Implications of Armenian Dram Appreciation for the Competitiveness of Armenian IT, Tourism, and Food Processing Industries

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Executive Summary

The Armenian currency appreciated more than 40 percent during 2003-2006. This sharp change in nominal exchange rate is considered a negative shock for local producers and especially for the exporters. The survey data of fifty eight Armenian companies is used to study how the appreciation has affected the competitiveness of Armenian tourism, IT, and food processing industries. We use the Stochastic Frontier modeling technique to estimate the level of and changes in the technical efficiency of the companies during 2003-2006. The technical efficiency parameters are then included into the regression model in order to reveal the possible impact of the currency appreciation on profits and export levels of the companies.

We find systematic and statistically significant impacts of exchange rate changes on the level of technical efficiency of the companies. We also find that work experience is another important determinant of degree of technical efficiency.

We study the relationships among exchange rates, technical efficiency, and export and profitability of the companies. We find that a one point appreciation of the nominal exchange rate causes a decrease in the export of an average Armenian IT company by 66 thousand drams (about 200 USD) per year, average food processing company by 12 thousand Drams (about 40 USD) per year, and a loss of profit of an average incoming tour operator and hotel by 112 thousand AMD (or about 340 USD per year).

Our recommendations, among others, include removing the existing 1% of total revenue restriction on the training expenses, creating a link between educational institutions and employers in the area of curriculum development, and allowing paying the VAT on imported equipment and machinery in installments, according to the depreciation schedule.

JEL Classification: C1, C3, D2

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1. Industry Overview

IT and Tourism

Both Armenian information and communication (ICT) and tourism industries experienced rapid growth during the last decade and are considered to be among the most dynamic and perspective sectors of Armenian economy.

According to Enterprise Incubator Foundation (EIF, 2007) and the Ministry of Trade and Economic Development[1] of Armenia, the average annual growth rate of ICT industry was about 30%. 165 companies operating in the industry employ about 5000 people. The industry output in 2006 was about 85 million USD comprising about 2% of GDP of Armenia, and about 63% of the output was exported.

The share of tourism in the GDP of Armenia is about 6-7%, being at the same time one of the main export categories.[2] Table 1 shows the dynamics of international tourist arrivals for 2001-2006. The industry maintains high annual growth rates (on average 25%) and has become one of the most important and dynamic sectors of the Armenian economy. It is estimated that, on average, one foreign tourist spends in Armenia about 10 days and about $1,600 USD, not counting international travel expenses.[3]

Table 1. International Tourist Arrivals to Armenia, 2001-2006.

	2001	2002	2003	2004	2005	2006
Int. Tourist Arrivals, thousand	123,262	162,089	206,094	262,685	318,563	381,136
Growth rate of Int. Tourist Arrivals	-	31.50%	27.15%	27.46%	21.27%	19.64%

Source: Ministry of Trade and Economic Development of Armenia.

Theoretically, domestic currency appreciation can have extremely negative effect both for tourism and IT industries. Along with appreciation, domestic prices (when denominated in foreign currency) become more expensive for foreign visitors and their number may decrease in favor of alternative cheaper destinations. According to the recent study of ECA International,[4] Yerevan is ranked 21st among most expensive cities for visitors and is ahead of Paris (23), Vienna (25), Berlin (27), and even Manhattan, NY (28). This position of the Armenian capital is, in part, due to the domestic currency appreciation.

Most of Armenian IT companies either export their products or operate as outsourcing contractors. Most of their costs are denominated in Armenian drams, labor being the largest cost category, which makes cost-cutting almost impossible. In the competitive market, the entire burden of dram appreciation can be offset only by an increase of dollar price, if that company operates at the possible highest efficiency level. On another side, the real dram wages in Armenian IT sector are driven up by a deficit of properly skilled labor which makes Armenian IT companies even less competitive in the international market.

[1] www.minted.am
[2] ibid
[3] ibid
[4] http://www.eca-international.com/ASP/ViewArticle2.asp?ArticleID=175

Food Processing

The food processing industry is traditionally one of the important sectors of the Armenian economy. In the mid 80s, the sector accounted for about 18% of total industrial output. Armenia was always famous for its brandy and wine, canned fruits and vegetables, traditional meat products, fresh and dried fruits, etc. After the collapse of the FSU and the hard transition process, worsened by the economic blockade and war, the food processing industry experienced a dramatic decline. Many companies stopped operating, and others tried to survive, utilizing just 5-10% of their capacity. After the privatization in 1994-1999, the industry started reviving, benefitting from large volumes of foreign investments (about $60 million USD by 2000 (Decay, 2000)) and increased domestic demand driven by import substitution. Table 2 summarizes the main indicators of the food industry of Armenia during 1985-2006.

Table 2. Main Indicators of Food Industry of Armenia

	1985	**1997**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Number of enterprises, units	135	178	593	670	769	786	782	n/a
Volume of production, bln. Drams	-	93.7	114.9	126.7	150.8	161.9	185.4	189.4
Volume of production, thous. current USD	n/a	190,913	206,990	220,963	260,539	303,468	405,069	455,288
Share in total Industrial Output, %	18.4	36.8	37.1	37.1	36.6	31.3	29.5	29.4
Number of industrial production personnel, 1000 persons*	33.5	15.2	12.1	10.8	11.6	11.6	14.3	n/a
Food Export, thous. current USD	n/a	25,328	50,538	59,212	81,187	82,877	114,112	121,846
Food Export, share in Merchandise Export, %	n/a	10.9%	14.8%	11.7%	11.8%	11.5%	11.7%	12.4%
Food Import, thous. current USD	n/a	277,979	212,405	199,796	223,803	282,659	315,940	343,492
Food Import, share in Merchandise Import %	n/a	31.2%	24.2%	20.2%	17.5%	20.9%	17.5%	15.7%
Food trade balance, thous. current USD		-252,651	-161,867	-140,583	-142,616	-199,783	-201,827	-221,646
Nominal Exchange Rate, AMD per USD, (year average), drams		490.8	555.1	573.4	578.8	533.5	457.7	416
Change in Nominal Exchange Rate, % to previous year				3.3%	0.9%	-7.8%	-14.2%	-9.1%

**Without small- and super-small organizations.*
Source: Statistical Yearbook of Armenia 2006, NSS; "Industry" Statistical Collection, NSS, 1997; Author's calculations

During the 2000s, the share of the food processing industry has further grown, providing about 30% of total industrial output in 2005. At the same time, it became the third largest exporting industry, accounting for about 12% of total merchandise exports in 2005. The period of 1997-2005 was characterized by substantial import substitution growth. While domestic food production has almost doubled, food imports have increased by just about 14% compared to the level of 1997, with share in total merchandise import having decreased from 31% to 18%. However, the trade balance in food industry is still negative representing about 200 mln USD or about 180% of current food export. Armenia is still highly dependent on imported food products which is about half of the total food consumption.

Despite the increase of the number of enterprises operating within the industry, the level of output significantly decreased compared to the pre-transition level (see Table A1 of Appendix A). In 2006, the volume of production of almost all food products was significantly lower than in the pre-transition period, with the only exception being whole milk dairy products. While for some product

groups the difference is modest (alcohol-free beverages – 86% of 1985 level, meat – 75%, brandy 77%), for other products it is striking (grape wine – about 6%, sausages -7%, canned products – about 5%).

