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Analysis of Technical Efficiency: Lessons and Implications for Wheat Producing Commercial Farms in Ethiopia

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Abstract

This paper analyzes technical efficiency of wheat production under commercial farms in Ethiopia. The study also attempted to determine some farm specific, institutional and socio-economic characteristics which influence technical efficiency of wheat production. A stochastic frontier model is applied on cross sectional data of 32 commercial farms that were surveyed during 2010 production year. Cobb-Douglas type production function was found to best fit the data set. The maximum likelihood estimates of the stochastic frontier production function indicated that the elasticities of output with respect to seed, agrochemicals, tractor hours and DAP are positive and significant. On the contrary, the coefficients of area and labour are negative and significant. The production function associated with the commercial farms was characterized by constant returns to scale. The mean technical efficiency of wheat production is 82 percent. It was also revealed that 99 percent of the variations in wheat output from the best practice are due to inefficiency. Factors significantly affecting efficiency level of the commercial farms are found to be experience of managers, distance of the farm from main road, value of farm machineries owned by the farms and provision of mechanization services by the farms. Average age of farm machineries is the only factor that has a significant negative effect on the level of technical efficiency.

Key words: Technical efficiency, Stochastic Frontier model and Returns to scale

1. Introduction

In Ethiopia, agriculture is viewed as the engine of growth based on its potentially superior growth linkages, employment and market creation, provision of raw materials and foreign exchange generation. The apparent domination of agriculture connote growth of Ethiopian economy heavily depends upon the speed with which agricultural growth is achieved (Lulit 2010). Accordingly, Ethiopia follows Agriculture Development Lead Industrialization (ADLI) strategy that aims to strengthen the dependence between agriculture and industry by increasing the productivity of peasant farmers, expanding large scale private commercial farms and by reconstructing the manufacturing sector in such away that it can make use of the country's natural and human resources.

Currently investment in agriculture sector is found to be more attractive and profitable in diverse sub-sectors ranging from food products, industrial raw materials to bio-fuel. The Ministry of Agriculture and Rural Development has given the responsibility of providing technical support for private sector in agriculture development to the Agricultural Extension Department through the Private Support Team (MoARD 2009). The support ranges from providing information, technical support, and facilitation of other public services as long as they are related to the success of the investment project.

The private sector has involved in the agro-industry sector and promote the out growers scheme of development. In November 2009, the Ethiopian government formally announced a policy of encouraging the growth of commercial agriculture in a bid to increase exports and farm productivity. A central feature of this new policy was the preliminary allocation of 2.9 million hectares for commercial agricultural ventures. To give a sense of perspective, the amount allocated comprises 3 percent of Ethiopia's total land area, 4 percent of the total arable land in the country and close to 17 percent of the total land under cultivation (Access Capital 2010).

Large numbers of state and private grain producing commercial farms operate in Bale zone of Ethiopia. Large scale farming system requires bringing extensive areas of land under crop cultivation with the use of modern agricultural inputs, modern technology and hired labor contrary to family labor in the small scale farming systems. In addition, this type of farming requires large amount of capital to undertake farming activity. Despite these facts, little has been done, if any, to analyze whether the existing commercial farms are producing the maximum possible output given their resource bases and technology which of course should be the first logical step to be adopted in order to improve their production and productivity.

2. Objectives of the Study

The main objectives of this empirical study are:

1. To analyze the mean level of technical efficiency of wheat producing commercial farms in Bale Zone of Ethiopia.

2. To identify the factors that affect technical efficiency of commercial farms in the study area.

3. Methodology

3.1 Overview of the Study Area

Bale zone is located between latitude 5^{0} 22'- 8^{0} 08'N and longitudes 38^{0} 41'- 40^{0} 44'E. It is bounded with Somalia National Regional State in East, West Harar and Arsi zone in North, West Arsi in west and Guji in South. The total land coverage of Bale Zone is 62 711 km^{2} which ranked Bale as the first largest zone in Oromia National regional State in Ethiopia.

The annual mean temperature of Bale zone is 17.5^{0}c. The maximum and minimum temperatures are 25^{0}c and 10^{0}c respectively. In most of Bale region rainfall distribution is bimodal with the annual total of approximately 850 mm split roughly between *Belg* (from March to May) and *Meher* (from June to October). Both seasons are suitable for wheat (*Triticum Aestivum*) and Barley (*Hordem Vulgare L.*) production. Maximum and minimum annual rain fall recorded in the zone are 1 200 mm and 550 mm respectively.

