ANALYSIS OF TECHNICAL INEFFICIENCY OF FOOD AND TEXTILE INDUSTRIES IN CENTRAL JAVA PROVINCE

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Abstract:
Considering three linear CES frontier production models and their technical inefficiency measurement, this paper analyses the low of the human resources quality in food and textile industries in Central Java Province. The assumptions of the models are time varying and half normal distribution of the data assumptions. Comparison of the capital-production labor model to the capital-nonproduction labor and production labor-nonproduction labor models shows that the most important variable is capital, and the least important variable is nonproduction labor that indicating the low of the human resources problem. The indication is not supported by the time-to-time technical inefficiency comparison, but is supported by the incremental technical inefficiency comparison. Stakeholders of food and textile industries in Central Java Provinces should participate to solve the human resources quality problem. If the human resources quality problem solved, then the industrial technical inefficiency decreases. The stakeholders are government, firms, labors and their associations, and universities. The participations should be focused on natural industrial growth and qualified labor relationship. Cooperation among them solves the industrial problems, reindustrializes and revitalizes industries.

Keywords: CES, Frontier, Inefficiency, Labor Quality, Industries

Introduction

Pitt and Lee (1981) for example, analysed weaving industry technical efficiency. Others analyses were done by Hill and Kalirajan (1993), Battese, Rao and Walujadi (2001) and Margono and Sharma (2014).

Technical efficiency of Indonesian textile and food industries however, is not analysed yet. The fact that the industries are and will be treated as leading industry does not encourage research of its technical efficiency. Also, the presence of problems such as the low human resources quality does not encourage research of its technical efficiency. Textile and food industries as a leading industry can be known from Indonesian Development Acceleration and Widening Master Plan (Masterplan Percepatan dan Perluasan Pembangunan Indonesia= MP3EI) information issued by Ministry of Economic coordination (2011: 76-79). One of development corridors is Java Island Corridor, whereas one of the leading sectors in Java Islandcorridor is textile and food industries. Problems facing by the food and textile industries are the low of the human resources quality. This problem can be known from analysed done by Hastuti et.al (2011: vii). It is written that the sources of the problem are their low level of education that they are graduated from secondary school and their mainstays to work that they rely on physical mainstays. Wajdi (2012) analysed the small role of labor in the small scale industry. Analysis done by Riyardi and Setiaji (2014) also indicates the problem of the low quality. Even the problem causes difficulty in physical capital renewing and investment.

It is important to analyse the technical efficiency of food and textile industries. The analysis informs the discrepancy between the frontier and the actual efficiencies. The technical inefficiency can be measured. Also, the analysis can be used to indicate the low human resources quality as the source of technical inefficiency. The lower is the human resources quality; the higher is the technical inefficiency. This analysis tries to address all of them.
Two main properties color the analysis. The first property is the CES production function. The second property is the indirect technique to analyse the low human resources quality as a source of technical inefficiency. Three CES functional forms are established to analyse the relationship between production labor, nonproduction labor, capital and output produced in the food and textile industries. The CES production function used is different to the production function usually used in the stochastic frontier approach. For example, it is different to the Cobb-Douglas production function such as employed by Baten, Kamil and Fatama (2009). Also, it is different to the translog production functions such as employed by Mustapha and Thalib (2007). The indirect technique is not a usual technique to analyse the source of technical inefficiency, but it is used because the low of the human resource quality as the source of the technical inefficiency cannot be measured quantitatively. The indirect technique is done by a comparison among three CES functional forms. The properties cause the analysis is different to the previous analyses.

**Measuring Technical Inefficiency using Stochastic Frontier Model**

Measuring technical inefficiency is measuring the rest of the technical efficiency. Jondrow et al. (1982) proposed a method to estimate the technical inefficiency based on the stochastic frontier production function. The observation level of technical inefficiency estimation can be drawn from its data distribution. The half-normal and exponential data distribution casesproof that the technical inefficiency can be estimated. The method enables the stochastic frontier production function to be used in hand to estimate the technical inefficiency.

Constant Elasticity of Substitution (CES) Production Function is one of many functional forms of production function. Proposed by Arrow et al.(1961) the CES production function has two important features. The first is the nonlinear feature. The second is the elasticity of
substitution that is constant. Some researchers tried to measure the elasticity of substitution in the manufacturing industry using the CES production function. Their findings can be divided into three groups. The first group is the inelastic elasticity group, the second group is the elastic elasticity group and the third group is the complex findings group.