2. Exchange Rate: Real or Imaginary Threat?

The Armenian national currency – the Dram – was introduced in November 1993 at the rate of 200 Soviet Roubles equal 1 Dram. The ensuing few years were characterized by high rates of inflation and currency depreciation. In 1996 the Central Bank adopted the floating exchange rate regime and announced low inflation as the main target of Bank's policy. By the end of 1990's the Government was able to achieve macroeconomic stabilization and the economy started growing at high rates.

Table 3. AMD/USD Exchange Rate Dynamics, 1997-2007

	1997	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Oct. 2007**
Nominal Exchange Rate, AMD per USD, (year average), drams	490.8	555.1	573.4	578.8	533.5	457.7	416	335
Change in Nominal Exchange Rate, to previous year, %			3.3	0.9	-7.8	-14.2	-9.1	-19.5

Source: Statistical Yearbook of Armenia 2006, NSS

Starting from 2004, the Armenian currency has been experiencing dramatic appreciation (see Table 3). The most common official explanation of that phenomenon are high inflows of remittances from abroad, possible undervalued position of the real exchange rate prior 2003, rapid growth in income and productivity, as well as a process of de-dollarization of the economy following new banking and legal regulations and the depreciation of dollar with respect to other major world currencies (Euro, Yuan, Yen, etc). Despite high pressure, Central Bank of Armenia continues to follow its policy of prioritizing low inflation rate rather than supporting stable exchange rate. The common reaction of Armenian officials to the complaints of Armenian producers and exporters regarding the negative impact of the appreciation has been advice to increase the productivity.[5] However, few appear concerned with the feasibility of such productivity growth. Moreover, according to a recent study by the World Bank (World Bank, 2007), Armenia has achieved significant improvement in the labor productivity. It is quite possible that many Armenian enterprises that already have modernized their technology and have applied effective management and quality control systems, have already completed the catch-up process in productivity, and sustaining further productivity growth might not be feasible for them.

This study will attempt to estimate the degree of the technical efficiency of Armenian food processing, Information and Communication Technology companies (ICT), hotels, and incoming tour operators and check how the dram appreciation has affected their performance and competitiveness.

[5] See for example, Vahagn Grigoryan, "The Future of Export", (in Arm. language), www.cba.am/verluc/2.9.pdf

What do Managers Think?

In order to supplement the findings of the empirical analysis and gain better insight into the situation, we conducted a series of brief interviews with CEO's of a number of companies from both industries. The answers are summarized in the Table 4.

Table 4. Mean results of the Interview answers

	# of companies	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
IT companis	38	35	503	48	23	77	4
Hotels	21	20	523	30	1	34	5
Tour Operators	33	53	460	33	11	76	3
Food Processing companies	32	47	420	26	2	55	5
Weighted average of 124 companies		40	474	35	11	64	4

Q1. What would you expect the percentage difference of Company's 2006 revenue to be, if the exchange rate remained at the level of 2003, i.e. 580 drams per 1 USD?

On average, the managers claimed that their revenues would be about 40% higher if the exchange rate were unchanged, the largest impact being for incoming tour operators – more than 50%. IT managers mentioned that the appreciation of Dram makes their companies less competitive compared to other outsourcing countries, and at least 5 firms - branches of foreign companies, mentioned that their headquarters had been seriously considering the possibility of shutting down their Armenian office.

For hotels and tour operators, the major problem is the continued appreciation of Armenian tourism service which causes Armenia losing the battle in the global tourism market. They argue that it is the flow of tourists of Armenian origin that allows the industry to survive, however this growth is about to slow down.

Food companies selling in domestic markets are concerned with the loss of sales because most of the population is surviving with the flow of remittances, and the appreciation of dram is affecting the welfare of remittance recipients and thus the demand for food products.

Q2. What AMD/USD exchange rate would be the most favorable for Your Company and would make it competitive?

The desirable exchange rate is at the average 474 drams per US dollar which is about 47 percent higher than the rate of 335 drams prevailed during the study.

Almost all respondents mentioned that they are concerned not only with the real appreciation of the currency but also with unpredictability of the exchange rates. Sometimes the uncertainty

creates even more problems when they need to make price re-calculations, sign agreements, print and distribute booklets, catalogues, etc.

Q3. and Q4. What is the percentage change of your Company's export prices (in USD) and domestic prices (in AMD) compared to 2003?

Both export and domestic prices have increased during last 4 years. However, while domestic prices increased at average 11 percent (which is consistent with the inflation in the country for the same period), the export prices have grown at about 35 percent, which in its turn is close to the appreciation rate for the same period.

This is evidence that the companies raise their foreign prices in order to offset the exchange rate effect which makes them less competitive in the international market.

Q5. What percentage of your Company's capital assets and human resources is being used (rate of utilization), on average, during year?

The answers to this question reveal serious efficiency problems. The most striking, in this regard, is with respect to hotels, with their average occupancy rate of about 35 percent. While the tourism industry has a seasonal nature and 76 percent of workload can be justified, for the IT industry the rate of 77 percent should be an issue of concern. The food companies operate on average at 50% or their capacity.

Q6. Please, evaluate State – Your Company interrelations according to 0-10 point system (0 - extremely unfavorable, 10 - the most favorable).

The average ranking of this answer was 4 points. The main reasons for such low evaluations of the relationship with the State are tax and customs administration problems, corruption, lack of business assistance programs, the State's inability to improve the quality of education, etc.

The predominant opinion among managers is that the process of appreciation is irreversible, regardless the causes of this phenomena. However, they insist that if the CBA follows such a monetary policy, the government should take adequate measures to help domestic companies to survive in this unfavorable environment.

Despite the fact that both the IT and tourism industries are priority sector of economy for the Armenian Government, these industries have no privileges or advantages compared to other sectors of economy.

The most common problems identified by the respondents[6] and their suggestions are presented below:

<u>Tax and Customs Administration:</u>

- Currently, all imported equipment is taxed with 20% VAT and customs duties are applied to the most of them. Usually, the customs value is determined by customs officers without any justification, regardless of the invoice value, and is based on internal instructions rather than market prices. It is suggested that these industries should be exempt from VAT tax and customs duties on imported equipment and on domestic investments into capital assets.
- Decrease profit tax for exporters, from the current 20% to 10%;

[6] The suggestions and policy recommendations in this chapter are those of respondents and may be different from the views of authors.

- Simplify the procedure and enforce the refund of overpaid VAT tax;
- Provide temporary (1-2 year) tax exemptions for newly established ICT companies.
- Hotel Restaurant taxation. Many hotels complained that the hotel restaurants are taxed identically to other restaurants, tax being calculated on the square meterage base. They claim that this approach is not acceptable since hotel restaurants serve only hotel customers and are marginally profitable while regular restaurants earn high profits on hosting different occasions (weddings, birthday parties, etc.), and the two categories cannot be treated identically. Some hotels, especially in the regions, were going to close their restaurants and stop providing breakfast to their customers.

Finance

- Create a mechanism for providing low interest, long-term loans to exporters;
- Improve the access to the long-term loans for ICT companies.

Education and training

- A shortage of skilled ICT specialists is observed, and many companies consider this as one of the most important obstacles for further expansion of the industry;
- A shortage of specialized managers (hotel managers, IT managers) is another serious problem;
- Companies need the Government to provide free training or cover training costs of managers and other key employees;
- The Government should cover the costs of participation in various international trade fairs, symposiums, networks, etc.

Protection of intellectual property rights. It is well-known that the protection of intellectual property rights is one of the most important factors stimulating the investment into R&D since the investors are sure that the potential benefits of new inventions or innovations will belong to them only. Many Armenian IT companies mentioned that as long as the protection of intellectual property right is not enforced, there will be no serious development of the ICT industry and little investment into R&D should be expected.