3.2 Types and Sources of Data

Primary and secondary data sources were used to generate production, agronomic, socio-economic and institutional information used in this study. The primary data were based on the 2010 farming season collected from commercial farms in Bale zone of Ethiopia. To this effect structured questionnaire was prepared to collect data from commercial farms. The process of primary cross sectional data collection was conducted through multiple visits to sample commercial farms which paved the way to gather timely and reliable information on the overall farming operations. This is, because it is better inquiring farm managers about a particular operation at the time of the real operation than recall data at the end of the cropping season. This study also made use of secondary data from records of commercial farms, governmental and non governmental institutions and published and unpublished documents mainly for descriptive purposes.

3.3 Sampling Design

The commercial farms sampling involves two stages. First, 4 *woredas* (Gihnir, Gasera, Sinana and Agarfa) were purposively selected from Bale zone based on the concentration of commercial farms in the specified areas. Second stage involves randomly selecting wheat producing commercial farms from these 4 *Woredas* using proportional percentage on the considered total number of sample commercial farms, 32. Accordingly, 19, 7, 4 and 2 sample commercial farms were selected from Gihnir, Gasera, Sinana and Agarfa *woredas* respectively.

3.4 Specification of the Empirical Model

Stochastic frontier analysis was introduced by the pioneering work of Aigner *et al.* (1977) and Meeusen & Van den Broeck (1977). The method allows us to decompose deviations of actual observed output from the estimated frontier into random deviations and inefficiency. The stochastic frontier for a sample data of *n* firms is defined by:

$$Y_i = f(x_i, \beta).\, e^{v_i - u_i} \qquad (1)$$

Where, i= (1,2,3,...,n) are the number of sample farms. Y_i denotes wheat output for the i^{th} farm. f (.) is the appropriate functional form. x_i is (1xK) row vector, with the first element equal to 1, of input quantities used by the i^{th} farm. β is (Kx1) column vector of unknown parameters, which includes the intercept term, to be estimated. u_i is non-negative random variable which captures technical inefficiency of the i^{th} farm. v_i is two-sided error term which captures random shocks in the production of the i^{th} farm.

Generally, the two-step approach and the 'direct' or one-step approach appears to be the two major methods that could be pursued in identifying the factors affecting technical inefficiency. Previously, technical efficiency (TE) was estimated using a two-stage process. First, was to measure the level of efficiency/inefficiency using a normal production function. Second, was to determine socio-economic characteristics that determine levels of technical efficiency using a probit model. Due to inconsistent assumptions of the two-step procedure, the 'direct' or ‘one step’ approach is used in this empirical work to incorporate those exogenous factors directly in the production frontier model. Besides, as stated by Battese *et al.* (1989), such variables may have a direct impact on production.

$$\mu_i = Z_i + w_i \qquad (2)$$

Where, μ_i is inefficiency effects.

Z_i is a 1×M vector of variables which may influence efficiency of i^{th} farm. δ is an M×1 vector of unknown parameters to be estimated (which would generally be expected to include an intercept parameter). w_i is random error term such that μ_i is obtained by a non negative truncation of $N(Z_i\delta, \sigma_u^2)$.

The technical efficiency of production of the i^{th} farm in the data set, given the level of inputs, is defined by the conditional expectation evaluated at the maximum likelihood estimates of the parameters in the model, where the expected maximum value of Y*i* is conditional on u_i =0 (Battese & Coelli 1988). The measure of TE*i* must have a value between zero and one.

$$TE_i = E(Y_i | u_i, X_i) / E(Y_i | u_i = 0, X_i) = e^{-ui} = \exp(-Z_i\delta - w_i) \qquad (3)$$

Given the specifications of the stochastic frontier model expressed in Equations (7) and (8), the stochastic frontier output (potential output) for the i^{th} farm is the observed output divided by the technical efficiency, TE*i*, expressed as:

$$Y^* = Y_i / TE_i = E(X_i\beta + v_i - u_i) / E(-u_i) = \exp(X_i\beta + v_i) \qquad (4)$$

