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CO_2 Emission from Brickfields in Bangladesh: Can *Ethical Responsibility by Doing* Reduce Level of Emission?

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Recent years' rapid urbanization and then rural to urban migration have created increasing demands of bricks usages in Bangladesh. However, brick industry has been largely using inefficient, dirty technology and burns woods-coal. It injects huge volume of CO_2 in atmosphere. For policy guidance on the issue, this study analyzes the basic issues of CO_2 emission from brickfields in terms of marginal damage (MD) analysis. Findings show that the marginal social costs are higher than marginal private (producer of bricks) costs where brickfields are benefiting with the expense of Bangladeshi society as a whole. As time passes by, rises of brick-prices have been causing upward trends of welfare losses where producers' surpluses are dominating in the total surplus. This economic situation has been causing higher deadweight loss year after year. Addressing the issues, national strategies and policy actions are needed. Reforestation efforts can be achieved in multi-faucets: brick-fields' charity, government policies on planting trees & policies on motivational efforts inspiring citizens of Bangladesh. Motivational policy can be: i) inspiring celebration individual's "Birthday, Having 1st child in family and Event of marriage" by planting trees, ii) forcing to utilize green tech in brick kilns and iii) conducting academic research where financial supports are in need.

Keywords: *brickfields, effluent gases emission, causes social costs & deadweight loss, reforestation, motivational efforts of government policies*

Introduction

From the beginning of civilization, bricks as a product have been playing important roles for construction of houses and other infrastructure and are a major catalyst for economic progress. An estimated over 1,500 billion baked-clay bricks are produced globally every year where Asian countries alone produce 1,300 billion bricks (US EPA 2012). Usages of bricks are common practice in many parts of South Asian Countries, which require a large scale of brick production in many countries in this part of the world. Asia alone per year produces 86.7 percent of world's bricks production in the world (US EPA 2012).

Bangladesh, a South Asian country, is one the second highest brick producer after India. Considering the case of small scale industries, the brick industry is a developing industry because of increase in demand of bricks locally. Here bricks are the most important building material in urban areas. With rising income, it has become a significant building material in rural areas as well. Rapid urbanization

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has created an increasing demand for residential, commercial, industrial, public buildings and other infrastructures. In Bangladesh, it has been contributing over one percent to the country's GDP (BUET 2007) and generating employment for about two million people, despite the fact that vast majority of these kilns use outdated technologies.

However, conventional brick making in South Asian Countries including Bangladesh is a highly polluting, energy intensive and producing a large scale of CO_2. More specifically, burning wood and coal in brick kilns produces mainly high level of CO_2 and other effluent gases. Thus brickfields inject them into atmosphere and deplete atmospheric O_2. In year 2020, Bangladesh emitted CO_2 from brickfields over 9.8million tons (World Bank 2020). Here the percentage in last 10 years of CO_2 emission from brick kilns was 72.784, which is very alarming (Imran et al. 2014).

With high-trends of CO_2 emission from brickfield, besides other policy options, this study raises question: can ethical responsibility by doing reduce level of emission in Bangladesh and beyond?

Addressing the question posed, this study takes on the challenges to layout policy guidance curtailing the magnitudes of CO_2 emission using welfare analysis. It analyzes the basic issues in terms of marginal damage (MD) analysis and the neoclassical partial equilibrium demand and supply theory (Rahman 2000a, 2000b, 2002). It further analyzes the reasons of disparity between social and private cost by conventional marginal damage analysis (Rahman and Edward 2003, Rahman 2019). Thus the findings can be utilized as guidance in policy design in Bangladesh and beyond. Finally, the reforestation techniques are laid out as examples of "ethical-responsibility by doing" in aim to curtail the magnitudes of CO_2 level in atmosphere.

Problem Statement

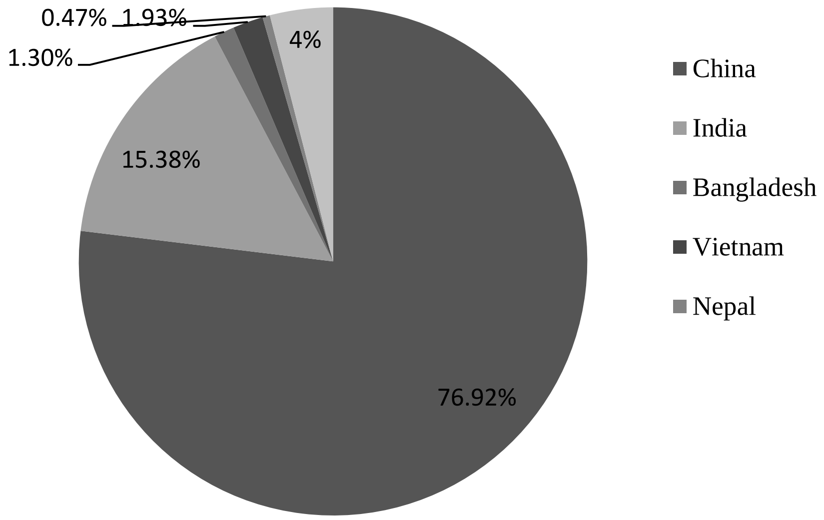
Usages of bricks are common practice in many parts of South Asian Countries, which require a large scale of brick production in this part of the world. Figure 1 shows China and India dominate the brick production level in Asian counties where China alone produces 76.92 percent and India stands second with 15.38 percent of brick production. Bangladesh produces around 17 billion bricks, which 1.30 percent of Asian total brick production (US EPA 2012).

