relationship between inventory investment, sales, and production depends on the prevailing type of economic shocks. Two basic models in this approach imply two different types of correlation between inventory investment and sales.

If supply shocks are predominant, production is more volatile than sales, and inventory investment and production tend to be positively correlated. Consider a representative firm which faces frequent supply shocks in the form of a changing marginal cost schedule. To minimize costs, the firm increases production and accumulates inventories – depending on the circumstances, in form of finished goods or investment/intermediary goods, or both – in those time periods when marginal cost is low. Conversely, the firm decreases production and reduces inventories when marginal cost is high.

If a firm experiences mostly demand shocks, its production is less volatile than sales while its inventory investment and sales tend to be negatively correlated. If the representative firm's marginal cost is constant but it faces a frequently changing demand, it minimizes costs by smoothing production and reducing inventories each time sales exceed the level of production, and the other way around. Put differently, if firms have convex adjustment costs when they change their level of production and there are frequent fluctuations in demand, inventories would be the solution to the firm's cost minimization problem (Ramey, 1991). Thus a firm facing a given average level of demand would operate at a constant production level and use inventories to buffer fluctuations in demand, as long as costs of holding inventories are below the adjustment costs. Thus, inventories provide insurance to the firm against unexpected fluctuations in demand, and their level depends on demand volatility.

Another analytical framework for understanding inventories accumulation was suggested by Fisher and Hornstein (2000). They developed a general equilibrium version of the

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[4] For instance, while average annual change in inventories in the US over the last 20 years is less than one percent of GDP, the value of change of inventories to GDP ratio for some years is six times higher.
[5] For an empirical discussion see Blinder and Maccini (1991). It should be also noted that over the business cycle inventories are much more volatile in the durable goods sector than in the nondurable goods sectors (Hornstein and Praschnik 1997).

(S,s) model of inventories accumulation with aggregate uncertainty. This model describes optimal behavior of a firm in the retail sector facing idiosyncratic risks and fixed order costs. It generates two important stylized facts of the inventory investment: (a) inventories and sales are positively correlated, and (b) orders are more volatile than sales.

The models discussed up to this point have may shed light on some aspects of inventories accumulation in Iran, but for the purposes of our analysis they have two serious limitations. Firstly, they assume perfectly competitive markets which is hardly the case in Iran (see Section 4). Secondly, they focus on finished goods inventories, whereas in Iran, as will be discussed below, non-finished goods represent a large portion of inventories (see Section 5). We therefore proceed to discuss other analytical frameworks which allow to relax some of these assumptions.

The user cost of capital approach of the neo-classical theory of investment suggests that level of inventories could be reduced by high shadow price of finance and increased by high expected appreciation of inventories. The user cost is given by:

$$c = r + \delta - \mu \qquad\qquad (2),$$

where r is the cost of finance (when bonds and equities are perfect substitutes it is equal to interest rate), δ is depreciation rate (fairly small for inventories), and μ is the rate of appreciation of inventory holdings. The two main determinants of the user cost are r and μ. A higher expected rate of appreciation of inventories, other things being equal, reduces the user cost, hence increases inventory demand. In contrast, the higher is the cost of acquisition of inventories or the cost of finance – which is increasing in the exchange rate if a part of inventories are imported and requires currency finance – other things being equal reduces its demand. To the extent that inputs are tradable goods, a higher exchange rate results in higher prices for both imported and domestically produced goods. A lower cost of acquisition of inventories, e.g. when the exchange rate is lower than its trend due to a positive oil shock, induces greater demand for inventories.

3.2 Where else the average change in inventories is large and why? Some international evidence

There are other possible explanations for excessive accumulation of inventories which are not covered by the standard theories. Firstly, it might be undertaken by the firms, most notably publicly-owned, which do not maximize their profits either because this is not (the only) their objective, or because they lack appropriate incentives to do that. Secondly, as mentioned above the inventories statistics in the national income data by design includes error terms.

To identify possible determinants of variation in the change of inventories statistics of this sort, we turn to the international data. Figure 2 presents data on "change in inventories" for twelve countries in which the average for this statistics in the 1990s[6]

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[6] We use 1990s rather than 1988 – 2003 as a period for international comparisons because data for a number of transition economies which are important for this analysis are available only since 1990.

exceeded 3% of GDP. Understanding what these countries have in common can help in identifying the causes of the phenomenon.