De-monopolization. This issue is considered especially important by ICT companies. Very high prices and low quality of internet and telephone services, accompanied with the non-transparent system of state contracts on IT services, create significant negative spillovers and market distortions.

The most important message of the companies' officials was that the situation is very critical, and if the Government wants to preserve the emerging Armenian food processing, IT, and tourism industries, they should act as quickly as possible, otherwise even in one year it might be too late.

3. Methodology and Model Specification

Stochastic Frontier Model

The method used in our analysis is called Stochastic Frontier Model which we will use to estimate the degree of technical efficiency (TE) of Armenian companies. The obtained levels of technical efficiency, then, will be regressed on the exchange rate to see whether the appreciation of the Armenian currency has affected the technical efficiency and thus the competitiveness of the companies.

We will assume that the surveyed companies have production functions with inputs X and output Y. In the perfectly efficient world, the ith firm in time t would produce the output Y_{it}

$$Y_{it} = f(X_{ijt}, \beta) \tag{1}$$

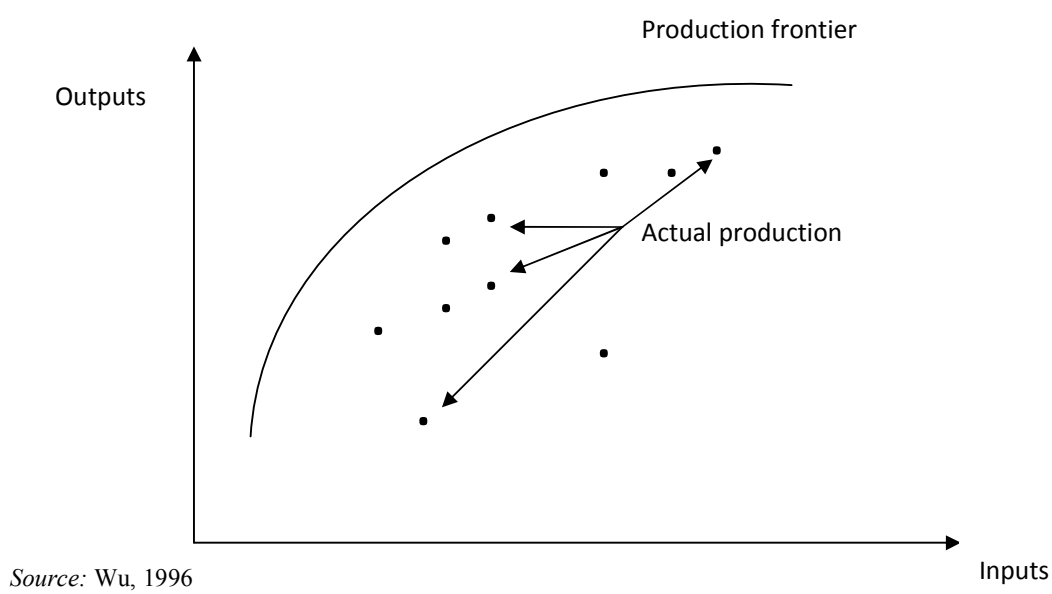
and X_{ijt} is the i-th firm's j-th input at time t. However, as Farrell (Farrell, 1957) specifies, in real life two types of efficiencies exist: technical efficiency that allows firms to produce the maximum level of output given the level of inputs and allocative efficiency that requires production of given level of output as cheaply as possible. To understand the level of efficiency of the firm, we need to have the level of output of the absolutely efficient firm, which is known as production frontier, and then compare the output of the firm with the frontier.

The stochastic models for estimating the production frontier and level of efficiency were introduced in 1977 by Aigner, Lovell and Schmidt (Aigner, 1977) and Meeusen and Van Den Broeck (Meeusen, 1977). In these models the efficiency is measured as ξ_i such that

$$Y_{it} = f(X_{ijt}, \beta)\xi_i \tag{2}$$

where ξ_i belongs to the interval within 0 and 1. A firm is perfectly efficient when $\xi_i = 1$, in which case the firm's actual production is at the highest possible level and is located on the production frontier (Figure 1.). If $\xi_i < 1$, the firm is not producing the maximum output of the inputs X_{ijt}, given the available technology reflected by the production function $f(X_{ijt}, \beta)$.

Figure 1. The Production Frontier and Technical Efficiency



Source: Wu, 1996

In addition to inefficiency, each firm experiences also some exogenous shocks v_{it} that are introduced into the model as stochastic error term.

$$Y_{it} = f(X_{ijt}, \beta)\xi_i \exp(v_{it}) \tag{3}$$

Taking logs of both sides and defining $u_i = -\ln(\xi_i)$ gives

$$\ln Y_{it} = \ln(f(X_{ijt}, \beta)) - u_i + v_{it} \tag{4}$$

Where v_{it} and u_t are independently and identically distributed, truncated at zero, with mean μ and variance σ_μ^2, and v_{it} and u_t are distributed independently of each other; cov(u_i,v_i)=0. Following Battese and Coelli (1992), we parameterize u_t as

$$u_{it} = \exp(-\eta(t - T_i))u_i \tag{5}$$

where T_i is the last time period in the ith panel and η is the decay parameter. When $\eta>0$, the degree of inefficiency decreases over time, when $\eta<0$, the degree of inefficiency increases over time. The last period i.e. when $t=T_i$, contains the base level of inefficiency for the given firm. If $\eta>0$, the level of inefficiency decreases toward the base level, and if $\eta<0$, the level of inefficiency increases to the base level.

In our study, to estimate the production frontier and inefficiency terms of the companies, we will use two specifications of the production function: Translog production function (6) and Cobb-Douglas production function (7).

$$\begin{aligned}\ln Y_{it} &= \beta_0 + \beta_t \ln t + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \frac{1}{2}\beta_{tt}(t)^2 + \frac{1}{2}\beta_{KK}(\ln K_{it})^2 + \frac{1}{2}\beta_{LL}(\ln L_{it})^2 + \\ &+ \beta_{KL}(\ln K_{it})(\ln L_{it}) + \beta_{Kt}(\ln K_{it})(\ln t) + \beta_{Lt}(\ln L_{it})(\ln t) - u_{it} + v_{it}\end{aligned} \tag{6}$$

and

$$\ln Y_{it} = \beta_0 + \beta_t \ln t + \beta_K \ln K_{it} + \beta_L \ln L_{it} - u_{it} + v_{it} \tag{7}$$

where capital (K), labor (L) time (t) are input factors used to estimate the stochastic frontier model, and Y is the output.

We assume that both production functions have constant return to scale: RTS=1, which is tested for both model specifications.

Technological Progress (TP) is the derivative of the production function with respect to time:

$$TP = \beta_t + \beta_{tt}(t) + \beta_{Kt}(\ln K_{it}) + \beta_{Lt}(\ln L_{it}) \tag{8}$$

If TP is positive (negative), then the production frontier shifts up (down).

For the Cobb-Douglas production function, TP is constant and is the coefficient of time β_t.

Change of Technical Efficiency (TE) is the derivative of the negative of the inefficiency measure with respect to time:

$$TE = -\frac{du_{it}}{dt} \tag{9}$$

If TE is greater than zero, then the technical inefficiency declines over time and vice versa.