Rohmana and Utami (2010) and Danilwan (2010) can be grouped into the first group. Rohmana and Utami (2010) found that the elasticity of substitution between capital and labor of the textile and apparel industries in Indonesia since 1987 until 2008 was 0.43. Danilwan (2010) found that the elasticity of substitution of the ratan industry in the West Java province since 1996 until 2008 was 0.40. Their findings were an inelastic elasticity between labor and capital that indicated the substitution between labor and capital was not easy.

Other observations assuming differential technology across time and countries, developed country and long run elasticity also found that the elasticity of substitution was inelastic. The cross-countries elasticity of substitution found by Claro (2003) was close to one, the elasticity of substitution of some firms in three decades in the Britain as observed by Barnes et al. (2008) was 0.5 and long run elasticity of substitution of some countries found by Pessoa et al. (2005) was 0.7.

The second group includes Ismail and Jajri (2004) and Mawardati (2005). Ismail and Jajri (2004) found that in all Malaysian manufacturing industries the substitution elasticity between the homogenous labor and the capital is higher than unity. Even, it was found that the more intensive is the capital in the industry, the higher is the elasticity of substitution. Also, the finding was analyzed as better than previous findings that found less than unity of the elasticity of substitution. Mawardati (2005) analyzed that the substitution between labor and capital in the
Indonesian food industry was bigger than unity, which indicated the easy condition of the substitution between labor and capital.

The third group includes Salem (1995) and Kalim (2001). They found more than one finding. Observing 1983 to 1994 of 14 industries data in Tunisia, Salem (1995) found that the oil and gas industry and transportation and communication industry had an elastic elasticity of substitution, whereas the textile, clothing and leather industry had a unity of the elasticity of substitution and other 11 industries had an inelastic elasticity of substitution. Observing consumer, intermediate and capital goods industries in Pakistan, Kalim (2001) found that the elasticity of substitution of the consumer goods industry is inelastic whereas the elasticity of substitution of intermediate and capital goods industries is elastic. The consumer goods industry is not recommended as a source for employment policy, and the rest are recommended a source for employment policy. Collison and Legendre (1999) which analyzing data spanned from 1980 until 1987 of 800 French manufacturing firms found that all of the firms can be classified into two groups by their elasticity of substitution. The first group is firms that had a small elasticity of substitution. Their elasticity of substitution is around 0.6. The second group is firms that had a big elasticity of substitution. Their elasticity of substitution is around 0.9.

**Method**

The CES frontier model is applied to estimate the technical inefficiency of food and textile industries in Central Java Province Indonesia. The model is a panel data model. The time series data spans from 2001 until 2010, whereas the food and textile industries is detailed into the sub-industries consist of food, beverage, textile and textile product industries. The model is used to capture relationship between capital, production labor, nonproduction labor and quantity
produced in the industries.

Three linear CES frontier models are prepared. The linear CES frontier models are:

\[ \ln Q_{kl1it} = \alpha_{0l1k} + \alpha_1 K_{it} + \alpha_2 \ln L_{1it} + \alpha_3 [\ln L_{1it} - \ln K_{it}]^2 + \varepsilon_{l1kit} \] ................. (1)

\[ \ln Q_{kl2it} = \beta_{0l2k} + \beta_1 \ln K_{it} + \beta_2 \ln L_{2it} + \beta_3 [\ln L_{2it} - \ln K_{it}]^2 + \varepsilon_{l2kit} \] ................. (2)

\[ \ln Q_{l1l2it} = \theta_{0lk} + \theta_1 \ln L_{2it} + \theta_2 \ln L_{1it} + \theta_3 [\ln L_{1it} - \ln L_{2it}]^2 + \varepsilon_{l1l2it} \] ................. (3)

Model (1) is to capture the relationship of capital (K) and production labor (L_1) to the output (Q_1), model (2) is to capture the relationship of capital (K) and nonproduction labor (L_2) to output and model (3) is to capture the relationship of production labor (L_1) and nonproduction labor (L_2) to the output. To inform that every variable in the linear CES production functions has different coefficient, the coefficients are parameterized by different symbols. The symbols of every variable in equation 1, 2 and 3 are α, β and θ that are subscribed by 1, 2 and 3 notation respectively. The ε error is a composed error consists of ν and μ errors. The ν error captures random disturbance and the μ error capture technical inefficiency error. The panel data feature can be seen from the subscription “it” of every variable.

Three steps is conducted to form each of the frontier linear CES model. The first step is to form the ordinary least square panel data regression function. The second step is to form the corrected ordinary least square panel data regression function. The third step is to form the maximum likelihood panel data regression function.