Figure 2. Change in inventories in the countries where its average value exceeded 3% of GDP during the 1990s
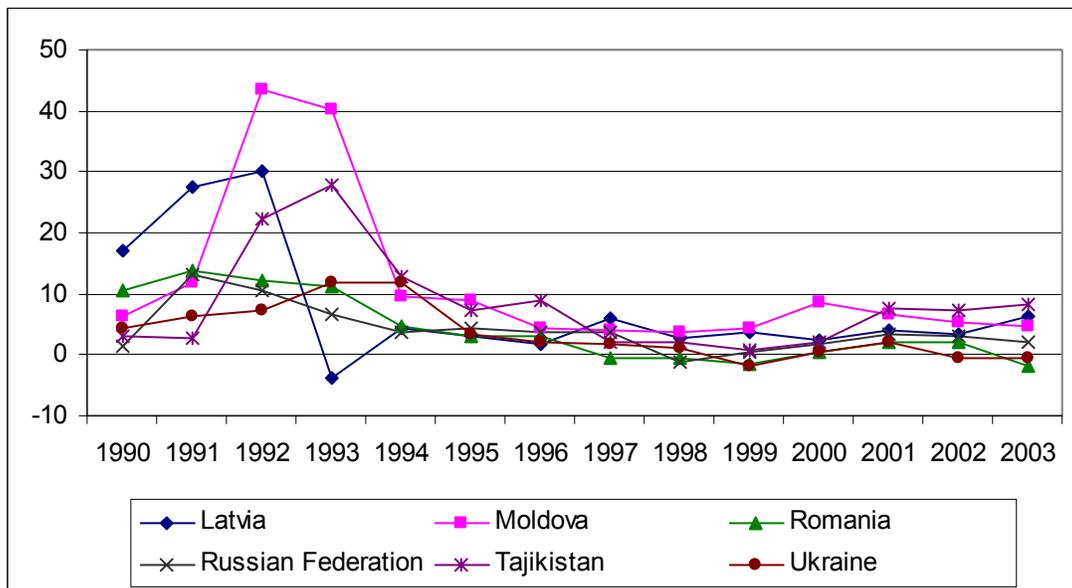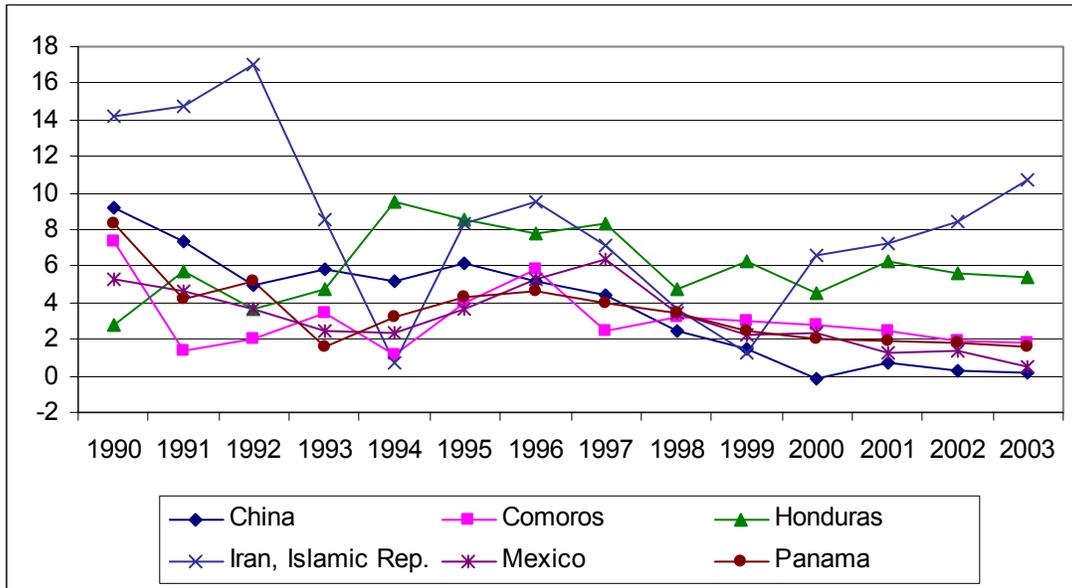
Source: World Development Indicators and Central Bank of Iran

The group includes:

- transition economies of Easter Europe and Central Asia with large share of public ownership of the assets for a large portion of the 1990s (Latvia, Moldova, Romania, Russia, Tajikistan, Ukraine);
- resource-rich economies (Iran, Mexico, Russia, Panama)[7];
- economies which experienced periods of high inflation (Comoros, Honduras, Iran, Latvia, Moldova, Romania, Russia, Tajikistan, Ukraine);
- economies which experienced substantial capital flight due to a number of aggregate imbalances.[8]

The first two common features – large share of public ownership and abundance of natural resources – suggest that excessive accumulation of inventories might be due to the soft budget constraints. For economies with a large state sector it has long been observed that the chronic loss making state-owned enterprises are provided with on and off budgetary resources to hang on (Kornai, 1979). Similarly, in those economies where the government is heavily involved in financing and/or managing development projects the projects tend to take much longer to be completed and the state often pays for the cost overruns.

Kornai, Maskin, and Roland (2003) suggest that existence of a soft budget constraint could be due to a dynamic commitment problem. After providing initial financing to a budget-constrained organization (BC-organization, such as a state-own enterprise or government development project), a supporting organization (S-organization, such as fiscal or monetary authorities) might be unable or unwilling to commit itself not to extend additional public resources to finance the cost overruns. Furthermore, the government's behavior towards loss making state-owned enterprises and development projects can be a function of revenue expectations, especially in an economy dependent on volatile (oil) revenues. For example, during high revenue periods S-organizations are able to approve a larger number of new development projects and provide more subsidies to the ongoing ones; during low revenue periods, they are under pressure to limit fiscal expansion and hence limit allocations of this sort. If BC-organizations, based on historical precedents, can see this change of attitude by an S-organization, they will contest for more government resources and rent in high-oil revenue periods. Among other things, this often results in a large number of unfinished projects which are accounted as inventories in the national accounts system.

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[7] Volatility of commodity prices is a major shocks-producing factor in an economy dependent on the natural resources. Pindyck (2001) maintains that commodity price volatility increases volatility in consumption and production and as a result market agents will want to hold greater inventories to buffer these fluctuations.