In their article, Bravo-Ureta, *et al*. (1993) suggested that the stochastic frontier production function could be established in two ways. First, if no explicit distribution for the efficiency component is made, the estimation is using a stochastic version of corrected ordinary least squares (COLS). However, if an explicit distribution is assumed, such as exponential, half-normal or gamma distribution, then the frontier is estimated by maximum likelihood estimates (MLE). According to Greene (1993), MLE makes use of the specific distribution of the disturbance term and this is more efficient than COLS. For this work, ML estimates was used which require distributional assumptions for the composed error term. u_i are non-negative random variables assumed to account for technical inefficiency in production and to be independently distributed as truncations at zero of the $N(\mu_i, \sigma^2)$ where μ_i is defined by inefficiency model. And v_i is random variable that will be assumed to be identically distributed as N $(0, \sigma_v^2)$ representing the usual random shocks and is independent of u_{ij}.

We followed Battese & Coelli (1995) using Battese & Corra (1977) parameterization. The maximum likelihood (ML) estimates of the production function (7) are obtained from the following log likelihood function;

$$\ln L = N/2\ln(\pi/2) - N/2\ln\sigma^2 + \sum_{i=1}^{N}\ln\left[1 - F\left(\varepsilon_i\sqrt{\gamma}/\sigma\sqrt{1-\gamma}\right)\right] - 1/2\sigma^2\sum_{i=1}^{N}\varepsilon_i^2 \quad (5)$$

Where, ε_i are residuals based on ML estimates, N is the number of observations, F(.) is the standard normal distribution function, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2/\sigma^2$

Measurement of farm level inefficiency requires the estimation of non-negative error u_i . Given the assumptions on the distribution of u_i and v_i , Jondrow *et al.* (1982) first derived the conditional mean of u_i given ε_i . Battse & Coelli (1988) drive the best predictor of the technical efficiency of i^{th} farm as,

$$E\left[\exp(u_i|\varepsilon_i\right] = \left[1 - F(\sigma_A + \gamma\varepsilon_i/\sigma_A)/1 - F(\gamma\varepsilon_i/\sigma_A)\right]\exp(\gamma\varepsilon_i + \sigma_A^2/2) \quad (6)$$

Where, $\sigma_A = \sqrt{\gamma(1-\gamma)\sigma^2}$. The maximum likelihood estimates of the production function in equation (1) and technical inefficiency effects in equation (2) were simultaneously estimated in a single step procedure using a computer program FRONTIER Version 4.1 written by Coelli (1996). FRONTIER provides estimates of β, σ^2, γ and average technical efficiencies and farm level efficiencies.

3.5 Selection of Functional Form

One of the key matters that arise, which is not unique to frontier studies, concerns the choice of functional form in the stochastic frontier models. Cobb-douglas functional form best fits the commercial farms data set. In a Cobb-Douglas production function, the sum of *β's*, $\beta_1 + \beta_2 + \beta_3 + \ldots$, is the degree of homogeneity, which measures whether the production function is constant ($\beta_1 + \beta_2 + \beta_3 + \ldots = 1$), Increasing ($\beta_1 + \beta_2 + \beta_3 + \ldots > 1$), or decreasing ($\beta_1 + \beta_2 + \beta_3 + \ldots < 1$) returns to scale (Palanisami *et al.*, 2002). Returns to scale refer to the change in output when all the inputs are changed proportionately. For a given proportional increase of all inputs, if output is increased by the same, larger and smaller proportions there are constant, increasing and decreasing returns to scale respectively (Varian, 2005).

Thus Cobb-Douglas frontier function for the commercial farms was specified as;

$$\begin{aligned}\ln(output) &= \beta_0 + \beta_1\ln(Area) + \beta_2\ln(Seed) + \beta_3\ln(ValAgChm) + \beta_4\ln(Lab) + \\ &\quad \beta_5\ln(Trahrs) + \beta_6(Dap) + \beta_7\ln(Urea) + v_i - u_i \end{aligned} \quad (7)$$

Where, Output - is the total output of wheat obtained from the i^{th} farm in quintal.

Area- is the area of the i^{th} farm which was covered with wheat in hectare.

Seed- is the amount of wheat seed applied on the i^{th} farm in quintal.

ValAgChm- value of wheat protection agrochemicals (herbicides, pesticides and fungicides) in Birr sprayed on the i^{th} farm during the production season.

Labour- the total pre-harvest labor force in man-days used on the i^{th} farm.

