AGRICULTURAL LAND CONVERSION IN JOGJAKARTA: AN EMPIRICAL ANALYSIS

Joko Mariyono
Universitas Ahmad Dahlan Yogyakarta
joko.mariyono@anu.edu.au

Abstract

Agriculture needs to exist because of ecological and economic reasons. Recently, the amount of agricultural lands tends to decrease inevitably because it has been converted to other businesses. This study aims to analyse agricultural land conversion in Jogjakarta using econometric models based on economic analysis. Panel data used in this study is compiled from five regions during period of 1975-2000. Estimation is carried out using panel regression. The results show that agricultural lands decrease as transportation infrastructure increases. Wetland and dry land is convertible as the value of farmer exchange rate and population change. Wetland will be created as the farmer exchange rate increases, and will be converted as population increases; and vice versa for the case of dry land. Dry land gets more economic and demographical pressure than wetland. As a result, dry land is converted more that wetland.

Keywords: *agricultural land conversion, farmer exchange rate, panel regression*

INTRODUCTION

The national demand for foods is steadily increasing along with the steady rise in population growth. However, Indonesian agricultural production still faces classical problems such as shortage of water in dry season, lack of fertilisers during early planting season, and agricultural land conversion. The two first problems have temporary impact, but the last problem has permanent impact on rice production. Once the lands are converted to other non agricultural purposes, it will never back to the original agricultural lands. As a result, there is permanent decrease in total production of agricultural outputs.

It is predicted that in 2020 there is around 9.3 million hectares of paddy field needed for fulfilling demand for rice at national level. But, know there is only 8.1 million hectares of paddy field available, which is around 45 % in Java and Bali. The problem is that the amount of land is not increasing overtime, but it is steadily decreasing (Anonim, 2005). The exact rate of agricultural land conversion is still debatable because of different source of data. As it is reported that the rate of agricultural land conversion in Java and

Bali is around 45,000 hectares a year (Anonim, 2006). Study of Pakpahan et al., (1993) mentions that rate of agricultural land conversion in four provinces of Java is around 23,140 hectares per year. By using data from Badan Pertanahan Nasional, Husodo (2003) stating that agricultural lands converted to housing and industrial area in Java is 81,176 hectares during the period of 1994-1999.

Economically, agricultural land conversion does not only impact on agricultural productions; but also leads to loss of agricultural jobs for both former and land owners and agricultural wage workers; loss of agricultural investments such as irrigation, institutions and other infrastructures; and negative environmental consequences (Firman, 1997). In fact, agricultural sector provides most jobs in rural area (Hill, 2000; Soekartawi, 1994). The implication is that there will be huge amount of opportunity cost resulting from agricultural land conversion.

Ecologically, the agricultural land conversion leads to decrease in carrying capacity of lands. Irianto (2004) highlights agricultural land conversion has potential impact on reduction in ground water production and flood. For example, flood in Jakarta is mainly caused by agricultural land conversion in Bogor (Ashari, 2003). Moreover, loss of water resource is highly costly because water resource has high total economic value (Usman, 1991). Agricultural land conversion also leads to loss of aesthetics (Soetisna et al., 1992) because agricultural landscape provides natural services such as amenity, clean air, and biodiversity.

The fact that agricultural land conversion has various permanent impacts on production of rice, ecology, and socio-economics of rural life, it is still important to study agricultural land conversion. This paper aims to analyse the determinants of agricultural land conversion using econometric models. An analytical frame work of land conversion based on microeconomic theory and mathematical models will be built and data set on agricultural lands will be used to test empirically. Results of empirical test will be discussed.

LITERATURE REVIEW

Agricultural land conversion is unavoidable as a consequence of economic development. The rate and determinants of agricultural land conversion varies in terms of both spatial and temporal aspects. In common, agricultural lands to be converted are not merely sown with food crops, but also with estate crops, and fishery. Study on agricultural land conversion is somewhat interesting because the determinants of agricultural land conversion stems from many factors including economic, social, and cultural factors. Many studies summarised Ashari (2003) show that wetland conversion in Java is influenced by structural change, economic growth, geographic and demographic factors. Kustiawan (1997) specifically mentions that agricultural land conversion in northern coastal Java occurs due mainly to internal and external factors, and government policies. Firman (1997) mentions that wetland conversion in northern regions of West Java is largely triggered by domestic and foreign investments in the manufacturing, finance and service sectors. It seems that political factor is more dominant than others factors, because may actors and institutions have involved in land conversion in those regions.

In micro scale, the main reason of wetland conversion is geographical factors. When wetland is located is industrial area, the value of land will be high such that the owners sell the land (Syafa'at et al., 1995). In addition, Rusastra et al., (1997) support the fact that the owners will purchase wetland in other places which is cheaper. Thus with the same amount of money, the owners will get wider land.

In economic point of views, agricultural land conversion is mainly influenced by the value of agricultural products relative to value of non agricultural ones. The value of agricultural products can be represented by farmer exchange rate. When farmer exchange rate is low, there is non incentive for farmers to retain agricultural practices as generating income (Ashari, 2003). Husodo (2003) mentions that continual decrease in farmer exchange rate is one of fundamental problem that needs to be seriously handled. The other factors that trigger agricultural land conversion are population growth and transportation infrastructures. More populated area needs more land for housing and others economic activities. Additionally, decentralisation is likely to accelerate the process of wetland conversion (Anonim, 2002).