[8] This imbalances were caused by different shocks in different countries, such as the impact of a war, large negative swings in the terms of trade leading to large and volatile changes in prices of inputs and finished goods.

Finally, high inflation may affect the change in inventories statistics in two ways. Firstly, when there are no organized futures markets to hedge against adverse movements in input prices, inflation may complicate business planning for the firms, thus leading to above-normal inventory accumulation. Secondly, in economic environment where inflation is highly variable whereas nominal interest rate is much more rigid (which prevailed in Iran during the period under the study), the user cost of capital for inventory accumulation declines, raising the demand for inventories. Thirdly, high inflation may put an upward pressure on the level of statistical errors. In the surveys used for compiling national accounts gross income is initially calculated at producers' prices, gross expenditure – at consumers' prices. The larger is the difference between CPI inflation and PPI inflation – which naturally tends to increase during the periods of high inflation – the larger will be statistical error in the national accounts.

## 4. Economic developments in the post-war Iran

After the war with Iraq ended in 1988, Iran embarked on a large infrastructure reconstruction program, which pushed gross fixed capital formation to the levels consistently above 30% of GDP. Fiscal expansion was furthered by implementation of an ambitious social program. During this period Iran also pursued economic reforms including removal of some trade restrictions, partial liberalization of the foreign exchange system, and narrowing the range of goods for which domestic prices were controlled. While early effects of the reforms were positive, they did not prevent excessively expansionary fiscal stance from causing serious macro imbalances. Imports of capital and intermediary goods were rising rapidly (Figure 3), with a major peak in 1991-92, when both public and private companies which had access to foreign finance were acting in anticipation of higher exchange rates after the liberalization; cost of capital effect on the accumulation of inventories was at work.

As the country's access to longer-term external financing was limited at the time, the large current account deficit was financed through the surging short-term debt and excessive drawing on foreign exchange reserves. In 1994 a bunch of forthcoming short-term debt repayments coincided with the period of falling oil prices, causing a severe balance of payments crisis. This led to reversal of a number of policy reforms. In order to achieve current account surpluses needed to avoid default on the external debt, the government imposed tight import restrictions and reinstituted multiple exchange rates. In 1994, we observe the lowest positive change in inventories in Iran over the post-war period[9].

The events of the early 1990s highlighted dependency of the Iranian economy on the imports of capital goods. Figure 4 illustrates positive correlation between imports and gross fixed capital formation expressed as a share of GNE in Iran, which is quite substantial (correlation coefficient 0.49) and correlation between imports and change in inventories, which is even stronger (0.79).

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[9] Change in inventories was negative in 1988, but the war with Iraq was still going on for the part of this year.

Figure 3. Imports of capital and intermediary goods by Iran
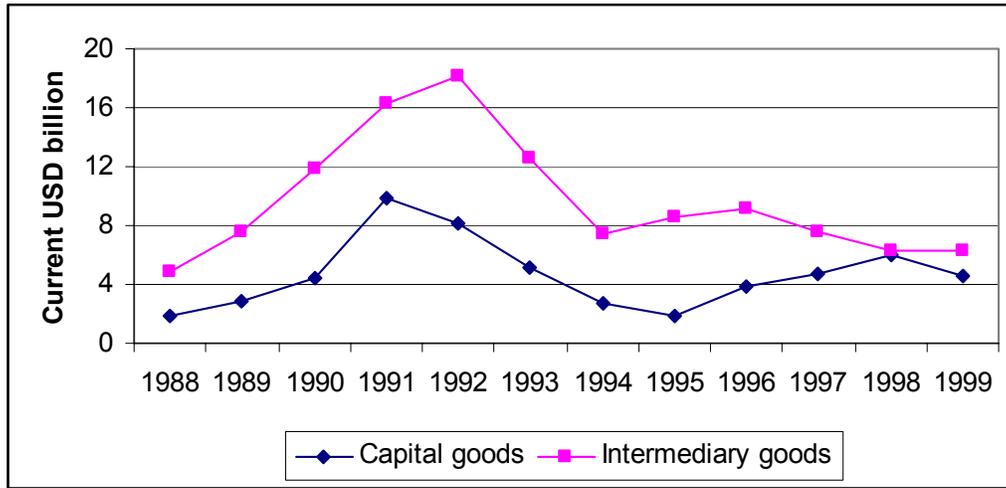
Source: Central Bank of Iran

Figure 4. Capital formation and imports in Iran
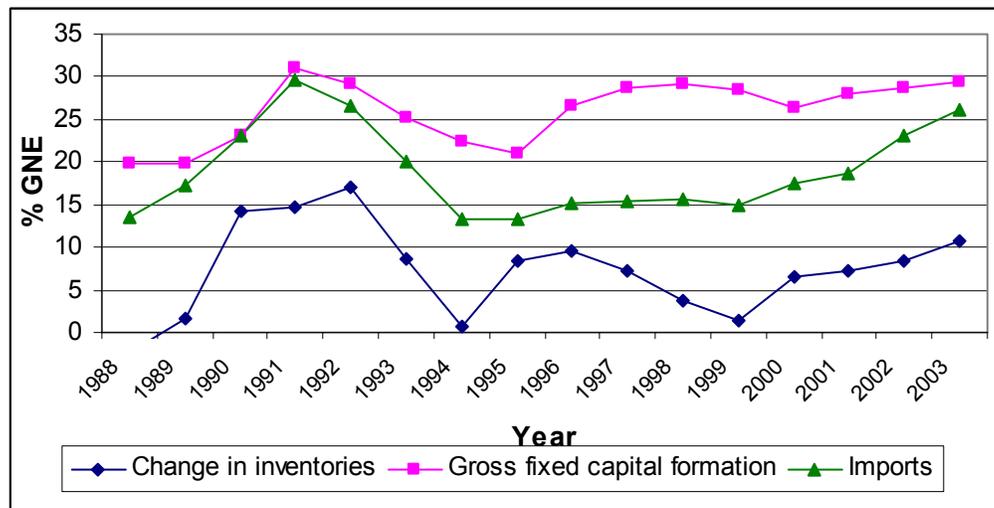
Source: Central Bank of Iran