4. Data

The data used for this study was obtained during the survey of Armenian food processing companies, IT companies, tour operators and hotels conducted during June-September, 2007. Initially, data of 50 companies from each sector of economy was intended to be studied; however, only 23 food processing companies, 15 incoming tour operators, 7 hotels, and 13 IT companies agreed to provide their firm-level data (see Appendix B for the summary statistics). The data for Revenue, Capital, Wages and other monetary variables is expressed in Armenian drams; it is adjusted for the inflation by using GDP Deflator of Armenia with base year of 1996 which was obtained from IMF World Economic Outlook Database. The data on domestic inflation and the exchange rate was obtained from the National Statistical Service of Armenia (NSS). We also calculated a measure of foreign inflation, which is the average inflation rate of ten main trade partners of Armenia weighted by their share in total Armenian trade. The data on trade was obtained from NSS, and the data on price levels from IMF World Economic Outlook Database. The data of Real Effective Exchange Rate was obtained from CBA of Armenia.

5. Empirical Results

The number of companies from each industry was insufficient for conducting the stochastic frontier analysis separately for each industry, so we decided to group IT and tourism industries together and include an industry dummy variable for accounting for industry specific variation. The number of companies (23) was sufficient for analysis of the food processing industry.

We calculate the change in technical efficiency based on two production functions. In Model 1 we use a Translog production function (see equation 6) and in the Model 2 we use a Cobb-Douglas production function (7). In both models, the inputs are capital, labor and time. We assume that technical efficiency varies over time (time-variant, equation 5) and has a truncated normal distribution. We also calculate the measure of technological progress (TP). In the Translog model, e Technological Progress (TP) is calculated using equation 8, and TE is calculated according to equation 9. In the Cobb-Douglas model, TP is the coefficient of time and TE is calculated according to equation 9.

In both models, the null hypothesis of Constant Return to Scale (CRS) is accepted based on the likelihood ratio test.

We estimate technical efficiency and technological progress for each firm, for every year. The mean TE and TP by year are presented in the Table 5 and

Table **6**.

Table 5. Mean of Estimated Parameters: IT, Tour Operators, and Hotels, 2003-2006

year	te1	te2	tp1	tp2
2003	0.4369728	0.4716637	-0.2318835	-0.0768452
2004	0.4860817	0.5213609	0.0213009	-0.0768452
2005	0.5035055	0.5472735	0.1761738	-0.0768452
2006	0.4912892	0.5453566	0.2722712	-0.0768452
Total	0.4834649	0.5263201	0.0892652	-0.0768452

Note: te – technical efficiency, tp = technological progress. 1 and 2 refer to the Model 1 and Model 2 respectively.

The positive sign of TE shows that in both cases the degree of technical inefficiency is decreasing over time. An interesting observation is that in both models, the technical efficiency is increasing for 2003-05 but the rate is slowing down in 2006. Technological Progress (TP) indicates the direction of change of the production frontier. In the first model, starting from 2004, the frontier is shifting up. In the case of second model, the TP is constant and can be interpreted as an average progress during the last 4 years.

Table 6. Mean of Estimated Parameters: Food Processing, 2003-2006

year	te1	tp1
2003	0.2632050	-0.5384401
2004	0.2599808	-0.1620835
2005	0.2679276	0.0995709
2006	0.2666353	0.2382905
Total	0.2646437	-0.0580394

Note: te – technical efficiency, tp = technological progress. 1 and 2 refer to the Model 1 and Model 2 respectively.

For the food processing industry, Model 2 did not provide economically meaningful results, so we drop the results. In Table 6 we see that the degree of TE is fluctuating during the specified period.

Table 7 and Table 8 provide summary statistics of the estimated parameters of TE by industry. We can see that TE index of the food processing industry is the smallest, and within the tourism industry, hotels are about 15-20% less efficient than tour operators. In the case of IT companies, their mean TE is almost at the same level of about 51% in both models, however this industry has the largest spread in terms of technical efficiency (with largest standard deviation) showing that while some IT companies are successful in improving their efficiency, others are lagging far behind.

Table 7. Summary Statistics of TE1 by Industry, Average 2003-06

	Obs	Mean	Std. Dev.	Min	Max
Hotel	22	0.4300364	0.2061671	0.2121916	0.8590048
IT	27	0.4987445	0.2722411	0.0623348	0.8645540
Tour Operators	22	0.5181412	0.2335382	0.0999397	0.8691981
Food Processing	73	0.2646437	0.2539802	0.0324986	0.8200656

Table 8. Summary Statistics of TE2 by Industry, Average 2003-06

	Obs	Mean	Std. Dev.	Min	Max
Hotel	22	0.5058211	0.1912658	0.2499393	0.8819743
IT	27	0.5112230	0.2806895	0.0629765	0.8730741
Tour Operators	22	0.5653473	0.2485631	0.1085106	0.8742781

We want to estimate how the change in exchange rate affects the technical efficiency of the firms. In regressions, the calculated firm and time specific technical efficiency, TE1 and TE2, are the dependant variables. Two measures of exchange rate are alternatively considered: i) nominal AMD/USD exchange rate (*exch*) together with domestic inflation rate (*infa*) and trade weighted foreign inflation rate (*inff*), and ii) Real Effective Exchange Rate[7] (*reer*) calculated by Central Bank of Armenia. The foreign inflation rate for each year is calculated using average of the inflation rates of the ten largest Armenian trade partners, weighted by share of the trade of each country in the total foreign trade of Armenia.

Since we are trying to estimate the changes in the competitiveness of Armenian producers, in addition to macroeconomic variables we also include firm specific variables, such as marketing expenses in thousands of drams (adjusted by GDP Deflator) and average work experience of the employees expressed in years. Unfortunately, the data on trainings was not reliable and consistent and was not included into the model.

The regression results or random effect models are presented in Appendix C (IT and Tourism Industries) and Appendix D (Food Processing Industry).

The first model specification provides the following results for IT and Tourism Industries:

$$te1 = 0.3554323 + 0.0002701*exch*** - 0.0011503*infa - 0.0002147*inff +$$
$$+ 0.0005063*exp** + 5.09e\text{-}07*marketr + 0.0279733*tour - 0.0501147*hotel \quad (10)$$

Note: significant at 10%; ** significant at 5%; *** significant at 1%.*

The regression results using TE2 as a measure of technical efficiency are identical:

$$te2 = 0.4780624 + 0.0000438*exch*** - 0.0001404*infa + 0.0002289*inff$$
$$+ 0.0000968*exp** + 1.24e\text{-}07*marketr + 0.0578764*tour + 0.0000625*hotel \quad (11)$$

Note: significant at 10%; ** significant at 5%; *** significant at 1%.*

The regression results for food processing industry are the following:

$$te1 = 0.\ 2681958 + 0.0000164*exch*** + 0.\ 0000148*infa + 0.\ 0003993*inff +$$
$$+ 0.000027*exp - 4.10e\text{-}09*marketr \quad (12)$$

Note: significant at 10%; ** significant at 5%; *** significant at 1%.*

From both specifications, for all three industries, we can see that the nominal exchange rate has statistically significant impact on the level of technical efficiency. The positive sign shows that the effect of the appreciation of Armenian currency for the technical efficiency and thus competitiveness of the companies is negative. The positive sign is robust to changes in the model specification and independent variable. We run similar regressions by using consumer price index

[7] REER is a composite index that incorporates nominal exchange rate and prices levels of both Armenia and its trade partners. For additional details on the methodology and calculations of REER refer to website of the Central Bank of Armenia: http://www.cba.am/publications/prog/annex.pdf

(CPIa and CPIf) instead of inflation rate as a measure of domestic and foreign price levels, and we found similar results.

The coefficients for work experience are positive and significant at 5% significance level in (10) and (11). This means that work experience is one of the important determinants of technical efficiency in IT and Tourism industries.