Tractor hours- pre-harvest tractor hours used on i^{th} farm.

Dap- the total amount of DAP applied on i^{th} farm in quintal.

Urea- total amount of Urea fertilizer applied on i^{th} farm in quintal.

v_i and u_i are as specified above.

The inefficiency effects model for the commercial farms, which was analyzed in one step procedure along with equation 7, is specified as;

$$\mu_i = \delta_0 + \delta_1 Edu + \delta_2 OwnS + \delta_3 Exp + \delta_4 Dis + \delta_5 ValMach + \delta_6 AgeMach + \delta_7 MecSer + \delta_8 Off + w_i \quad (8)$$

Where,

Edu - is the education level of the farm manager measured in terms of formal years of schooling.

OwnS- is the ownership status of the farm which would be 1 if private owned and 0 state owned.

Exp - is the measurement of the manager's experience in years.

Dist- is the distance of the farm from the main road in Km.

ValMach- value in birr of the agricultural machineries (tractors, combine-harvesters and chemical sprayers) that were functional during the production season.

AgeMach- the average age of the functional agricultural machineries (tractors, combine-harvesters, planting equipments and chemical sprayers) in the farm during the study period.

MecSer- is a dummy variable which would take 1 if the farm provides mechanization services to the surrounding community and 0 otherwise.

Off- is off-farm activity engagement of the manager defined as a dummy variable which would take 1 if the manager had other engagements and 0 other wise.

w_i is as specified in equation (2).

4. Results from the Econometric Model Analysis

4.1 Hypotheses Tests

These various tests of null hypotheses for the parameters in the frontier production functions and in the inefficiency models are performed using the generalized likelihood-ratio test statistic defined by: $\lambda_{LR} = -2\{\ln[L(H_0)] - \ln[L(H_1)]\}$, where ln[L(H_O)] and ln[L(H_1)] denote the values of the likelihood function under the null (H_0) and alternative (H_1) hypotheses, respectively. Given that the null hypothesis is true, λ_{LR} has an approximate χ^2 –distribution. H_O is rejected when $\lambda_{LR} > \chi^2_C$, where χ^2_C is a chosen critical value.

The first null hypothesis is regarding the distribution assumption that the inefficiency component of the random error term follows. (H_0: μ = 0) specifies that a simpler half-normal distribution is an adequate representation of the data, given the specifications of the generalized truncated-normal distribution. The test statistic of 6.64 leads to rejection of the null hypothesis at 5 percent level of significance and therefore truncated normal distribution is more appropriate for the commercial farms data.

The second null hypothesis explores H_0: $\gamma = 0$, which specifies that the technical inefficiency effects are not present in the model i.e. wheat producing commercial farms are efficient and have no room for efficiency improvement. The resulting likelihood ratio test of 45.2 leads to rejection of the null hypotheses in favor of the presence of inefficiency effects in the model at 5 percent level of significance. Thus, the traditional average response function is not an adequate representation of the data. Therefore, the inclusion of the technical inefficiency term is a significant addition to the model.

The third null hypothesis which is tested is; H_0: $\delta_1 = \delta_2 = \delta_3 = \ldots\ldots \delta_8 = 0$ implying that the farm-level technical inefficiencies are not affected by the farm-oriented variables, policy variables, institutional and/or socio-economic variables included in the inefficiency model. This hypothesis is also rejected, implying the variables present in the inefficiency model have collectively significant contribution in explaining technical inefficiency effects. The results of a likelihood ratio test (λ_{LR}=41.78) shows that farm, institutional and policy related variables that are included in the commercial farms' model have a significant collective impact on technical inefficiency of the farms.

The fourth null hypothesis specifies the Cobb Douglas specification exhibit constant returns to scale, H_0: $\Sigma\beta_i = \beta_1 + \beta_2 + \beta_3 + \ldots = 1$. The test statistic of 3.1 leads to the acceptance of the null hypothesis and hence their production structure is characterized by constant returns to scale.

4.2 Parameter Estimates of the Frontier Model

A one step process was used to estimate technical efficiency using the maximum Likelihood method. Prior to estimation, the prevalence of multi-collinearity was checked for both the continuous and dummy variables entered in to the SPF model. The VIF values of all continuous variables entered in to the models were below ten, which is an indicator for the absence of severe multi-collinearity among the proposed continuous variables given the specification of Cobb-Douglas functional form. Similarly, contingency coefficients for dummy variables in inefficiency effects model are less than 0.75 indicating the absence of strong relationship between the dummy variables.