Some test will be conducted. The first test is the t-test for all coefficients in the ordinary least square panel data CES regression function. The t-test is in order to reject the null hypotheses of no influences of the independent variables. The second test is the sigma square and the one-sided LR tests of the maximum likelihood panel data CES regression function. The sigma square test is in order to reject the null hypotheses that the model is the ordinary least
square model, whereas the one-sided LR test is in order to reject the null hypotheses that the model is not the maximum likelihood model. The third test is the mu and eta test of the maximum likelihood panel data CES regression function. The mu test is the test to reject that the distribution is a truncated half normal distribution, whereas the eta test is to reject the null hypotheses that the data is not a time-varying data. The last test is LR test in order to determine the best model among many models.

The technical efficiency is measured by the formula 4, 5 and 6. The formula is developed from formula considered by Coelli (2007). The first formula is related to model 1, the second formula is related to model 2 and the third formula is related to model 3. The formulas are

\[
TE_{kl1it} = \frac{Y_{kl1R}}{Y_{kl1R}'} = \frac{\exp \left( \text{ld } 1(X_{it}, \alpha + V_{it} - U_{it}) \right)}{\exp \left( \text{ld } 1(X_{it}, \alpha + V_{it}) \right)} = \exp \text{kl1}(-U_{it}) \tag{4}
\]

\[
TE_{kl2it} = \frac{Y_{kl2R}}{Y_{kl2R}'} = \frac{\exp \left( \text{ld } 2(X_{it}, \beta + V_{it} - U_{it}) \right)}{\exp \left( \text{ld } 2(X_{it}, \beta + V_{it}) \right)} = \exp \text{kl2}(-U_{it}) \tag{5}
\]

\[
TE_{kl3it} = \frac{Y_{kl3R}}{Y_{kl3R}'} = \frac{\exp \left( \text{ld } 3(X_{it}, \theta + V_{it} - U_{it}) \right)}{\exp \left( \text{ld } 3(X_{it}, \theta + V_{it}) \right)} = \exp \text{kl3}(-U_{it}) \tag{6}
\]

The low of the human resources quality will be analysed by comparing the technical inefficiencies between the result of formula 4 and result from formula 5 and 6. If the technical inefficiency resulted from formula (4) is lower than the technical inefficiency resulted from (5) and (6), than the phenomena of the low of the human resources quality is captured. The comparison is obtained from the average, the time-to-time period and the incremental of technical inefficiency.
Result and Analysis

Frontier Estimation

The frontier model used is the maximum likelihood model that assumed time varying half-normal distribution. The maximum likelihood model is better than the ordinary least square model because the $\sigma$ in all models is positive, indicating that a distance from the frontier occurs and tested. Imposing the half-normal distribution assumption is better than imposing the truncated half-normal distribution. The value of log likely hood function in the model with the half normal distribution assumption is higher. The time varying models are better than the time-invariant models. The reason is because the one-sided log likelihood value is less than the value obtained from the OLS model. Table 1 presents the models.

Table 1

Linear CES Frontier Model with Time Variant and Half Normal Distribution Assumptions

<table>
<thead>
<tr>
<th></th>
<th>KL1</th>
<th></th>
<th>KL2</th>
<th></th>
<th>L1L2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td></td>
<td>Standard</td>
<td></td>
<td>Coefficient</td>
<td></td>
</tr>
<tr>
<td>Beta0</td>
<td>9.51386</td>
<td>23.76771</td>
<td>11.71680</td>
<td>2.31738</td>
<td>6.32092</td>
<td>3.88712</td>
</tr>
<tr>
<td>Beta1</td>
<td>0.61391</td>
<td>1.84052</td>
<td>0.61774</td>
<td>0.21939</td>
<td>15.49164</td>
<td>7.36082</td>
</tr>
<tr>
<td>Beta2</td>
<td>-8.74419</td>
<td>406.37012</td>
<td>-13.17202</td>
<td>41.90636</td>
<td>-1.60992</td>
<td>1.05640</td>
</tr>
<tr>
<td>Beta3</td>
<td>4.52043</td>
<td>203.21484</td>
<td>6.71274</td>
<td>209.54620</td>
<td>-6.44504</td>
<td>6.44504</td>
</tr>
<tr>
<td>Sigma-square</td>
<td>1.03026</td>
<td>2.11680</td>
<td>1.15755</td>
<td>0.35378</td>
<td>1.09193</td>
<td>0.38034</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.00397</td>
<td>0.00254</td>
<td>0.15379</td>
<td>0.25251</td>
<td>0.18846</td>
<td>0.27865</td>
</tr>
<tr>
<td>Eta</td>
<td>0.15595</td>
<td>2.56002</td>
<td>0.07385</td>
<td>0.07151</td>
<td>0.06722</td>
<td>0.06723</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td>-68.93293</td>
<td>-69.57271</td>
<td>-67.32923</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-sided Loglikelihood ratio</td>
<td>0.39856</td>
<td>1.98747</td>
<td>3.21074</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Technical Inefficiency**