Land conversion also happens in fisheries and estate crops. In fisheries, Tajerin (2005) studies conversion of brackish land in East Java. By using an econometric model, the study shows that brackish land conversion is mainly affected by rapid development of region, urbanisation and migrations. In estate crops, Asni (2005) carries out a study on land conversion in Labuhan Batu North Sumatera using multiple regressions. The study shows that significant factors influencing land conversion in estate crops are level of education, income, and saving.

THEORETICAL FRAMEWORK

With reference to a model of Stolper-Samuelson two sector economy (Silberberg and Suen, 2001), this study employs a product transformation curve, that is, a curved line that illustrates 'the different combinations of two outputs that can be produced with a fixed amount of production inputs' (Pindyck and Rubinfeld 1998: 228). The product transformation curve is concave to the origin because the production resources are not perfectly adaptable in (i.e., cannot be perfectly transferred between) the production of products (Salvatore, 1996). Figure 1 illustrates the product transformation curve.

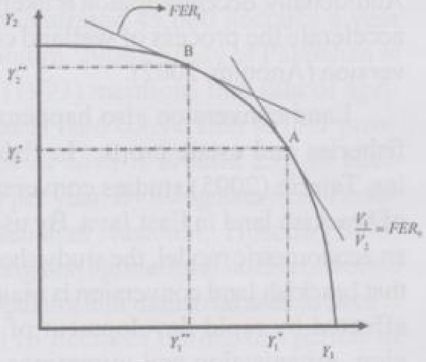

Figure 1
Product transformation curve

Let Y_1 and Y_2 be agricultural outputs and non agricultural outputs respectively. Production both outputs uses the same total lands (=agricultural land + non agricultural land). In this case, total land use is considered as fixed input. Following Silberberg and Suen (2001) the optimal productions of each sector will be reached when the ratio of value of agricultural products (V_1) to value of non agricultural products (V_2) is equal to slope of product transformation curve. Aggregately, the ratio of both values can be interpreted as farmer exchange rate (*FER*), that is, an index resulting from ratio of composite price taken by farmer to composite price paid by farmer (Supriyati, 2004). The combination of agricultural and non agricultural products will changes if *FER* changes. New combination of both products will be reached when the slope of product transformation curve is equal to new *FER*.

Suppose the initial condition is at point A, in which the farmer exchange rate is FER_0, and the optimal production of each product is Y_1^* and Y_2^* respectively. Then suppose the farmer exchange rate decreases from FER_0 to FER_1. The optimal condition will change from point A to point B in which the slope of product transformation is equal to . The production of Y_1 falls from to and the production of Y_2 rises from to . Since the total lands are fixed, there is a shift in lands from Y_1 to Y_2. This means that agricultural lands are converted to non agricultural lands. Conversely, if there is an improvement in farmer exchange rate, there will be a rise in agricultural production. However it is extremely difficult to convert non agricultural lands to agricultural one. One possible episode if farmer exchange rate increases is that creation of agricultural land or conversion from less productive to more productive one. For example, Asna (2005) showing that paddy field has been converted to palm oil plantation because of high value of palm oil.

The fall in farmer exchange rate can be a consequence of economic development and population growth. Housing and industrial area will need more land, and access to the location will be easier. This condition leads to increase in demand for land and price of land will be higher. This phenomenon causes farmers sell the agricultural lands. It is also possible that total land use will increase because of land expansion from unused lands. The creation of land means that the product transformation curve moves outward.

MATERIAL AND METHODS

Analytical Model

Based on the above theory, an analytical model can be established as in Figure 2.

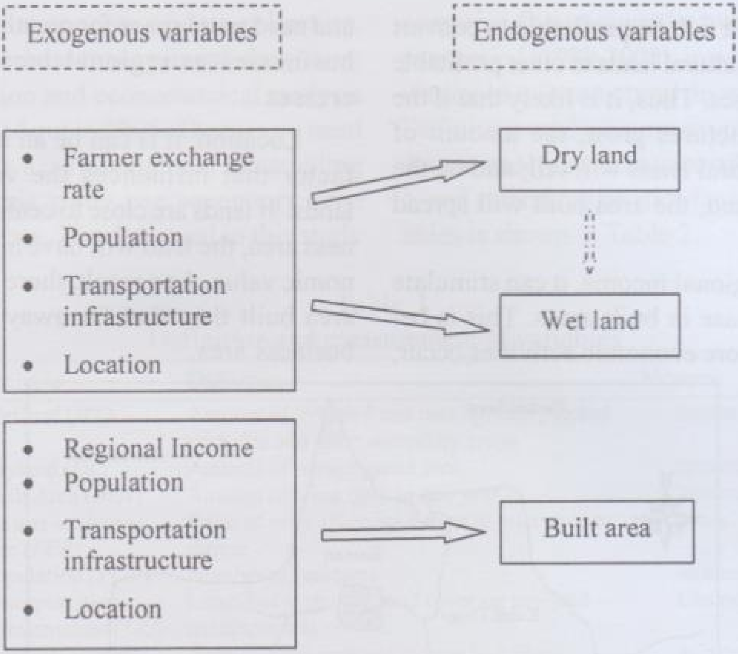

Figure 2
Analytical Model of Agricultural land conversion

In this analytical framework, the exogenous variables are farmer exchange rate, population, transportation infrastructure, regional income and location; and the endogenous variables are dry land, wetland and built area. The changes in exogenous variables will influence the changes in endogenous variables, but not vice versa. Let to explain how the exogenous variables can affect the endogenous variables. There are three analyses. The first is to determine factors reducing the amount of agricultural lands (wetland and dry land). The second is to determine factors increasing built areas. Last, is to analyse conversion between dry land to wetland.