The coefficient estimate of returns to scale for wheat production is 0.998 and significant at 1 percent probability level. This is similar to the accepted hypothesis that specifies the production of wheat under the commercial farms exhibit constant returns to scale.

Coefficients for land and labour have negative sign at 1 percent and 10 percent probability level respectively indicating, *citrus paribus*, an increase in land and labour by one percent each will cause wheat output to decrease by 1.29 and 0.03 percent respectively. This could probably mean that land and labor are used relatively more than the other accompanying inputs. Moreover, use of land unless accompanied by fertility improvement mechanisms will decrease wheat production. Other factors that may lead to such negative relationship between land and output include farm area measurement errors and unobservable variations in farms' land quality. The negative relationship between output and land in production processes has also been observed in other studies elsewhere in Ethiopia. Tsegaye & Ernst (2002) using data from Jima reached at the result that citrus paribus, maize production declines with the increase in the area of maize. The negative sign of labour might be associated with human damages on wheat crop especially during weeding and chemical spraying practices.

Coefficient for seed have the expected positive sign and significant at 10 percent level of probability. This means, *citrus paribus,* a one percent increase in seed will result 0.3 percent increase in wheat output. A positive and 1 percent level significant parameter of plant protection chemicals (herbicides, pesticides and fungicides) means that the wheat output increases with increase in the value of agro chemicals applied on farms, other factors remaining the same. This high effect of crop protection chemicals on intensive agriculture in the study area is probably an indication to the effect of deficiency in crop rotation.

High and positive elasticity coefficients of DAP and tractor hours indicates, keeping other things constant, a 1 percent increase in tractor hours and DAP will result in 0.9 and 1.1 percent increase in wheat output respectively. Chemical fertilizers are quite high in nutrients which are soluble and immediately available to the plants; therefore the effect is usually direct and fast. Knowledge about their importance may not be enough. Too much use of DAP and Urea makes the plant susceptible to insects and weed infestation (Rahnavard *et al.* 2009). In the study area, the recommended rates of applications for DAP and Urea are 100 kg/ha and 50 kg/ha respectively. Tractors allow timely operations of agricultural activities. The use of tractor is not limited to ploughing and seed and/or fertilizer sowing. Recently, using tractor for chemical spraying on wheat farms is receiving paramount attention from farm managers. Tractor trailed chemical sprayers increase the effectiveness of the chemical/s as it would be evenly distributed across the wheat field.

4.3 Technical Efficiency Estimates

The result indicated that the average technical efficiency score of the commercial farms is 81.9 percent, ranging between 29 and 99 percent. This implies that, on average, the commercial farms produced about 82 percent of wheat output that is attainable by best practice, given the current level of production inputs and technology. This suggests that, on average, wheat producing commercial farms could increase their production by as much as 18 percent through more efficient use of production inputs. Therefore, improvement of technical efficiency should be the first logical step for a considerable increase in wheat production and productivity in Bale zone. Besides, considering the potential for increasing production by using more resources like land is limited.

4.4 Actual visa-vis Potential Level of Wheat Output

Another important result in the analysis is the variance ratio parameter γ has a value of 0.99. This parameter was found to be significant at one percent level expressing that about 99 percent of wheat output deviations are caused by differences in farm's level of technical efficiency as opposed to the random variability that are outside their control. Applying equation 4, the potential attainable level of wheat output (in quintal) had farms used the available resources in an efficient manner was calculated using the actual observed individual farms wheat output and the predicted individual technical efficiency from the frontier models. The mean levels of both the actual and potential wheat outputs of the commercial farms during the production season were 22.4 qt/ha and 27.6 qt/ha, with the standard error of 6.2 and 9, respectively. Therefore, under the existing practices there is production variability and hence a room to increase wheat output following the best-practiced operations in the study area.

4.5 Determinants of Technical Efficiency

So far**,** the analysis has only focused on the stochastic frontier part of the model. This section reports on those sources of inefficiency related to farm-oriented, institutional and/or socio-economic variables which are also estimated simultaneously with the elasticity estimates.