The technical inefficiency of food and textile industries in Central Java province is on average 12.47%. The highest technical inefficiency is contributed by the textile product industry, 16.6%. The lowest technical inefficiency is contributed by the beverage industry, 9.34%. The technical inefficiency increases to more than 38% when the production labor replaced by the nonproduction labor. Also, the technical inefficiency increases when the capital variable is replaced. The technical inefficiency increases to 39.02%. This is indicating that the most important variable is capital. The importance is followed by production labor and nonproduction labor. The Superior importance of capital variable and the less important of nonproduction labor variable indicate the low of the human resources quality in food and textile industries. Table 2 Shows the Value.

**Table 2**

**Average Technical Inefficiency of Food and Textile Industries in Central Java Province:**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Capital-ProductionLabor</th>
<th>Capital-NonProductionLabor</th>
<th>ProductionLabor-NonProductionLabor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>0.123418</td>
<td>0.556871</td>
<td>0.563309</td>
</tr>
<tr>
<td>Beverage</td>
<td>0.093364</td>
<td>0.154782</td>
<td>0.242327</td>
</tr>
<tr>
<td>Textile</td>
<td>0.116645</td>
<td>0.338554</td>
<td>0.206166</td>
</tr>
<tr>
<td>Textile Product</td>
<td>0.165547</td>
<td>0.492271</td>
<td>0.549109</td>
</tr>
<tr>
<td>All Industries</td>
<td>0.124743</td>
<td>0.385619</td>
<td>0.390228</td>
</tr>
</tbody>
</table>

The technical inefficiency of food and textile industries in Central Java Province always decreases time to time. Table 3 show the decreasing for all models. This decreasing informs that improvement to the low of the human resources quality occurs.
Table 3

Technical Inefficiency of Food and Textile Industries in Central Java Province:
2000 – 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital-ProductionLabor</th>
<th>Capital-NonProductionLabor</th>
<th>ProductionLabor-NonProductionLabor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.23344691</td>
<td>0.49651417</td>
<td>0.49066947</td>
</tr>
<tr>
<td>2001</td>
<td>0.20537898</td>
<td>0.47518866</td>
<td>0.47149457</td>
</tr>
<tr>
<td>2002</td>
<td>0.18004236</td>
<td>0.45406395</td>
<td>0.45248263</td>
</tr>
<tr>
<td>2003</td>
<td>0.15733271</td>
<td>0.43321666</td>
<td>0.43368977</td>
</tr>
<tr>
<td>2004</td>
<td>0.15733271</td>
<td>0.41271713</td>
<td>0.41516821</td>
</tr>
<tr>
<td>2005</td>
<td>0.11918328</td>
<td>0.39262884</td>
<td>0.39696582</td>
</tr>
<tr>
<td>2006</td>
<td>0.10338252</td>
<td>0.37300802</td>
<td>0.37912588</td>
</tr>
<tr>
<td>2007</td>
<td>0.08950852</td>
<td>0.35390348</td>
<td>0.36186866</td>
</tr>
<tr>
<td>2008</td>
<td>0.07737007</td>
<td>0.33535663</td>
<td>0.34468233</td>
</tr>
<tr>
<td>2009</td>
<td>0.06678306</td>
<td>0.3174016</td>
<td>0.32814105</td>
</tr>
<tr>
<td>2010</td>
<td>0.05757404</td>
<td>0.30006553</td>
<td>0.31208698</td>
</tr>
<tr>
<td>2011</td>
<td>0.04958224</td>
<td>0.28336893</td>
<td>0.29653947</td>
</tr>
</tbody>
</table>

The rate of decreasing of the technical inefficiency of the food and textile industries in Central Java is sharp in the KL₁ model, but flat for other models. Picture 1 shows the decreasing. As mentioned above, the decreasing indicates the improvement to the low quality of the human resources. The rate of decreasing however still shows that the industries face the low of the human resources quality. The labor, especially the nonproduction labor is less important than the capital.
**Framework to solve Industrial Problems**

Assuming too many labors in industries, to solve the low of labor quality and technical inefficiency problems the unqualified production and nonproduction labors should be excluded from industries. The labors in the industries are qualified production and nonproduction labors. They are expected to well handle industrial capital. The unqualified production and nonproduction labors are distributed to other sectors that relate to the industrial sector such as agricultural, natural resources and trade sectors. The industries problems solved. Even, the industries are supported by other sectors that developing because of labor increasing from industrial sector.