Farmer exchange rate (*FER*), is defined as index resulting from ratio of price taken by farmer to price paid by farmer (Supriyati, 2004). When the index is getting greater, agricultural products are more valuable, and vice versa. Consequently, farmer will shift to other business if *FER* declines. Thus, it is likely that agricultural lands will be converted to other business if *FER* continually declines.

Population, it can give a pressure to agricultural lands to be converted to housing and other purposes. The higher population regions will need more land for housing. It is likely that when population goes up, agricultural lands will reduce; and conversely, the area built will increase.

Transportation infrastructures, it can boost the value of lands including agricultural lands that have access to road. This is because more economic activities will be created; and subsequently it will be profitable to convert the agricultural lands to other profitable businesses. Thus, it is likely that if the infrastructures grow, the amount of agricultural lands will fall; and on the other hand, the area built will spread out.

Regional income, it can stimulate an increase in built areas. This is because more economic activities occur, and need more space for creating other businesses as regional income increases.

Location, it is can be an intrinsic factor that influences the value of lands. If lands are close to central business area, the land will have high economic value. As a result, there is more area built than that far away central business area.

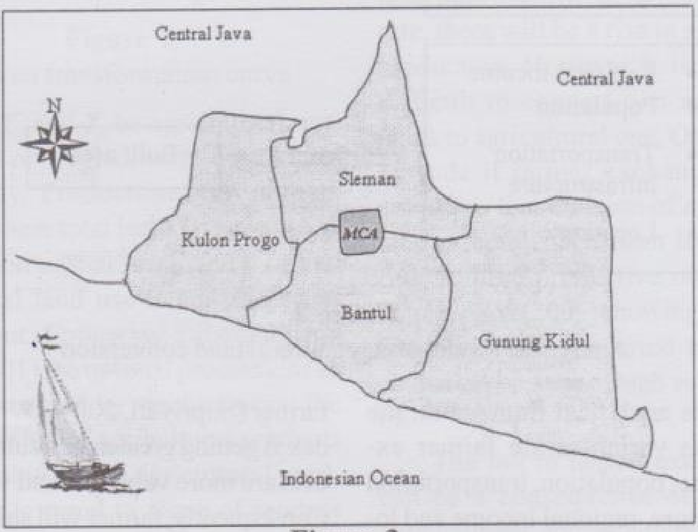

Figure 3.
Area of Jogjakarta Province

As shown in Figure 3, there are two regions: Sleman and Bantul close municipal area (*MCA*) which is central business area. Thus, it is likely that the regions will have more area built than others. It is interesting to see whether there is land conversion between dry land and wetland. This is because the amount dry land is huge and potential to be converted to other purposes.

Data Collection and Location

This study uses the case of Jogjakarta province at which development of infrastructure and development of areas have been rapidly progressive, in spite of the fact that agricultural land conversion in Jogjakarta is the least in terms of volume compared with other provinces in Java (Pakpahan et al., 1993; Husodo, 2003). This development is suspected to trigger agricultural land conversion to non-agricultural purposes. The data are compiled from a number of sources including the Annual Report of the Provincial Agricultural Office, and statistical data published by the Provincial and District Statistical Offices. This study that consists of data collection, data database management, data transformation and econometrical analysis is carried out in 2005. There is no need to apply a certain method of sampling since this study use secondary time series data. The data used in this study comprise five regions in twenty one-year period (1980-2000), in which there was rapid infrastructural development. Definition and unit measurement of data to analyse are expressed in Table 1, and summary statistics for such variables is shown in Table 2.

Table 1
Definition and measurement of variables

Variable	Definition	Measure
Wetland (*WL*)	Amount of irrigated and rain-fed area planted with rice and other secondary crops	hectare
Dryland (*DL*)	Amount of non-irrigated area	hectare
Built Area (*BLA*)	Amount of areas built in one year	hectare
Farmer exchange rate (*FER*)	Ratio of price taken by farmer to price paid by farmer	index
Population (*POP*)	Number of residents	million
Transportation infrastructure (*TRI*)	Length of asphalted road covering new and existing roads	kilometre
Regional Income (*RIC*)	Amount total regional income in a year.	million
Municipal Area (*MCA*)	Location of municipal area	dummy
Bantul (*BTL*)	Location of Bantul district	dummy
Sleman (*SLM*)	Location of Sleman district	dummy
Semi-urban area (*SUB*)	Region in municipal area, and regions that have direct border with municipal area.	dummy

Table 2
Summary statistics for variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
WL	105	12,488.4	8,815.633	155	30,414
DL	105	28,214.48	29,949.29	1,468	95,937
BLA	105	17,464.37	8,162.22	1,468	28,938
FER	105	107.6619	9.176973	96.3	131.1
POP	105	607,723.4	150,455.6	381,452	850,176
TRI	105	827.955	573.348	167.28	2,256.23
RIC	105	2,303,060	1,972,797	187,268	5,286,367

***Note:** Author's calculation*

MODEL ESTIMATION

Factors' influencing agricultural land conversion is modelled as:

$$WL_{it} = \alpha_0 + \alpha_1 FER_{it} + \alpha_2 POP_{it} + \alpha_3 TRI_{it} + \alpha_4 MCA + \alpha_5 BTL + \alpha_6 SLM + \varepsilon_{it} \quad (1)$$

$$DL_{it} = \alpha_0 + \alpha_1 FER_{it} + \alpha_2 POP_{it} + \alpha_3 TRI_{it} + \alpha_4 MCA + \alpha_5 BTL + \alpha_6 SLM + \varepsilon_{it} \quad (2)$$

where *DL* is dry land and *WL* is wetland, *FER* is farmer exchange rate, *POP* is population, *TRI* is transportation infrastructure, *MCA* is dummy location for municipal area, *BTL* is dummy location for Bantul region, *SLM* is dummy location for Sleman region, *e* is disturbance error, subscript *i* and *t* represents region and time respectively.