In the following years, trade and exchange controls were slowly and selectively relaxed, but at the same time oil prices kept falling while economic sanctions on Iran were tightened, producing a supply shock for the firms. These developments produced large confidence losses, a run on foreign exchange in 1995, rapid depreciation of the nominal exchange rate, and high inflation. Figure 5 depicts trends in the PPI inflation (correlation coefficient 0.04), CPI inflation (-0.20), and change in inventories, while Figure 6 – between PPI-CPI inflation differential and change in inventories, for which the correlation coefficient is much higher (0.55).

Figure 5. Inflation and change in inventories in Iran
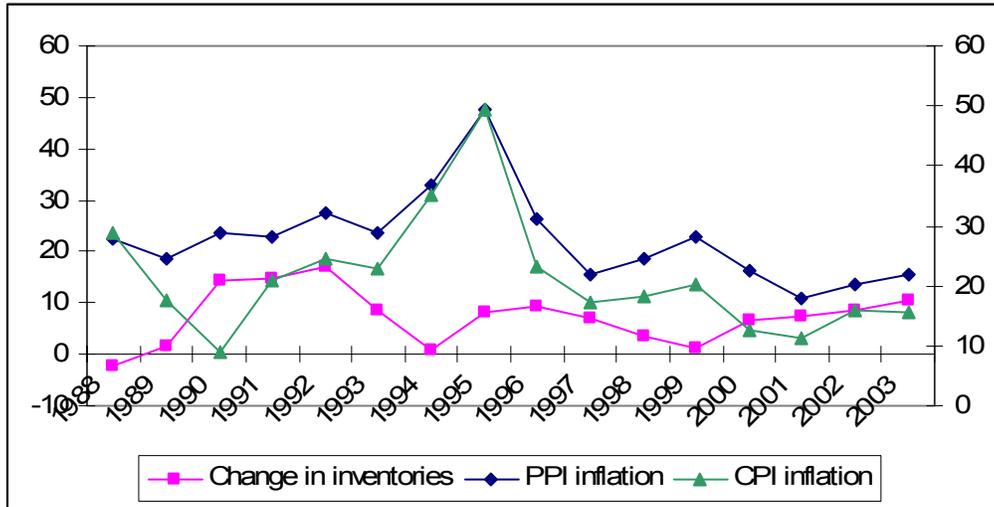
Source: Central Bank of Iran

Figure 6. PPI-CPI inflation differential and change in inventories in Iran
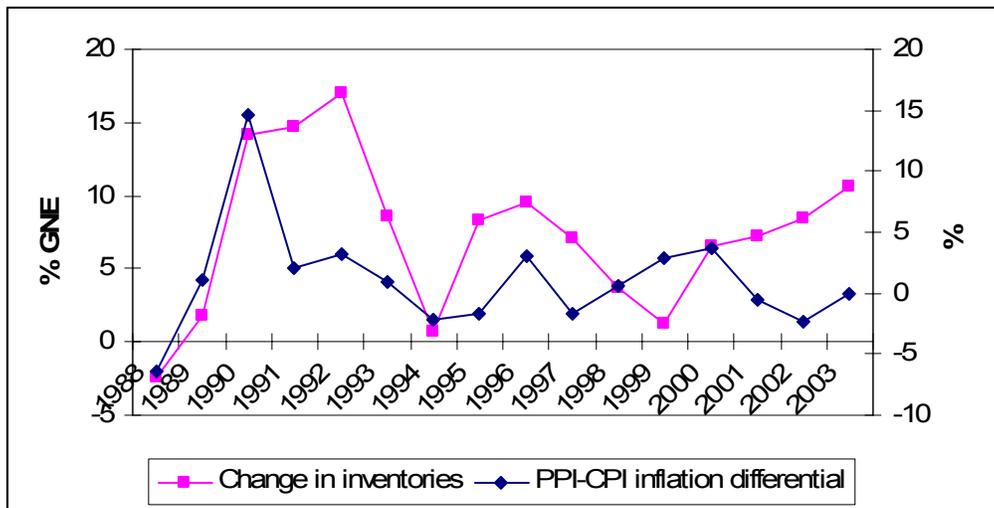
Source: Central Bank of Iran

Continued macroeconomic and political instability encouraged currency substitution and reinforced Iran's chronic problem over the last thirty years – capital flight. In 1998-99, a trough in the oil prices coincided with repayment of the rescheduled debt, producing another balance of payment crisis, which, though less severe than the previous one, further delayed economic liberalization. Even though the Central Bank raised the rates on the domestic bank deposits, particularly those with longer maturities, to make holdings of Rial more attractive, it could not possibly outweigh consequences of the currency shocks.