The coefficients of the domestic and foreign price levels, as well as marketing expenses are not significant and are sensitive to the model specifications.

The industry dummies also are highly insignificant, meaning that the determinants of technical efficiency don't differ between IT and tourism industries.

To better assess the situation, in the next two regressions three of the previously used variables (*exch*, *infa*, and *inff*) are substituted for by one variable – Real Effective Exchange Rate (*reer*).

$$te1 = 0.6885364 - 0.0021411*reer*** + 0.0006226*exp* + 7.91e\text{-}07*marketr + \\ + 0.0278303*tour - 0.0513877*hotel \quad (13)$$

and

$$te2 = 0.\ 5328573 - 0.0003383*reer*** + 0.0001125*exp** + 1.65e\text{-}07*marketr + \\ + 0.0578545*tour - 0.0001084*hotel \quad (14)$$

Note: significant at 10%; ** significant at 5%; *** significant at 1%.*

And for Food Processing Industry, we have

$$te1 = 0.2899901 - 0.0001198*reer*** + 0.\ 0000339*exp - 7.36e\text{-}09*marketr \quad (15)$$

The results are comparable with (10) – (12). Again, the exchange rate appreciation has negative and highly significant effects for the degree of technical efficiency,[8] and work experience has positive and significant coefficients for the IT and Tourism industries, but not for food companies.

To continue our analysis, we use Tobit model in order to estimate the possible effect of the change in the degree of technical efficiency (te1 and te2) on the exports of IT and food processing companies (Appendix E). Unfortunately, the data on number of foreign customers obtained from tour operators and hotels is not consistent and reliable, and we cannot conduct a similar analysis for tourism industry[9].

We find that for IT industry

$$export = -64415.22 + 244478*te1 \quad (16)$$

$$export = -66121.35 + 243023.3*te2 \quad (17)$$

[8] It is important to note that while the sign of *reer* is opposite to the sign of *exch*, the effect it similar. It is explained by the methodology of *reer* calculation: the appreciation means an increase of value of *reer* but decrease of value of *exch*.

[9] If we had a reliable data on the number of foreign customers for each tour operator, we could use a similar model and regress the number of customers on the degree of technical efficiency to find out indirectly the total number of customers lost due to the exchange rate appreciation.

and for Food Processing industry

$$export = -147614.9 + 743663.2 * te1 \quad (18)$$

All coefficients of TE are significant at 1% significance level.

The results of (16) suggest that, on average, 10% improvement in the degree of technical efficiency of a company brings about 24.5 million dram or 73.9 thousand USD[10] of additional exports of IT products and 74 million (about USD 225 thousand) of additional exports of processed food.

Now we can use our estimates for calculating the effect of each point of dram appreciation on exports.

According to (10), appreciation of the nominal exchange rate by 1 dram is causing the technical efficiency of an average Armenian IT company to decrease by 0.0002701. On the other hand, from (13) we know that a decrease of TE by 10% will decrease the export of an average IT company by 24.5 million AMD. This means that a one point appreciation of the nominal exchange rate will cause the export of an average Armenian IT company to go down by 0.0002701* 244,478,000=66,034 drams which is equal about 200 USD (at the current rate of 1USD=331AMD). If we want to estimate the total impact that the appreciation during a specified period had for the entire industry, we should use the following formula:

$$Loss\ in\ Export^{IT} = 66{,}034 * Number\ of\ companies * \Delta\ exchange\ rate \quad (19)$$

Similarly, a one point appreciation of the nominal exchange rate will cause the export of an average Armenian food processing company to go down by 0.0000164 * 743,663,200=12,196 drams which is equal about 37 USD (at the current rate of 1USD=331AMD), and

$$Loss\ in\ Export^{FOOD} = 12{,}196 * Number\ of\ companies * \Delta\ exchange\ rate \quad (20)$$

When we compare IT and food industries, two important observations can be made. The elasticity of technical efficiency of IT companies with respect to nominal exchange rate is more than tenfold higher than in food processing industry which means that IT companies are more sensitive to the exchange rate appreciation. On the other hand, the change in technical efficiency has 3 time larger impact for the export level of food companies implying that the return on TE improvements is larger.

Table **9** presents the estimated export losses of the Armenian IT industry starting from 2004.

Table 9. Estimated Loss of Exports in IT industry due to dram appreciation, 2003-06

	2003*	2004	2005	2006*	Oct. 2007	**Total**	Total, [95% Conf. Interval]
Operating Companies, IT Industry*	110	125	141	160	165		
Industry Revenue, mln. USD*	37.7	49.3	64.4	84.2	-		
Industry average revenue, mln. USD*	0.34	0.39	0.45	0.52	-		
Domestic market, mln. USD*	13.5	17.8	23.5	30.9	-		

[10] At the rate of 331 AMD per 1 USD, Oct. 2007

Exports, mln. USD*	24.2	31.5	41.0	53.3	69.3			
Export loss, mln. AMD**	-	373	707	441	926	**2,446**	1,495	3,398
Export loss, mln. USD**	-	0.699	1.544	1.059	2.798	**6.100**	3.727	8.473
Ratio of Lost Export to the actual Export**	-	2.2%	3.8%	2.0%	4.0%			
Nominal Exchange Rate, AMD per USD, end of the year, drams	578.8	533.5	457.7	416.0	331.0			

*Source: *- EIF 2007; ** - Authors calculation.*

We found that starting from 2004 Armenian IT industry has lost export opportunities of about 6 million USD of value.

In our survey, the total export of the surveyed IT companies was 1,095 million AMD during 2004-2006. For the same period, the nominal exchange rate has appreciated from 579 AMD/USD in 2004 to 416 AMD/USD in 2006. According to (19), the total exports loss of our 13 IT companies amounts to 140 million AMD or about 13% of total exports.

Similarly, food industry has lost about 45 million AMD of export opportunities or about 3% of actual exports.

Next, we estimate how the change in TE due to the dram appreciation has affected the profitability of the tourism and food processing industries. We use a random effect regression model (see Appendix F). The results suggest that TE has a significant and positive effect for the profitability of tourism companies. On average, each point of dram appreciation causes an average tour operator and hotel to lose about 112 thousand AMD or about 340 USD and the average food processing company to lose just 14 USD of profit before tax.

Table 10. Estimated Average Loss of Profit per Tour Operator and Hotel

	2004	2005	2006	Oct. 2007	**Total**	Total [95% Conf. Interval]	
Profit loss per company, mln. AMD	5.092	8.521	4.687	9.555	**27.855**	2.487	53.223
Loss of Profit, per company, USD	9,545	18,616	11,268	28,867	**68,296**	6,098	130,493

From Table 10 we see that only in 2006, an average tourism company has lost about 9.5 million dram of profit before tax (about 29 thousand USD), while the total loss starting from 2004 has amounted to 28 million drams (68 thousand USD).

During the period of 2004-2006, the lost profit of all surveyed tour operators and hotels amounted to 401 million AMD or 15% of actual profit. For food companies, the profit loss was modest at slightly less than 1%.

Our analysis strongly suggests that the IT and tourism industries, and to lesser extent food processing industry, have been seriously affected by dram appreciation, and since the appreciation process continues, urgent measures should be undertaken by the government for helping companies to offset this negative pressure and stay competitive in domestic and international markets.

6. Policy Recommendations and Conclusion

The survey data of 58 Armenian companies are used to study how the appreciation has affected the competitiveness of Armenian IT companies, hotels, tour operators and food processing industries. We use the Stochastic Frontier Modeling technique to estimate the level and changes in technical efficiency of Armenian companies for the period of 2003-06. The technical efficiency parameters are then included into the regression model in order to reveal the possible impact of currency appreciation on export volumes and profitability of the companies.