Factors' influencing built area is modelled as.

$$BLA_{it} = \delta_0 + \delta_1 INF_{it} + \delta_2 POP_{it} + \delta_3 RIC_{it} + \delta_4 MCA + \delta_5 BTL + \delta_6 SLM + \delta_7 SUB * INF_{it} + \delta_8 SUB * RIC_{it} + \delta_9 SUB * POP_{it} + \varepsilon \quad (3)$$

where *BLA* is amount of built areas, *RIC* is regional income, *SUB* is semi-urban area, symbol (*) represents interaction between corresponding variables. The interactions are built based on a reasonable point of view that each change in corresponding variable will have different respond in semi urban from non semi urban areas.

A model representing dry land converted to wetland is expressed as:

$$DL_{it} = \beta_0 + \beta_1 \overline{WL}_{it} + \beta_2 \overline{BLA}_{it} + \beta_3 MCA + \beta_4 BTL + \beta_5 SLM + \varepsilon \quad (4)$$

where symbol bar (¯) on *WL* and *BLA* indicates expected value resulting from instrumental variables.

Estimation of the models (1), (2) and (3) is conducted using random effect of panel regressions[1]. Whereas model (4) is estimated using random effect panel instrumental variable regression because wetland and built area are endogenous variables which can not be independent variables directly (Gujarati, 2003). The instrumental variables used to make those variables exogenous are *FER, POP, TRI and RIC*. Panel random effect is selected because of efficiency, compared with fixed effect (Greene 2003; Wooldridge 2000). Druska and Horrace (2004) point out that when estimation is conducted using panel regression of which time is sufficiency long, the fixed effect model is no longer relevant. Testing for co-integration of all model needs to be done since the data consist of time-series and cross-sectional data. This is done by testing for unit root of residual of each model. A procedure of Dickey-Fuller test is used o identify the existence of non-stationary residual. When *t*-test is not significant, the model is not co-integrated and the estimated will be spurious (Gujarati, 2003). The problem of non-stationary residual can be coped with by transforming the data.

[1] The five year lags of infrastructure and population have been included in three models. But coefficient on lags is not significant. This means that infrastructure influences agricultural lands and area built at the same year and so does the population.

RESULTS AND DISCUSSION

Descriptive Analysis

Descriptively, the changes in endogenous and exogenous variables analysed here can be seen in the following figures.

Figure 4 shows that wetland in Sleman and Bantul have larger amount of wetland than Kulon Progo and Gunung Kidul. But the amount in Sleman dan Bantul declines continually over the period. One possible cause is that both regions directly border with municipal area. The amount of wetland in Kulon Progo and Gunung Kidul are relatively stable, even in Gunung Kidul the amount of wetland has ever increased.

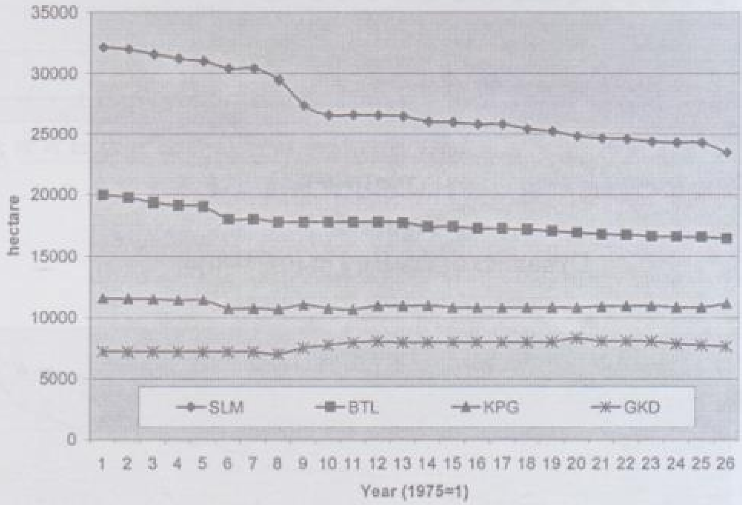

Figure 4
The dynamics of wetland in Jogjakarta

Figure 5 shows that Gunung Kidul has the highest amount of dry land, even though the amount is gradually decreases after reaching a peak at the middle period. The amount of dry land in Bantul and Sleman are steady; whereas in Kulon Progo has experienced a sharp increase in the mid of 1980s.

Figure 6 shows that there is a steady increase in area built in all regions, with Kulon Progro that has fastest increase in area built. Bantul and Sleman have relatively the same rate of increase in area built. One possible cause is that both regions have been developed earlier at the same period that other regions.