Financial sector witnessed some policy reforms in the second half of 1990s. Since 1995 a number of private non-bank financial institutions - which are credit and saving institutions without permission to issue checks - have been given official permit by the Central Bank to enter the credit market. Allocation of credit by public banks was partially decentralized as well. In a few years the monetary authorities were given the clearance to issue permit for private banks, and since 2000 a number of private banks have been given permission by the central bank to begin operations, though their share in total assets of the banking system remains low (about 7 percent). Figure 7 depicts change in inventories against changes in credit allocated to the private sector; correlation between these two variables is negative (-0.22)

Figure 7. Change in inventories and change in the private sector credit in Iran
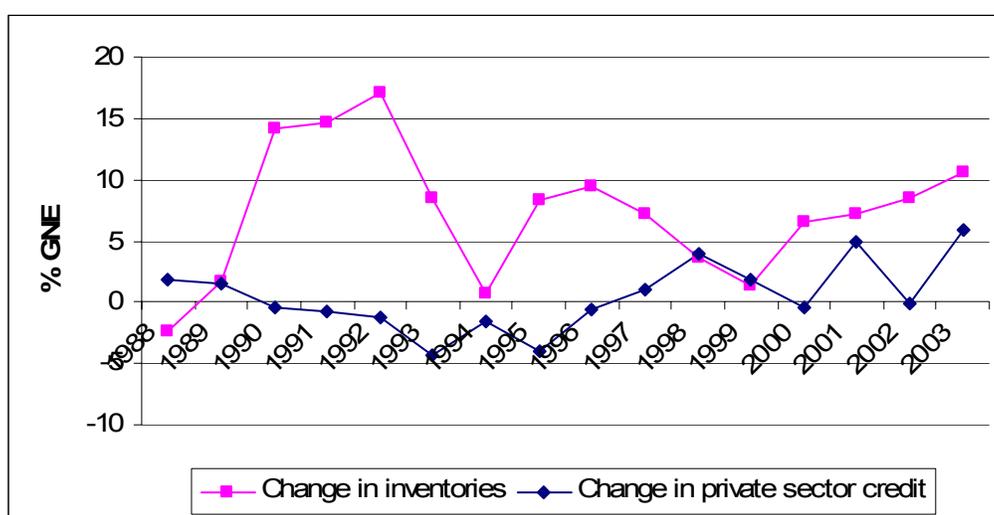
Source: Central Bank of Iran

Only on the verge of new millennium the Iranian economy saw acceleration of the reforms. As oil prices started to increase, external debt to GDP ratio has been reduced to a single-digit level, and international reserves have increased. The government has established Oil Stabilization Fund (OSF), which consists of two parts and has dual purpose – stabilizing the economy by protecting it from the oil prices volatility, and providing foreign exchange needed to finance imports of intermediary and capital goods by potential exporters. Inflation has declined substantially compared to the 1990s, though stabilized at rather high level (around 15 percent since 2002). The exchange rate was finally unified in 2002. In anticipation of this event, imports surged as firms which had access to cheap foreign currency responded to the incentives generated by cost of capital effect reinforced by fears of imports rationing because of political risks related to the Second Gulf War. In addition to adopting a managed floating exchange rate, the government significantly reduced import registration deposits, somewhat simplified licensing procedures for imports, eased currency rationing, and relaxed restrictions on the transfer of money by domestic residents abroad. Low interest rates on the loans from the OSF have reduced the cost of capital for financing imported intermediate/capital goods.

The volume of foreign currency loans granted to the private sector from OSF funds has risen from $1.179 billion in 2002 to $2.587 billion in 2004.

Generally, economic environment prevailing during 2000-2004 has been less conducive to capital outflow than during the previous decade. However, low lending rates from OSF credit facilities might have created some negative externalities from this lending – stronger incentive for the importers to over-invoice as means to transfer funds abroad. Over-invoicing increases the volume of notional debt by the borrowing firms and at the same time increases their cash holdings (the difference between the notional debt and the actual value of invoice). The difference is in effect equal to a low-cost line of credit which the firms can use for financing other activities, which in a sense resembles cost of capital effect on investment in inventories.

5.   Explaining the change in inventories statistic for Iran

We argue that variation in the change in inventories could be explained by (i) impact of cost of capital effect and supply shocks expectations; (ii) soft budget constraints syndrome, (iii) statistical errors related to differentials between PPI and CPI inflation; and (iv) possible credit rationing effects which bind on private purchase of intermediary and consumption goods.

Strong positive correlation between economic growth and change in inventories suggests that supply shocks dominated over demand shocks in the context of the Iranian economy during the period under examination. Indeed, firstly, the economy is dependent on the oil revenues and on imports of capital and intermediary goods; hence it tends to be currency-constrained during the periods of low oil prices, which generate supply shocks. Secondly, Iran has been under economic sanctions of varying strength from US and other countries. The Iranian government (as well as some other economic agents) perceives a hostile external environment, which again provides incentives to stock pile essential commodities and products, especially when intensity of sanctions is expected to increase – which is an equivalent of a supply shock.

Exchange rates differentials, cheap OSF import loans, and licenses needed to perform import transactions create incentives to the companies which have access to them to over-invest in inventories in anticipation of supply shocks which would increase the appreciation rate of the imported capital and intermediary goods. Outflow of capital could be one of the forms of this investment, as it might be thought of as investment in inventories in a form of foreign goods or financial assets.