The model shows that the level of technical efficiency of Armenian companies has been rapidly growing during the last 3 years, but reversed in 2006. We find a systematic and statistically significant negative relationship between dram appreciation and the degree of technical efficiency of the companies. We also find that technical efficiency is an important determinant of export levels. We estimate that starting from 2004, the Armenian IT industry has lost about 6 million USD of export opportunities. We also found that each point of dram appreciation is causing an average IT company to lose about 66 thousand AMD (about 200 USD) of exports per year and the average food processing company to lose about 12 thousand AMD (37 USD) per year.

We study the relationship between the degree of technical efficiency and profitability of Armenian tour operators and hotels. We find that each point of dram appreciation causes an average tour operator and hotel to lose about 112 thousand AMD or about 340 USD of profit before tax. The profit loss of food processing companies is negligible.

We also find strong positive correlation between average work experience of the company's employees and the degree of technical efficiency of that company.

In the conditions of continued dram appreciation, the Armenian government and senior company managements should work together in seeking possible ways for overcoming the negative pressure created by the exchange rate appreciation. According to the model (equation 10), one of the company level determinants of technical efficiency is work experience, one year increase of average work experience of the company's staff offsetting about 2 points of dram appreciation. If we consider trainings as a means of improving skills and adding experience, they can become a powerful tool for improving efficiency and productivity of the company. *According to the current legislation, a firm cannot claim more than the equivalent of 1% of total revenue as training expense. This restriction should be removed as it* will create incentives for the companies to spend more money on staff training. Also, more free training should be organized through state business assistance programs.

Improving knowledge and making education better targeted is another challenge especially in IT sector. Many managers complained that new graduates have very poor skills and knowledge, and they have to spend a lot of resources to train and educate them. One of the recommendations is to create a link between educational institutions *and employers in the area of curriculum development:* before confirming a certain course, the curriculum should be reviewed and discussed with potential employers, and only after their approval the course should be taught in the college.

It is well known, that 20% VAT tax on investments and on the import of capital assets (such as equipment, electronics, etc) creates an additional tax burden and affects the investment decision of the companies. Of course, it would be ideal if import of capital assets were exempt from VAT tax and customs duties. However, if it not possible at all, the government could consider adding ICT industry into the list of privileged companies that are allowed to *pay the VAT by installment*,

according to the accepted depreciation schedule. For example, if a depreciation period of an imported server is 3 years, the company could pay the calculated VAT tax during 3 year period, at 3 equal installments.

All these and other policy recommendations should be implemented as part of a state-private dialogue. The appreciation continues, and there is no doubt that it has created additional (sometimes almost disastrous) challenges for newly emerged Armenian economy, and all available intellectual, financial, and political resources should be mobilized to help Armenian companies overcome this situation.

Appendices

Appendix A. Output of Food Industry of Armenia in Physical Terms

	1985	1997	2001	2002	2003	2004	2005	2006
Meat, 1000 t	70	32	38	38	41	43	47	53
Sausages, t	26,200	40	1,108	1,044	998	841	1,053	1,775
Wholemilk dairy products(in milk equivalent), 1000 t	177	251	197	207	218	279	299	313
Cheese, t	26,000	1,500	4,792	4,819	14,257	14,413	14,403	14,487
Animal butter, t	390	11	13	29	48	44	105	n/a
Vegetable oil, t	6,792	279	262	1,559	2,204	385	289	2,735
Pasta products (macaroni), t	14,000	400	675	1,085	1,196	2,334	2,634	2,981
Groats, t	n/a	n/a	16	12	8	22	1,141	291
Confectionery, t	40,000	1,500	3,085	3,507	3,969	3,964	4,836	7,454
Flour, thsd. t	393	143	114	110	132	147	140	152
Bread and bakery products, 1000 t	312	373	299	294	294	295	295	295
Salt, 1000 t	n/a	n/a	29	30	32	32	35	37
Canned products, 1000 conditional cans/t *	494,000	31,000	38,006	52,571	16,955	7,852	12,103	13,890
of which								
Meat	n/a	n/a	-	-	582	525	1,347	n/a
Fish	n/a	n/a	323	266	226	144	87	n/a
Vegatable	n/a	n/a	751	2,471	1,673	705	996	n/a
Tomato	185,000	11,000	24,441	43,531	12,945	5,396	5,618	n/a
Fruit	216,000	19,000	12,491	6,303	1,529	1,082	4,055	n/a
of which jam, confiture	n/a	n/a	406	551	877	826	827	n/a
Alcohol-free beverages, 1000 liter	44,830	16,360	27,434	26,817	33,183	36,223	31,981	38,409
Natural juices, 1000 liter	n/a	n/a	1,812	2,519	4,248	4,588	4,341	5,971
Cigarettes, mln. units	11,958	815	1,623	2,815	3,222	2,720	3,020	2,825
Mineral water, 1000 liter	147,500	13,000	20,157	18,286	19,542	19,929	24,115	27,240
Alcoholic beverages								
Beer, 1000 liter	60,370	5,040	9,975	7,078	7,312	8,834	10,751	12,618
Vodka, 1000 liter	15,970	5,920	9,456	10,335	10,122	12,878	13,596	12,801
Brandy (cognac), 1000 liter	11,690	3,920	5,026	6,060	7,217	7,333	9,135	9,060
Grape wine, 1000 liter	66,460	3,370	6,394	4,008	2,046	6,224	6,740	3,826
Champagne, 1000 liter	3,280	1,520	582	622	670	569	519	543

**Since 2003 production of canned products have been calculated in tons.*

Source: Statistical Yearbook of Armenia 2006, NSS; Social-Economic Situation in RA January-December, 2006; "Industry" Statistical Collection, NSS, 1997

Appendix B. Mean of Key Variables Obtained during the Survey, 2003-2006

Food Processing companies

year	rev	prof	cap	labor	wagepr	wageadm
2003	413148	54779	163237	43	23	35
2004	494124	39997	189464	51	23	43
2005	466309	48603	202869	63	29	63
2006	559972	64752	173037	71	34	66

Tour Operators

year	rev	prof	cap	labor	wagepr	wageadm
2003	64419	14516	20701	10	45	51
2004	60514	11715	14324	11	52	53
2005	66387	13111	14187	13	63	68
2006	70807	10903	13230	13	72	76

Hotels

year	rev	prof	cap	labor	wagepr	wageadm
2003	316775	107529	413874	58	32	54
2004	402104	120367	514335	61	34	53
2005	316402	89705	644795	68	39	75
2006	316606	126420	1175143	71	46	104

ICT

year	rev	prof	cap	labor	wagepr	wageadm
2003	109591	27133	30523	48	58	128
2004	121564	16629	148931	53	114	106
2005	178755	22780	179223	59	135	148
2006	203816	23906	122773	51	137	158

Notes: *rev – revenue, in thous. of AMD;*

prof – profit, in thous. of AMD;

cap – capital assets, in thous. of AMD;

labor – average number of employees, person;

wagepr – average monthly wage of productive workers, in thous. of AMD

wagepr – average monthly wage of administrative workers, in thous. of AMD

Appendix C. Output of Regression Analysis of TE determinants, IT and Tourism Industries