The coefficient of managers' experience is estimated to be positive as expected and statistically significant at the 1 percent level. The implication is that farm managers with more years of experience tend to be more efficient in wheat production. It is possible that such farm managers gained more years of farming experience through "learning by doing," and thereby becoming more efficient.

The positive and 1 percent level significant coefficient of distance of the farm from the main road was unexpected. However, there are probable logical explanations about it. One, many of the 'far' farms were recently organized so that they possess land that was left fallow for a significant number of years. Therefore, the soil of these farms has rich nutrients that could enhance wheat yield. The other is, managers of such 'far' farms reside in the operational site during main agricultural activities and thus they made sure the right thing was done at the right time. As a result, farms that are distant from the main road are more efficient.

It was hypothesized that farms with a higher value of agricultural machineries will operate closer to the frontier. The coefficient of this variable shows the same result as hypothesized and statistically significant at 1 percent probability level. The reason behind it could be the fact that farms that are equipped with farm machineries can perform the different agricultural production activities on time. Especially in rain fed agriculture, like we have in the study area, it is comprised of time bounded activities. The success of farms significantly relies on scheduled cultural practices. This can only be achieved if the farm has a reliable access to different farm machineries that are required for specific agricultural activities.

The coefficient of age of farm machineries has a negative sign and statistically significant at 1 percent level implying farms with old farm machineries are less technically efficient in wheat production than farms with relatively new machineries. Old machineries are usually blamed for wasting inputs or outputs at their times of operations. Old machineries also waste more time in repair and maintenance being so shared large part of the farms' asset that otherwise would be used for productive purposes. Farms that possess farm machineries aging greater than the mean, 7 years, scored lower level of technical efficiency than those whose machineries' ages are less than the mean. The mean technical efficiency difference between them is statistically significant at one percent.

The positive and 10 percent level significant coefficient of the mechanization services variable indicates, farms that provide machinery rental services of different agricultural operations to the surrounding community are technically more efficient than those who do not. The reason could be, such farms are usually programmed since they should use the machineries on their farms first to complete the particular operation and sale the service to others afterwards. Moreover, the additional income they earn will most likely supplement cash requirements of the farm. The mean efficiency difference between farms that provide mechanization service and those that do not is 8 % and statistically significant at 10 percent probability level.

5. Conclusions

A stochastic frontier approach was employed to set out the level of technical efficiency and simultaneously determine the farm specific, socioeconomic and institutional factors that affect level of efficiency of commercial farms in Ethiopia. A survey was carried out to collect cross sectional data in 2010 production season. The Cobb-Douglas production frontier was estimated using maximum likelihood to obtain asymptotically efficient and consistent parameter estimates and determinants of inefficiency. The diagnostic statistics confirmed the relevance of stochastic function, presence of one sided error component, and that a classical regression model of production based on ordinary least square estimation would be inadequate representation of the data.

Wheat production under the commercial farms exhibit constant returns to scale. The technical efficiency scores of the wheat producing commercial farms range between 29 and 99 percent with a mean value of 82 percent. The empirical findings also revealed that 99 percent of the variation in wheat output from the frontier is due to inefficiency. Thus, there is considerable scope to expand wheat output and hence productivity by increasing production efficiency at the relatively inefficient farms and sustaining the efficiency of those operating at or closer to the frontier.

A close examination of the relationship between technical efficiency and the various factors that are assumed to determine inefficiency indicated that experience of managers, distance of the farm from main road, current value of farm machineries and provision of mechanization services by the farms have positive and significant impact on technical efficiency of the farms' wheat production. On the contrary, average age of farm machineries is the only parameter that significantly reduces their technical efficiency.

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Table 1. Technical Efficiency Scores

No. of Farms	TE Scores	No. of Farms	TE Scores	No. of Farms	TE Scores
1	0.9603	12	0.9031	23	0.4558
2	0.7105	13	0.8253	24	0.2908
3	0.7745	14	0.9237	25	0.7148
4	0.8082	15	0.9569	26	0.9629
5	0.9727	16	0.9750	27	0.6734
6	0.8492	17	0.9132	28	0.7304
7	0.9108	18	0.4650	29	0.9291
8	0.7122	19	0.6781	30	0.9448
9	0.9922	20	0.8910	31	0.9471
10	0.9787	21	0.8112	32	0.9588
11	0.9836	22	0.5934		