Strong positive correlation between imports and change in inventories generally supports the above arguments. Indeed, if periodical shortage of foreign currency disrupts input supply and prices in an economy with shallow financial markets and limited mobility of international capital, acquisition of imported inventories is a form of profitable cash management at the firm level when the expected rate of appreciation of inventory holdings is high.

Shallowness of financial markets, as noted above, prevents enterprises from smoothing their supplies during the periods of low oil prices. Financial constraints may also bind on the ability of customers to purchase consumption and intermediary goods. Substantial negative correlation between change in inventories and growth of the credit extended to the private sector suggests that this could be the case in Iran.

Differential between PPI and CPI inflation was substantial in a number of years over the period of analysis, as is correlation of this variable with change in inventories. This suggests that a sizeable portion of this statistic could be due to errors and omissions.

During the 1990s, change in inventories to GNE ratio experienced two periods of precipitous declines corresponding to two periods of debt crunches, with troughs in 1994 and 1999. In part, these troughs could be explained by foreign currency shortage and severe import compression, but there might be other forces at work here as well, namely the soft budget constraints of the publicly owned firms, which represent a large portion of the Iranian economy. During the periods of high oil prices, the bail-outs which soften budget constraints are administered in different forms, including heavily subsidized loans from public financial institutions conditioned on the purchases from the enterprises which accumulated large stocks of the finished-goods inventories.

The story of unfinished development projects in Iran provides some anecdotal evidence on hardening budget constraints during the crisis periods. According to the government estimates, there are currently about 9,000 of such projects in Iran. A large portion of them was launched during the periods of high oil prices, and abandoned during one of the crises. In other words, development projects had (perceived) soft budget constraints ex-ante, but they proved to be hard ex-post. While facing a debt crunch and extremely tight fiscal space, the government had no other choice but to harden the constraints and this makes a strong downward pressure on the change in inventories statistic.

We perform econometric analysis of the change in inventories statistics using imports, change in private sector credit (all expressed as a portion of the GNE) and PPI/CPI inflation differential as independent variables. We add a "Crisis" dummy variable marking these two years to some specifications in order to account for possible special effects of the crisis discussed above. Since there are some reasons to believe, as discussed above, that average change in inventories in an efficient economy should be (close to) zero over a sufficiently long time period, we force regression line through the origin in some specifications.

We first use in our analysis the annual data for the post-war period, which leaves us with only 16 observations. This could affect the reliability of the statistical significance of our results. To check for this, we perform some robustness tests. The Jarque-Bera test fails to reject at any reasonable confidence level normality of the distribution of residuals in any of the reported regression specifications. The Phillips-Perron test rejected the unit root hypothesis for all variables at least at the 10% confidence level. To account for possible heteroscedasticity, we used regressions with White heteroskedasticity-consistent standard errors and covariance, and to account for possible autocorrelation we do sensitivity

analysis of our results using AR(1) model[10]. The results of analysis are reported in the Table 1.

The results suggest that imports to GNE ratio and PPI/CPI inflation differential are robust determinants of the change in inventories statistic in the annual national accounts, as corresponding coefficients are large and statistically significant at 1 percent confidence level in all but one specification and at 5 percent level in all but one specification, respectively. There is some albeit weak evidence that change in private sector credit could also affect the dependent variable[11]. We could be reasonably confident that during the crisis years of 1994 and 1999 change in inventories was significantly lower than in other years, even controlling for the tighter import restrictions. The set of independent variables included in our regressions explains no less than two thirds of variation in change in inventories in most specifications. The results reported in the Table 1 support our hypotheses outlined above.

Table 1. Results of the econometric analysis of the change in inventories
(annual time series)

Specification Variable	1	2	3	4	5	6	7	8
Imports	0.73***	0.72***	0.64***	0.59**	0.39***	0.43***	0.41***	0.45***
	(5.41)	(3.99)	(4.46)	(2.89)	(8.82)	(7.42)	(9.66)	(7.54)
Change in private sector credit	-0.46*	-0.33	-0.46*	-0.21	-0.42	-0.28	-0.45*	-0.18
	(-1.84)	(-1.22)	(-2.05)	(-0.90)	(-1.63)	(-1.05)	(-2.02)	(-0.81)
PPI/CPI inflation differential	0.32**	0.31*	0.33**	0.33**	0.44**	0.35**	0.41**	0.34**
	(2.48)	(2.12)	(2.46)	(2.61)	(2.65)	(2.27)	(2.40)	(2.55)
Crisis			-3.58**	-3.95*			-4.97***	-4.54***
			(-2.60)	(-2.02)			(-7.8)	(-4.61)
C	-6.58**	-6.14	-4.43	-3.04				
	(-2.23)	(-1.46)	(-1.37)	(-0.64)				
AR(1)		0.31		0.42		0.36		0.42
		(0.90)		(1.00)		(1.15)		(1.07)
R squared	0.76	0.74	0.80	0.83	0.66	0.67	0.76	0.81
Adjusted R squared	0.70	0.63	0.73	0.73	0.61	0.58	0.70	0.74

We further repeat the same set regressions using quarterly time series, controlling for seasonality by adding the quarter dummies[12]. This gives us advantage of higher number of observations (64), but on the other hand it effectively makes the definition of inventories more broad and by doing so adds noise to the statistic in question. Obviously, there is always some time lag between production and sale of the finished goods as well

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[10] This being said, we still need to keep in mind that the t-statistics from our regressions could be biased upward.
[11] Conditioning public banks loans to purchases from the public enterprises which accumulated large stocks of the finished-goods inventories could be one of the forces behind significance of the coefficient on growth of credit to the private sector in some specifications.
[12] Coefficients on the quarter dummies are not reported here.

as between purchase of capital goods and their actual investment. With higher frequency of observations, the change in inventories statistic is more likely to capture this even if the time lags are of ordinary length, and thus it becomes noisier for purposes of our analysis.