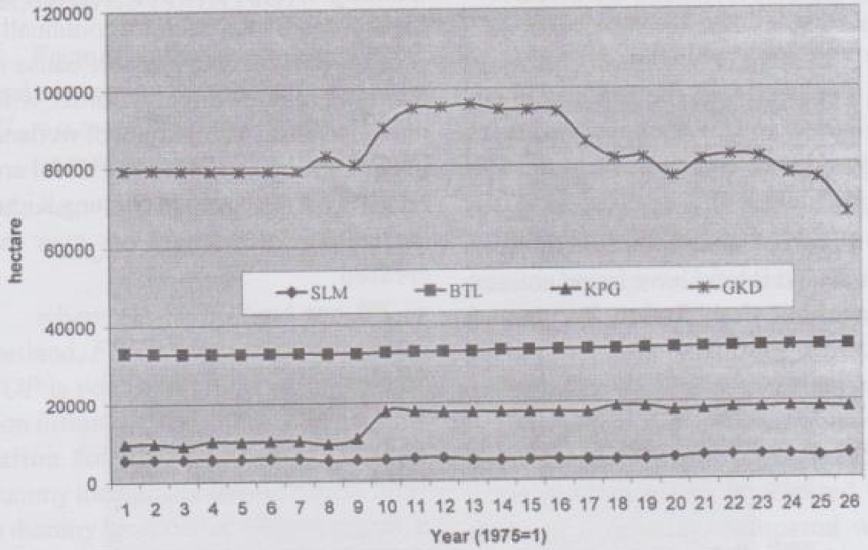

Figure 5
Dynamics of dry land in Jogjakarta

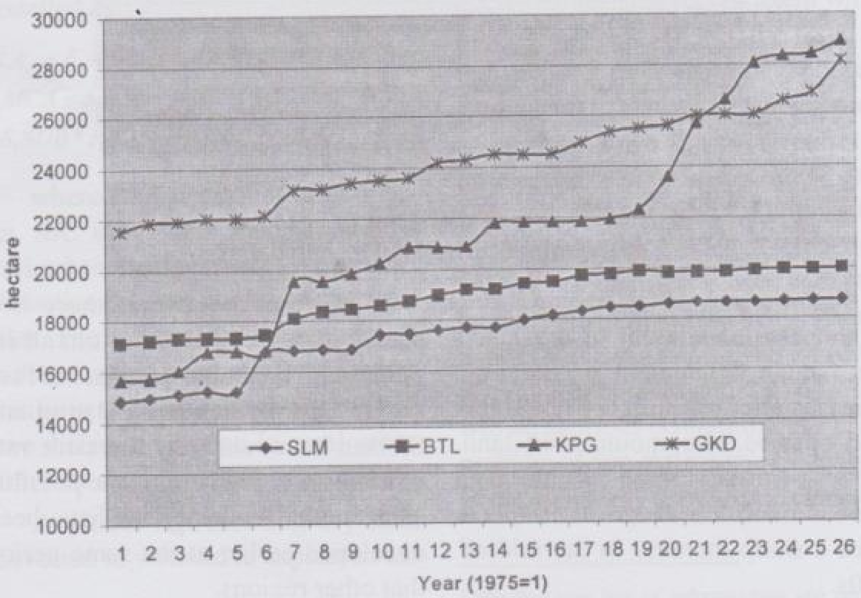

Figure 6
Dynamics of area built in Jogjakarta

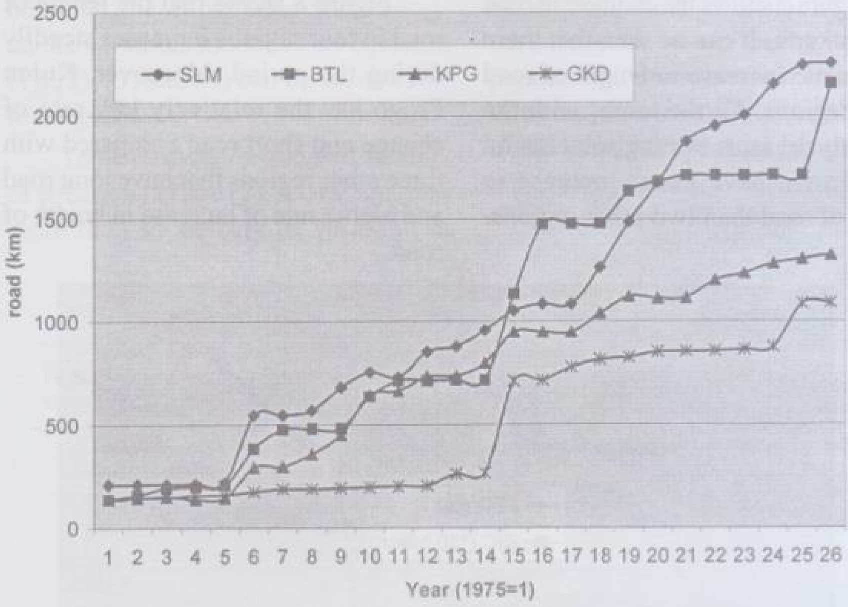

Figure 7
Dynamics of road in Jogjakarta

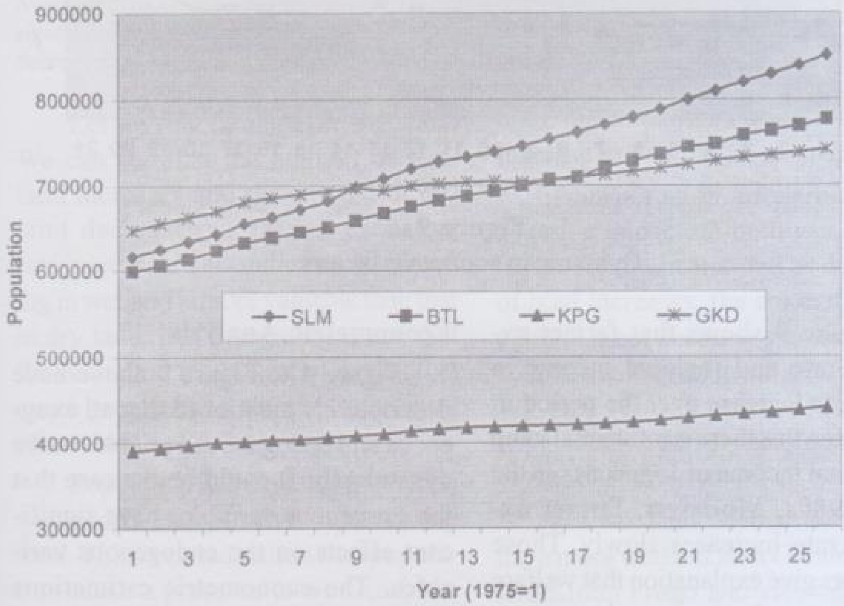

Figure 8
Dynamics of population in Jogjakarta

Figure 7 shows the changes in road in Jogjakarta. It can be seen that there is dramatic increase in length of road in all regions. Furthermore, with the relatively the same starting point Bantul and Sleman have faster increase in length of road than two other regions.

Figure 8 shows that the length of road in four regions increases steadily during the period. Moreover, Kulon Progo has the relatively low rate of change and short road compared with three other regions that have long road and higher rate of increase in length of road.

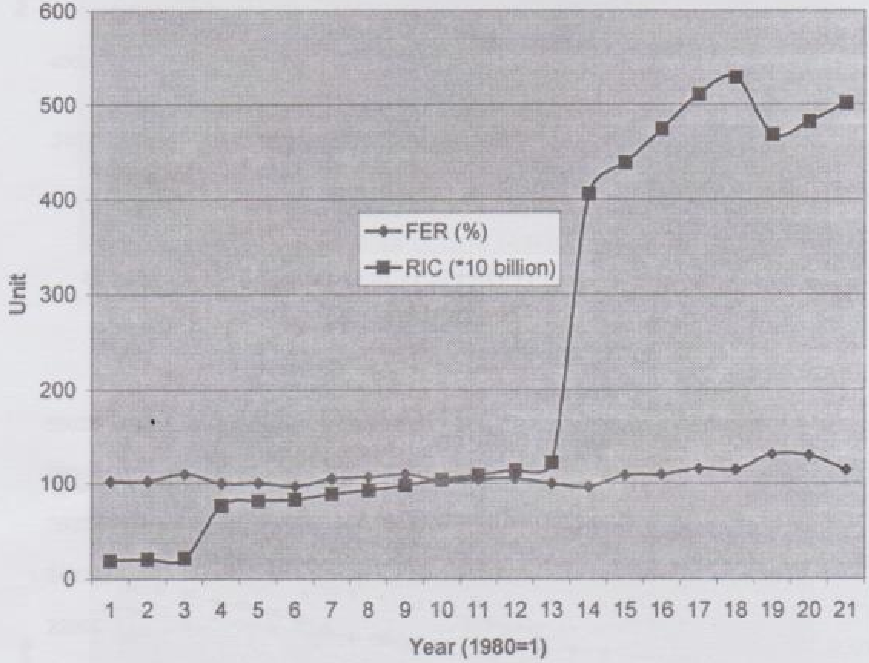

Figure 9
Dynamic in economic factors

Figure 9 shows that farmer exchange rate and regional income in Jogjakarta increase over the period. It can be seen that there is influential jump in regional income of Jogjakarta in the early 1980s. Moreover, farmer exchange rate increases slowly. Those indicators give explanation that welfare of farmers and other people are getting increased over time.

Econometric Analysis

Figure 4 to Figure 9 above have descriptively mentioned that all exogenous and endogenous variables move dynamically. It could be the case that the exogenous variables have significant effects on the endogenous variables. The econometric estimations below will explain how the exogenous variables influence the endogenous ones. Econometrically, the relationships between the exogenous and endogenous variables modelled as equation (1), (2), (3) and (4) can be seen in following tables.