Model specification 1

Dependent variable: te1 – technical efficiency of IT and Tourism industries obtained from Translog Production Function
Independent variable: Nominal bilateral exchange rate AMD/USD, domestic inflation rate, weighted foreign inflation rate, average work experience, marketing expenses, dummy variables for tour operators and hotels.

```
Random-effects GLS regression                   Number of obs      =        58
Group variable (i): id                          Number of groups   =        17

R-sq:  within  = 0.9679                         Obs per group: min =         1
       between = 0.0001                                        avg =       3.4
       overall = 0.0143                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(7)       =   1058.48
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         te1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        exch |   .0002701   .0000346     7.81   0.000     .0002024    .0003379
        infa |  -.0011503    .001325    -0.87   0.385    -.0037473    .0014466
        inff |  -.0002147   .0077871    -0.03   0.978    -.0154773    .0150478
         exp |   .0005063   .0002398     2.11   0.035     .0000362    .0009763
     marketr |   5.09e-07   4.54e-07     1.12   0.263    -3.81e-07    1.40e-06
        tour |   .0279733   .1471016     0.19   0.849    -.2603406    .3162872
       hotel |  -.0501147   .1657391    -0.30   0.762    -.3749573    .2747279
       _cons |   .3554323   .1186831     2.99   0.003     .1228178    .5880469
-------------+----------------------------------------------------------------
     sigma_u |   .2609599
     sigma_e |  .00330753
         rho |  .99983938   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Model specification 2

Dependent variable: te2 – technical efficiency of IT and Tourism industries obtained from Cobb-Douglas Production Function
Independent variable: Nominal bilateral exchange rate AMD/USD, domestic inflation rate, weighted foreign inflation rate, average work experience, marketing expenses, dummy variables for tour operators and hotels.

```
Random-effects GLS regression                   Number of obs      =        58
Group variable (i): id                          Number of groups   =        17

R-sq:  within  = 0.9534                         Obs per group: min =         1
       between = 0.0086                                        avg =       3.4
       overall = 0.0200                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(7)       =    742.93
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         te2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        exch |   .0000438   6.53e-06     6.70   0.000      .000031    .0000566
        infa |  -.0001404   .0002504    -0.56   0.575    -.0006312    .0003504
```

```
        inff |   .0002289   .0014718     0.16   0.876    -.0026557    .0031136
         exp |   .0000968   .0000453     2.14   0.033     7.95e-06    .0001857
     marketr |   1.24e-07   8.58e-08     1.44   0.149    -4.44e-08    2.92e-07
        tour |   .0578764   .1562754     0.37   0.711    -.2484177    .3641705
       hotel |   .0000625   .1760605     0.00   1.000    -.3450098    .3451349
       _cons |   .4780624   .1068555     4.47   0.000     .2686295    .6874954
-------------+----------------------------------------------------------------
     sigma_u |  .28207267
     sigma_e |    .000636
         rho |  .99999492   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Model specification 3

Dependent variable: te1 – technical efficiency of IT and Tourism industries obtained from Translog Production Function
Independent variable: Real Effective Exchange Rate (REER), average work experience, marketing expenses, dummy variables for tour operators and hotels.

```
Random-effects GLS regression                   Number of obs      =        58
Group variable (i): id                          Number of groups   =        17

R-sq:  within  = 0.9346                         Obs per group: min =         1
       between = 0.0000                                        avg =       3.4
       overall = 0.0151                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(5)       =    500.10
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         te1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        reer |  -.0021411   .0001045   -20.50   0.000    -.0023458   -.0019363
         exp |   .0006226    .000329     1.89   0.058    -.0000222    .0012674
     marketr |   7.91e-07   6.36e-07     1.24   0.213    -4.55e-07    2.04e-06
        tour |   .0278303    .137765     0.20   0.840    -.2421841    .2978447
       hotel |  -.0513877   .1552333    -0.33   0.741    -.3556394     .252864
       _cons |   .6885364    .094103     7.32   0.000      .504098    .8729748
-------------+----------------------------------------------------------------
     sigma_u |  .23759577
     sigma_e |  .00459649
         rho |  .99962588   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Model specification 4

Dependent variable: te2 – technical efficiency of IT and Tourism industries obtained from Cobb-Douglas Production Function
Independent variable: Real Effective Exchange Rate (REER), average work experience, marketing expenses, dummy variables for tour operators and hotels.

```
Random-effects GLS regression                   Number of obs      =        58
Group variable (i): id                          Number of groups   =        17

R-sq:  within  = 0.9220                         Obs per group: min =         1
       between = 0.0087                                        avg =       3.4
       overall = 0.0202                                        max =         4
```

```
Random effects u_i ~ Gaussian                   Wald chi2(5)       =    430.25
corr(u_i, X)       = 0 (assumed)                 Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         te2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        reer |  -.0003383   .0000179   -18.95   0.000    -.0003733   -.0003033
         exp |   .0001125   .0000563     2.00   0.046     2.24e-06    .0002228
     marketr |   1.65e-07   1.09e-07     1.52   0.129    -4.81e-08    3.78e-07
        tour |   .0578545   .1462734     0.40   0.692    -.2288361    .3445451
       hotel |  -.0001084   .1647926    -0.00   0.999    -.3230959    .3228791
       _cons |   .5328573   .0993873     5.36   0.000     .3380618    .7276527
-------------+----------------------------------------------------------------
     sigma_u |  .25720413
     sigma_e |  .00080072
         rho |  .99999031   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Appendix D. Output of Regression Analysis of TE determinants, Food Processing Industry

Model specification 1

Dependent variable: te1 – technical efficiency of Food Processing industry obtained from Translog Production Function

Independent variable: Nominal bilateral exchange rate AMD/USD, domestic inflation rate, weighted foreign inflation rate, average work experience, marketing expenses.

```
Random-effects GLS regression                   Number of obs      =        61
Group variable (i): id                          Number of groups   =        18

R-sq:  within  = 0.9344                         Obs per group: min =         2
       between = 0.0434                                        avg =       3.4
       overall = 0.0044                                        max =         4
Random effects u_i ~ Gaussian                   Wald chi2(5)       =    564.24
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         te1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        exch |   .0000164   2.44e-06     6.70   0.000     .0000116    .0000211
        infa |   .0000148   .0000937     0.16   0.875    -.0001688    .0001984
        inff |   .0003993   .0005416     0.74   0.461    -.0006623    .0014609
         exp |    .000027   .0000199     1.36   0.175     -.000012     .000066
     marketr |  -4.10e-09   5.20e-09    -0.79   0.431    -1.43e-08    6.10e-09
       _cons |   .2681958   .0628235     4.27   0.000     .1450639    .3913276
-------------+----------------------------------------------------------------
     sigma_u |  .27152788
     sigma_e |  .00025974
         rho |  .99999908   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Model specification 2

Dependent variable: te1 – technical efficiency of Food Processing industry obtained from Translog Production Function

Independent variable: Real Effective Exchange Rate (REER), average work experience, marketing expenses.