The natural industrial growth and qualified labor relationship model shows how the problems are solved and other sectors support the industrial sector. As shown in the Picture 2 only qualified production and production labors that handling industries and their capitals. Whereas the unqualified production and nonproduction labors are distributed to other sectors especially sectors that support industrial sector.
The Natural Industrial Growth and Qualified Labor Relationship Model

It is not important for the industrial sector to have a high industrial growth as its performance. That is because high industrial growth causes a hard responsibility for industries to absorb labors without any filter to separate skilled and unskilled labors that raising the industrial problems. In addition, high industrial growth causes a hard responsibility for the government to support. If it is not supported by a very good government management, especially in the government budget management, a high industrial growth causes debt and corruption problems.

The important for the industrial sector is to have a natural industrial growth. The industrial growth is only 2% until 3% higher than population growth. It is similar to Lucas’ theory of overcoming Malthus trap, although is different to his ambitious economic transformation and acceleration theory.

The natural industrial growth will support only the good quality of industrial firms. Furthermore, only the good-quality labors will be absorbed. Whereas, the low-quality labors can
be absorbed by the other sectors that supported industrial sectors.

All of the industrial stakeholders should take care of the low quality of labor and the technical inefficiency of such industries. Their concern should base on the natural industrial growth and qualified labor relationship model. Government policy and budget should be focused on the natural industrial growth. In addition, government policy and budget should be directed to other sectors that have close relationship to industrial sector. Industrial firms should focus on handling industry and its capital by qualified production and nonproduction labor. Labors and their associations should focus on labor quality improving. In the yearly minimum wage determination, they can offer different wage between qualified and unqualified labors. In addition, they can offer a higher minimum wage that covering labor quality improving cost. Universities should focus on teaching that educating student as qualified labor and human resources. The new curriculum, KKNI curriculum should be used to prepare skilled labor and human resources. In addition, research should be directed to model the relationship between natural industrial growth and qualified labor and to model the relationship between industrial sector and other sectors. Cooperation of all industrial stakeholders will reindustrialize and revitalize the industrial sector for better economic future.

Conclusion

Food and textile industries in Central Java Province technical inefficiency is studied using stochastic production function. The study used two important features. The first feature is the linear CES production function as a functional form of production function. The second feature is the low human resources quality analysis. The study developed the previous studies.

Three linear CES frontier production models was formed to capture the relationship
between capital, production labor, nonproduction labor and output produced by food and textile industries in Central Java province. The time varying and half normal distribution of data assumptions were imposing to the models.

The technical inefficiency of food and textile industries in central Java province is around 12.47%. The lowest technical inefficiency is the beverage industry, whereas the highest inefficiency is the textile product industry. The technical inefficiency declines time to time. The industries tend to have better performance.

The low of the human resources quality is the problem facing by the food and textile industries in Central Java province. Comparing the technical inefficiency resulted from the capital-production labor model to the other models shows that the source of the technical inefficiency is the labor quality. The incremental technical inefficiency comparison also shows that the industry faces the low of the human resources quality model.

Human resources quality of textile and food industries in Central Java province should be increased. All of stakeholders of textile and food industries in Central Java province should participate in the human resources quality increasing. The stakeholders are government, firms, labor, and universities.

The stakeholders should focus on the natural industrial growth and qualified industrial labor relationship implementation. The industrial growth is expected to be higher than population growth but is not expected at a high growth rate. The growth margin is expected around 2% until 3%. This industrial natural growth absorbs only the qualified production and nonproduction labors. Consequently, the industrial technical inefficiency will decrease.

The unqualified industrial production and nonproduction labors are expected to work in other sectors. They are distributed to industrial supporting sectors such as agricultural, natural
resources or trade sectors. The growth of other sectors will increase, and together with industrial sector growth, contribute to overall economic growth.

All of industrial stakeholders should support the industrial natural growth and qualified labor relationship. Cooperation among them is very important. They and their cooperation reindustrialize and revitalize the industrial sector in Central Java Province and Indonesia.

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