The results of these regressions reported in the Table 2 are generally consistent with those based on the annual time series, with one exception: coefficient on the PPI-CPI differential, while maintaining the same sign and order of magnitude, is not statistically significant in any specification[13].

Table 2. Results of the econometric analysis of the change in inventories (quarterly time series)

Specification / Variable	1	2	3	4	5	6	7	8
Imports	1.04*** (10.86)	0.78*** (8.52)	0.95*** (10.04)	0.74*** (8.64)	1.00*** (9.86)	0.68*** (7.80)	0.91*** (9.21)	0.66*** (8.19)
Change in private sector credit	-0.25 (-1.04)	0.12 (0.56)	-0.18 (-0.76)	0.12 (0.64)	-0.78*** (-4.10)	-0.16 (-0.91)	-0.59*** (-3.16)	-0.12 (-0.73)
PPI/CPI inflation differential	0.26 1.03	0.07 0.42	0.24 1.00	0.05 0.31	0.45 1.72	0.10 0.61	0.39 1.60	0.08 0.50
Crisis			-4.21*** (-2.77)	-5.62*** (-3.25)			-4.97*** (-3.15)	-6.34*** (-3.57)
C	-7.64*** (-3.14)	-7.09*** (-2.75)	-6.45*** (-2.75)	-5.62** (-2.32)				
AR(1)		0.59 (5.32)		0.59 (5.41)		0.69 (6.57)		0.66 (6.20)
R squared	0.73	0.81	0.76	0.84	0.69	0.78	0.73	0.82
Adjusted R squared	0.70	0.78	0.73	0.81	0.66	0.76	0.70	0.80

What could be said about the abnormally high average change in inventories based on the analysis of variation in this statistic? A part of the story is statistical errors and omissions as evident from the statistically significant coefficient on the PPI/CPI inflation differential in all regressions using annual data. However, we suggest that there are also two economic forces at work which contribute to this phenomenon.

Firstly, we interpret consistently large and statistically significant coefficient on the crisis dummy as evidence that soft budget constraints lead public firms to over-accumulate inventories – and possibly waste some of them. Like many other countries of the world, many Iranian state-owned enterprises are less efficient than private sector firms. Anecdotal evidence suggests that some of the capital goods imported by these enterprises

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[13] Possibly, this happens because "noises" introduced in the data by inflation differentials and by high frequency of the data partially cancel each other out.

for precautionary reasons have been either never invested or sunk into the projects which were never finished; it also appears quite possible that some goods produced by them have been never sold, thus becoming "chronic" inventories.[14]

Secondly, the largest determinant of the change in inventories is imports, and high average for the statistic in question potentially could be due to over-invoicing by importers as a means for hidden capital flight. To check whether or not hidden capital flight is a part of the explanation, we look at the data on Iran's imports and other countries' exports to Iran from the UN Commodity Trade Statistics Database, which are available from 1997 onwards. Specifically, we are interested in the data points where imports reported by Iran substantially exceed exports to Iran reported by other countries. As thresholds, we have chosen a margin between the two variables which exceeds both USD 30 million *and* 20 percent of exports reported by the country of origin. The total amount of differentials for these data is 2003 USD 14.2 billion for 1997-2003; the data points aggregated by major countries of origin for 1997-2003 are presented in the Figure 8.

To get an idea of which sectors account for large portions of the possible over-invoicing, we disaggregate the data points described above by 2 digit product codes of the World Customs Organization's Harmonized System (Figure 9), using a margin of USD one million between reported imports and exports as a threshold for the data points. The total amount of differentials for these data points is 2003 USD 16.8 billion[15].

The countries for which total differentials exceed one billion of 2003 USD are: Switzerland, Germany, Belgium/Luxembourg, and Brazil. The products which meet the same criteria are (product codes in parenthesis):

- Vehicles of railway and tramway and their parts/accessories (87);
- Boilers, machinery and mechanical appliance, and their parts, etc.(84);
- Cereals (10);
- Natural/cultured pearls, precious stones and metals, coins, etc.(71);
- Iron and steel (72).

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[14] Presence and significance of soft budget constraints also helps to establish dominant direction of causality between inventories and imports, which are related by accounting identity (1). It is more likely that increase in imports (most notable during the periods of higher oil prices) is driven by softening of the constraints and leads to higher inventories, less so that demand for inventories is driving imports.

[15] It exceeds total amount calculated based on the aggregated data because for some products for the countries and years in question the differentials turned out to be negative (possibly indicating smuggling, or for other reasons).