```
Random-effects GLS regression                   Number of obs      =        61
Group variable (i): id                          Number of groups   =        18

R-sq:  within  = 0.9121                         Obs per group: min =         2
       between = 0.0581                                        avg =       3.4
       overall = 0.0074                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(3)       =    425.23
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         te1 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       reer1 |  -.0001198   7.05e-06   -16.99   0.000    -.0001337    -.000106
         exp |   .0000339   .0000225     1.51   0.131    -.0000101    .0000779
     marketr |  -7.36e-09   5.82e-09    -1.27   0.206    -1.88e-08    4.04e-09
       _cons |   .2899901   .0613354     4.73   0.000     .1697749    .4102054
-------------+----------------------------------------------------------------
     sigma_u |  .26330417
     sigma_e |   .0002929
         rho |  .99999876   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Appenidix E. Output of Tobit models

IT Industry

1. Dependent variable: te1 – technical efficiency of IT and Tourism industries obtained from Translog Production Function

```
Obtaining starting values for full model:

Iteration 0:   log likelihood = -339.19909
Iteration 1:   log likelihood = -338.09634
Iteration 2:   log likelihood = -338.02567
Iteration 3:   log likelihood = -338.02453
Iteration 4:   log likelihood = -338.02453

Fitting full model:

Iteration 0:   log likelihood = -209.42266
Iteration 1:   log likelihood = -209.15759
Iteration 2:   log likelihood = -208.49901
Iteration 3:   log likelihood = -208.41576
Iteration 4:   log likelihood = -208.41301
Iteration 5:   log likelihood =   -208.413

Random-effects tobit regression                 Number of obs      =        27
Group variable (i): id                          Number of groups   =         8

Random effects u_i ~ Gaussian                   Obs per group: min =         2
                                                               avg =       3.4
                                                               max =         4

                                                Wald chi2(1)       =     25.39
Log likelihood  =   -208.413                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      export |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         te1 |     244478   48519.54     5.04   0.000     149381.4    339574.5
       _cons |  -64415.22   28943.82    -2.23   0.026    -121144.1   -7686.377
-------------+----------------------------------------------------------------
    /sigma_u |   102806.7   9953.772    10.33   0.000     83297.65    122315.7
    /sigma_e |   47056.11   8959.238     5.25   0.000     29496.33    64615.89
-------------+----------------------------------------------------------------
         rho |   .8267862   .0559387                      .6961766    .9146014
------------------------------------------------------------------------------

  Observation summary:        16     uncensored observations
                              11  left-censored observations
                               0 right-censored observations
```

2. Dependent variable: te2 – technical efficiency of IT and Tourism industries obtained from Cobb-Douglas Production Function

```
Obtaining starting values for full model:

Iteration 0:   log likelihood = -339.15012
Iteration 1:   log likelihood = -338.03716
Iteration 2:   log likelihood = -337.95508
Iteration 3:   log likelihood =  -337.9536
Iteration 4:   log likelihood =  -337.9536

Fitting full model:

Iteration 0:   log likelihood = -209.21367
Iteration 1:   log likelihood =    -208.77
Iteration 2:   log likelihood = -208.39435
Iteration 3:   log likelihood = -208.35855
Iteration 4:   log likelihood = -208.35791
Iteration 5:   log likelihood = -208.35791

Random-effects tobit regression                 Number of obs      =        27
Group variable (i): id                          Number of groups   =         8

Random effects u_i ~ Gaussian                   Obs per group: min =         2
                                                               avg =       3.4
                                                               max =         4

                                                Wald chi2(1)       =     26.37
Log likelihood  = -208.35791                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      export |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         te2 |   243023.3   47327.75     5.13   0.000     150262.6      335784
       _cons |  -66121.35   29029.59    -2.28   0.023    -123018.3   -9224.399
-------------+----------------------------------------------------------------
    /sigma_u |   102511.1   9812.481    10.45   0.000     83278.99    121743.2
    /sigma_e |   46441.68   8862.952     5.24   0.000     29070.61    63812.75
-------------+----------------------------------------------------------------
         rho |   .8297063   .0553546                      .7001194    .9164015
------------------------------------------------------------------------------

  Observation summary:        16     uncensored observations
                              11  left-censored observations
                               0 right-censored observations
```

Food Processing Industry

Dependent variable: te1 – technical efficiency of Food Processing industry obtained from Translog Production Function

```
Obtaining starting values for full model:

Iteration 0:   log likelihood = -924.25177
Iteration 1:   log likelihood = -924.19565
Iteration 2:   log likelihood = -924.19544

Fitting full model:

Iteration 0:   log likelihood = -690.76796
Iteration 1:   log likelihood =  -687.0899
Iteration 2:   log likelihood = -686.42755
Iteration 3:   log likelihood = -686.37083
Iteration 4:   log likelihood = -686.36997
Iteration 5:   log likelihood = -686.36997

Random-effects tobit regression                 Number of obs      =        69
Group variable (i): id                          Number of groups   =        20

Random effects u_i ~ Gaussian                   Obs per group: min =         2
                                                               avg =       3.5
                                                               max =         4

                                                Wald chi2(1)       =     20.51
Log likelihood  = -686.36997                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
      export |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         te1 |   743663.2   164192.9     4.53   0.000       421851     1065475
       _cons |  -147614.9   68387.89    -2.16   0.031    -281652.7   -13577.11
-------------+----------------------------------------------------------------
    /sigma_u |   156953.4   41315.08     3.80   0.000     75977.33    237929.5
    /sigma_e |   153072.1   17413.61     8.79   0.000       118942    187202.1
-------------+----------------------------------------------------------------
         rho |   .5125175     .14852                       .242388    .7767924
------------------------------------------------------------------------------

  Observation summary:        50     uncensored observations
                              19  left-censored observations
                               0 right-censored observations
```

Appenidix F. Output of Regression model

Tourism Industry

Dependent variable: prof – reported accounting profit of tour operators and hotels
Independent variable: te1 – technical efficiency obtained from Translog Production Function, hotel - dummy variables for hotels.

```
Random-effects GLS regression                   Number of obs      =        41
Group variable (i): id                          Number of groups   =        11

R-sq:  within  = 0.0030                         Obs per group: min =         2
       between = 0.4878                                        avg =       3.7
       overall = 0.2743                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(2)       =      6.41
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0406

------------------------------------------------------------------------------
        prof |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         te1 |   416177.7   193381.3     2.15   0.031     37157.25    795198.2
       hotel |   164544.4   85389.84     1.93   0.054    -2816.643    331905.4
       _cons |  -232723.9   129731.3    -1.79   0.073    -486992.5    21544.74
-------------+----------------------------------------------------------------
     sigma_u |  128448.33
     sigma_e |  80894.634
         rho |   .7160107   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Dependent variable: prof – reported accounting profit of tour operators and hotels
Independent variable: te2 – technical efficiency obtained from Cobb-Douglas Production Function , hotel - dummy variables for hotels.

```
Random-effects GLS regression                   Number of obs      =        41
Group variable (i): id                          Number of groups   =        11

R-sq:  within  = 0.0032                         Obs per group: min =         2
       between = 0.4150                                        avg =       3.7
       overall = 0.2180                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(2)       =      5.26
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0722

------------------------------------------------------------------------------
        prof |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         te2 |     426704   223108.4     1.91   0.056    -10580.43    863988.5
       hotel |   158213.3    90090.3     1.76   0.079     -18360.4    334787.1
       _cons |  -261552.4   157947.1    -1.66   0.098      -571123    48018.26
-------------+----------------------------------------------------------------
     sigma_u |  138338.29
     sigma_e |  80884.039
         rho |  .74523748   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Food Processing Industry

```
Random-effects GLS regression                   Number of obs      =        75
Group variable (i): id                          Number of groups   =        21

R-sq:  within  = 0.0294                         Obs per group: min =         2
       between = 0.2240                                        avg =       3.6
       overall = 0.2063                                        max =         4

Random effects u_i ~ Gaussian                   Wald chi2(1)       =      5.37
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0205

------------------------------------------------------------------------------
        prof |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         te1 |   275796.3   119000.3     2.32   0.020     42559.96    509032.6
       _cons |     -23838   45633.38    -0.52   0.601    -113277.8    65601.77
-------------+----------------------------------------------------------------
     sigma_u |  138198.63
     sigma_e |  55290.772
         rho |  .86202027   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

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