Table 3 shows estimated models of equation (1) and (2). It indicates that more than 95 percent of variation in agricultural lands is explainable with variations in farmer exchange rate, population, transportation infrastructures and location. Overall, all exogenous variables have highly significant effect on agricultural lands.

Table 3

Factor influencing amount agricultural lands in Jogjakarta

Exogenous variables	Wet land		Dry land	
	Coefficient	z-statistics	Coefficient	z-statistics
Constant	14,782	18.36***	38,913	5.14***
FER	14.67	1.87*	-190.43	-2.58**
POP	-0.0115	-18.29***	0.2090	35.33***
TRI	-0.6804	-4.14**	-12.50	-8.09***
MCA	-10,785	-53.13***	-27,527	-14.44***
SLM	19,353	86.34***	-77,230	-36.68***
BTL	9,878	48.55***	-40,333	-21.1***
R^2		0.9953		0.9643
$\chi^2(6)$		20865.37***		2643.63***
Co-integration test		-3.483***		-4.868***

*Note: random effect panel regression; *) significant at 10%; **) significant at 5%; ***) significant at 1%.*
Source: author estimation

Let see first farmer exchange rate. We can see that the amount of wetland increases and the amount of dry land decreases as farmer exchange rate increases. This indicates that farming in wetland is more valuable than that in dry land. It is interesting to see that the reduction in amount of dry land is much greater than the rise in amount of wetland.

Population has negative impact on wet land, but has positive impact on dry land. This is an indication that population make a pressure to wet land, but make a creation of dry land. The important phenomenon is that as regions more populated, the reduction in amount of wetland is less than the increase in amount of dry land. Thus in total, the amount of agricultural lands increase as population goes up.