Figure 8. Differentials between imports reported by Iran and exports to Iran reported by country of origin, 1997-2003.
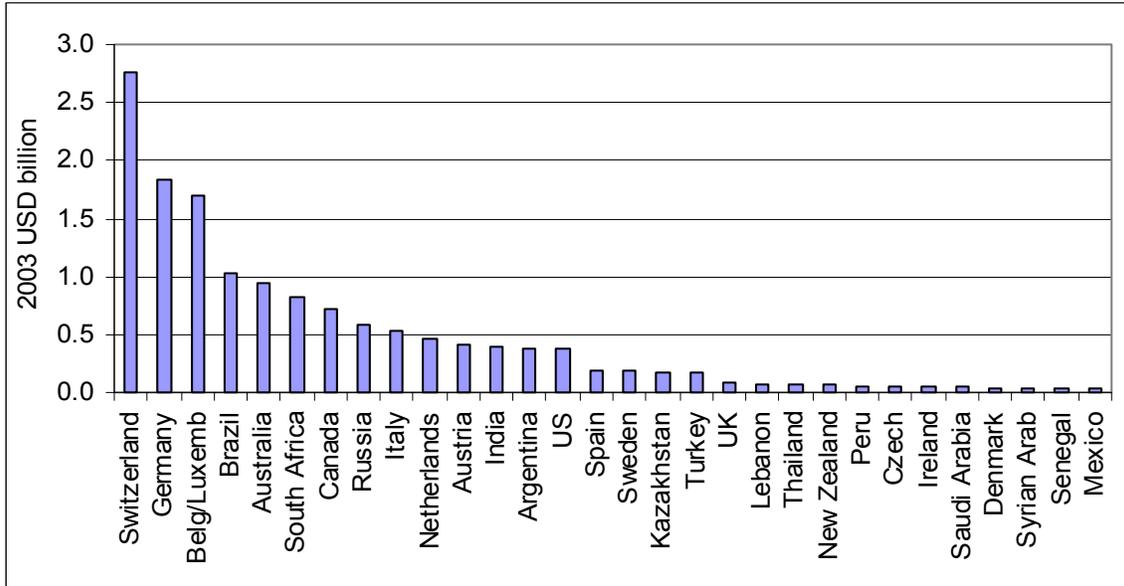
Source: UN commodity Trade Statistics Database, Harmonized System nomenclature, version 1992)

Figure 9. Differentials between imports reported by Iran and exports to Iran reported by two-digit product code, 1997-2003.
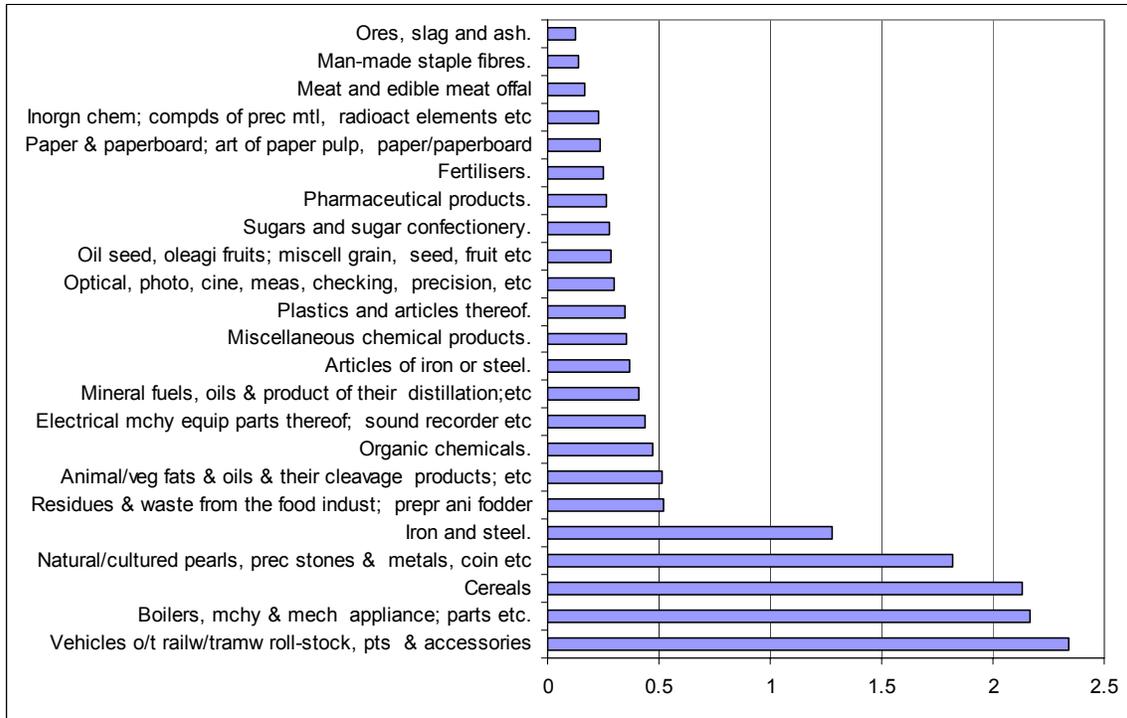
Source: UN commodity Trade Statistics Database, Harmonized System nomenclature, version 1992)

16

6. Concluding remarks

We argued in this paper that variation in the change in inventories in Iran could be explained by the tendency of risk-averse gents to over-accumulate inventories as a result of significant variations of the cost of capital and supply-shocks expectations in an economy dependent on the oil revenues and imports of capital/intermediary goods. This occurs in the context of underdeveloped financial markets and soft budget constraints of the public enterprises, the features which are not captured in the standard models of inventories accumulation assuming perfectly competitive markets. There is also evidence to suggest that high average change in inventories could be explained by capital flight hidden in the imports statistics, by wasting some of the over accumulated inventories under the soft budget constraint, and by statistical errors and omissions due to high PPI/CPI inflation differentials.

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