Transportation infrastructure has negative impact on both wet and dry lands. This indicates that as the length of road increases, the amount of agricultural lands decrease significantly. It could be converted to other businesses. We can see that the reduction in amount of wetland is less than that of dry land.

For wet land, Sleman and Bantul have more wetland than Gunung Kidul and Kulon Progo and vice versa. Co-integration test shows that the model of wetland and model of dry land is highly co-integrated, such that the models are not spurious.

Table 4
Factor influencing area built in Jogjakarta

Exogenous variable	Coefficient	z-statistics
Constant	13,106	14.47***
TRI	5.0172	7.81***
POP	0.0118	9.73***
RIC	0.0002	1.90*
MCA	-17,450	-34.78***
BTL	-3,435	-0.48^{NS}
SLM	-5,430	-0.72^{NS}
*SUB*TRI*	-4.6477	-3.84**
*SUB*POP*	-0.0003	-1.32^{NS}
*SUB*RIC*	5.0172	0.13^{NS}
R^2	0.9876	
$\chi^2(9)$	7580.41	
Co-integration test	-4.065***	

*Note: random effect panel regression; dependent variable: built area; *) significant at 10%; **) significant at 5%; ***) significant at 1%; ^{NS}) not significant*
Source: author estimation

Table 4 shows an estimated model of equation (3), that is, factor influencing area that has been built in each region of Jogjakarta. The model indicates that more than 98 per cent of total variation in built area is explainable with variations in transportation infrastructure, population, regional income and location. Overall, those factors have highly significant impact on determining the amount of area built.

As expected, transportation infrastructure, population and regional income have positive significant effect on area built. In other words, increases in those variables lead to increase in amount of area built. For example, the model suggests that when the length of road increases by one kilometre, area built will significantly increase by five hectares.

In municipal area, the amount of area built is significantly less than in Gunung Kidul and Kulon Progo. But, the amount of area built in Sleman, Bantul, Kulon Progo and Gunung Kidul is relatively the same. This is logic because those regions have large amount of lands, such that the amount area built is not significantly different.

Based on the interaction, the model shows that interaction between sub-urban area and transportation infrastructure is significantly negative. This suggests that when transportation infrastructure increases, the amount of area built in sub-urban area is less than that in non sub-urban in terms of responding to the increase in length of transportation infrastructure. It is reasonable since to build area in sub-urban is more costly than in non sub-urban could be the case. Co-integration test shows that the model is highly co-integrated, such that the models are not spurious.

Table 5 shows the estimated model of equation (4), that is, conversion of dry land to wetland and area built. The model is firstly estimated with linear equation. However the result indicates that the linear model is not co-integrated; and as a result the linear model could be spurious. The model is then transformed into logarithmic model, which shows that the log model is co-integrated; and subsequently the discussion below is based on the log model. The interpretation of log model is slightly different from the linear one, because estimated coefficients on corresponding variables in the log model express elasticity (Verbeek, 2002).

Table 5

Conversion of dry land to wetland

Exogenous variable	Linear model		Logged model	
	Coefficient	z-statistics	Coefficient	z-statistics
Constant	392568.2	5.37***	88.85494	4.30***
$\overline{WL}$	-20.5035	-8.09***	-4.24456	-5.67***
$\overline{BLA}$	-6.3402	-2.77**	-3.93178	-2.72**
MCA	-368016	-5.46***	-26.1518	-4.63***
SLM	-262851.3	-7.5***	-1.460925	-2.80**
BTL	-117310.9	7.35***	-1.764893	-5.43***
R^2		0.5964		0.7665
$\chi^2(5)$		175.39***		347.04***
Co-integration test		-2.197^{NS}		-3.159**

Note: random effect panel instrumental regression; instrumented: WL, BLA; *instruments: FER, POP, TRI and RIC: **) significant at 5%;***) significant at 1%.*
Source: author estimation

The log model shows that around 76 per cent variation in logged amount of dry land is explainable with variations in logged expected amount of wetland, expected amount of area built and location. Overall, those variables have significant impact on conversion of dry land. The model suggests that if expected amount of wetland increases by one per cent, the amount of dry land will decrease by around 4.2 per cent. This indicates that creation of wetland needs more dry land. Moreover, if expected amount of built area increases by one per cent, the amount of dry land will fall by around 3.9 per cent. In municipal area, Sleman and Gunung Kidul, percentage of dry land is less than that in Kulon Progo and Gunung Kidul.

CONCLUSION

Agricultural lands in Jogjakarta are declining along with increasing length of road, for which the amount of wetland decreases more slowly than that of dry land. And conversely the area built is increasing sharply. Since the length of road steadily increases (could be resulting from development of the regions), the agricultural lands will continually decrease, and area built increases. This phenomenon is not immediately worrying because the exogenous variables have different impact on agricultural lands. Recall the effect farmer exchange rate on both wet and dry lands. As farmer exchange rate rises, more wetland will be created.

Even though the fall in amount of dry land is greater than that of wetland, the creation of dry land is greater than the reduction in amount of wetland as population rises. Thus if economic development is still in support of increasing farmer exchange rate, the amount of wetland will increase and the amount of dry land will fall. Since increase in population is likely to be inevitable, the amount of total agricultural lands will be in relatively stable, but dry land and wetland are convertible. It is likely that the fall in amount of dry land is brought about by creation of wetland, in which creation of wetland need more dry land to be converted. The amount of dry land is not only converted to wetland, but also converted to non-agricultural purposes as economic condition grows. Economic development and population lead to an increase built area, and the area is mostly from dry land. From this analysis, there is a big question needs answering: where dry land have been converted from. This question arises because the amount of dry land is stable and tends to increase, but it has been converted to wetland and area built.

Acknowledgment

The author thanks Rika Harini, Faculty of Geography Gadjah Mada Univeristy, who has provided help in data compilation; and Inung Agustin, Centre for Analyses of Agricultural Economics and Policy, who has provided more literatures related to this study.

REFERENCES

Anonim, 2002. *Alternatif kebijakan pengendalian konversi lahan pertanian*, Sekretariat Dewan Ketahanan Pangan, Jakarta.

Anonim, 2005. Akutnya Konversi Lahan Pertanian, *Kompas Daily* 19 December 2005 p.21.

Anonim, 2006. Lahan pertanian di Kota Yogya tinggal 125 hektar, Pemerintah Propinsi DI. Yog yakarta, http://pemda-diy.go.id/berita/article.php

Ashari, 2003. Tinjauan tentang alih fungsi lahan sawah ke non sawah dan dampaknya di Pulau Jawa, *Forum Penelitian Agro Ekonomi*, 21 (2): 83-98.

Asni, 2005. Analisis produksi, pendapatan dan alih fungsi lahan di Kabupaten Labuhan Batu, *e-USU RepositoryÓ2005 Universitas Sumatera Utara*, http://library.usu.ac.id/download/fe/tesis.asni.pdf, (2 April 2006).

Druska. V. and Horrace, W.C., 2004. 'Generalized moments estimation for spatial panel data: Indonesian rice farming', *American Journal of Agricultural Economics*, 86(1): 185-98.

Firman, T., 1997. Land conversion and urban development in the northern region of West Java, Indonesia, Urban Studies, 34 (7): 1027-1046.

Greene, W.H., 2003. *Econometric Analysis*. Prentice Hall, New Jersey.

Gujarati, D.N. 2003. *Basic Econometrics*. McGraw-Hill, Boston.

Hill, H., 2000. *The Indonesian Economy,* Cambridge University Press, Cambridge.

Husodo, S.Y., 2003. Membangun kemandirian di bidang pangan: suatu kebutuhan bagi Indonesia, Jurnal Ekonomi Rakyat, 6, http://www.ekonomirakyat.org/edisi_18/artikel_3.htm (2 April 2006).

Irianto, G., 2004. Alih fungsi lahan: dampaknya terhadap produksi air DAS dan banjir, *Sinar Tani* 28 April 2004.

Kustiawan, A., 1997. Konversi lahan pertanian di Pantai Utara Pulau Jawa, *Prisma No.* 1 tahun XXVII, LP3ES Jakarta.

Pakpahan, A., Sumaryanto, Syafa'at, N., Friyanto, S., Saktyanu, K.D., Somaji, R.P., 1993. *Analisis kebijaksanaan konversi lahan sawah ke penggunaan non pertanian*. Pusat Penelitian Sosial Ekonomi Pertanian. Badan Penelitian dan Pengambangan Pertanian, Bogor.

Pindyck, R.S. and Rubinfeld, D.L. 1998. *Microeconomics*. Prentice Hall International, Inc. Upper Sadle River, New Jersey

Rusastra, I.W., Budhi, G.S., Bahri, S., Noekman, K.M., Tambunan, M.S.M., Sunarsih, Sudaryanto, T., 1997. Perubahan struktur ekonomi pedesaan: analisis sensus pertanian 1983 dan 1993. Pusat Penelitian Sosial Ekonomi, Badan Penelitian dan Pengembangan Pertanian, Bogor.

Salvatore, D., 1996. *Managerial Economics in a Global Economy*. McGraw-Hill, New York

Silberberg, E., dan Suen, W. 2001. *The Structure of Economics: a Mathematical Analysis*, McGraw-Hill, Boston.

Soekartawi, 1994. Peran sector pertanian dalam perekonomian Indonesia. *Jurnal Studi Indonesia*, 4, http://pk.ut.ac.id/jsi/4soeka.htm (2 April 2006).

Soetisna, U., Sumiasri, N., Margawati, E.T., 1992. Optimasi pemanfaatan lahan dengan sistem pekarangan, *Jurnal Studi Indonesia*, 2, http://pk.ut.ac.id/jsi/2Usep.htm (2 April 2006)

Supriyati, 2004. Analisis nilai tukar komoditas pertanian: kasus komoditas kentang, *ICASERD Working Paper No. 49*. Pusat Penelitian dan Pengembangan Sosial Ekonomi Pertanian, Departemen pertanian.

Syafa'at, N., Saliem, H.P., Saktyanu, K.P., 1995. Faktor-faktor yang memperngaruhi konversi sawah di tingkat petani, Prosiding Pengembangan Hasil Penelitian. Pusat Penelitian Sosial Ekonomi, Badan Penelitian dan Pengembangan Pertanian, Bogor.

Tajerin, 2005. Faktor yang mempengaruhi konversi lahan tambak di Jawa Timur, *Jurnal Studi Indonesia*, 15 (1), http://pk.ut.ac.id/jsi/151 maret05/tajerin.htm, (2 April 2006).

Usman, W., 1991. Air sebagai sumberdaya alam dan aspek ekonominya, *Jurnal Studi Indonesia*, 1, http://pk.ut.ac.id/jsi/1Wan.htm (2 April 2006).

Verbeek, M. 2002. *A Guide to Modern Econometrics*. John Wiley & Sons, LTD, Chichester.

Wooldridge, J.M., 2000. *Introductory Econometrics: A Modern Approach*. South-Western College Publishing, Australi