It is undeniable fact that brick industry plays a significant role in economic growth of a nation. However, it becomes a problem when brick industry undermines or fails to marginalize the consequences, in this case, the emission of CO_2 from its production process.

China and Vietnam are the only two countries that have transitioned into mostly using modern and efficient technologies for brick making, India, Bangladesh other neighboring Asian countries are still behind and dominating CO_2 emission from brickfields (US EPA 2012). In brick industry, wood and coal based fuels for brick production; India has estimated 13000 brickfields and Bangladesh has officially 7000 (DoE 2017). There are total 20 natural gas based brick kilns in

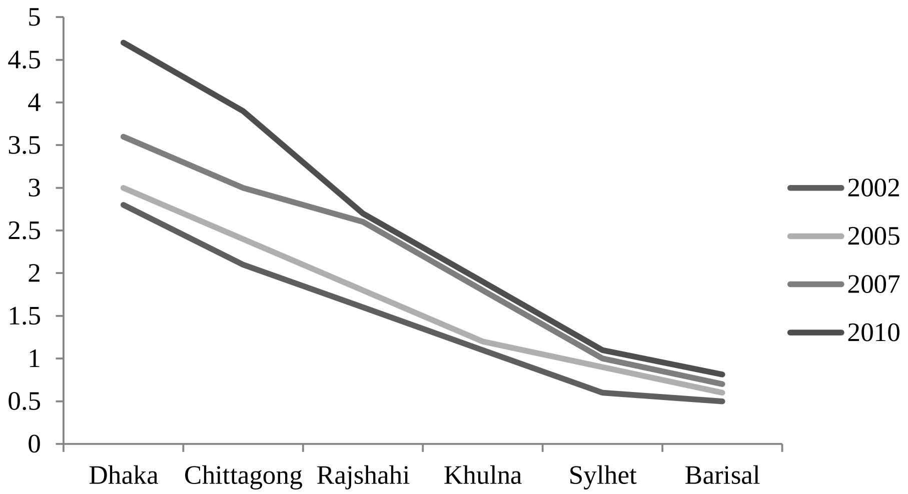
Bangladesh (World Bank 2020). However, news media report, there are estimated 11,000 brickfields in Bangladesh located all over the country where some are not even registered with the government (The Financial Express 2019, DoE 2017). Since data statistics relate to increasing rate of CO_2 emission level are available from six divisions namely Dhaka, Chittagong, Rajshahi, Khulna, Sylhet and Barisal, Figure 2 shows that Dhaka stands first and Barisal stands last in Bangladesh (Imran et al. 2014).

Figure 1. *Brick Production in Asian Countries*



Source: US EPA 2012.

Figure 2. *District-Wise CO_2 Emission Level in Bangladesh*



In Bangladesh, brick industry has been playing significant role for construction houses and other infrastructure and is a major catalyst for economic progress in Bangladesh. However, its production process injects a significant portion of CO_2

from brickfields, which is considered as a major contributor of greenhouse gas (GHG). Scientists found that CO_2 emission plays a critical role in the acceleration of global warming trends (USDOE 1993). In Bangladesh, the major source of CO_2 emission is wood and coal burning (DAPA 2015). This study is limited to looking into emissions level only from brickfield in Bangladesh.

The conventional brick making is held responsible for a host of accompanying perils. There is no disputing that amidst the many hazards affecting the environment, traditional brick making is one that not only adversely affects the ecosystem but more damagingly leaves a harmful impact on livelihood means of the masses, including among others cultivation. This is particularly so when it comes to conventional brick making practiced in Bangladesh for ages

Fired clay bricks are one of the most important construction materials in Bangladesh. Bangladesh stands as the fourth largest brick producer in the world. This industry accounts for approximately 1% of the country's GDP.

Figure 3. *Bangladesh Brick Sector at a Glance - Wood & Coal Fired Kilns*

Source: Daily Sun, 20/01/19.

Table 1. *Brick Sector in Bangladesh*

Total no. of coal fired kilns (Ested)	7,000
Annual brick production	23 billions
Value of output	$2.53 billion
Coal consumption	5.7 million ton
Emission of CO_2	16 milion tons
Clay consumption	3,350 mil cft
Total employment	1 millions

Source: DoE 2017.

Bangladesh has a population of 159.9 million and at current growth rate, Bangladesh will require constructing approximate 4 million new houses annually to meet the demand for the growing population and that, in turn, will lead the growth for the brick sector. Table 1 provides a snapshot of brick sector in Bangladesh (Figure 3).

The brick-industry is largely using inefficient, dirty technology, informal seasonal employment methods and haphazard growth that has created a huge environmental problems. It has been impacting on human health, agricultural yields and global warming. Addressing this issue, the authorities concerned put the blame for being unable to efficiently prevent the kilns from emitting black smoke and violating other environmental rules on local influential and dishonest brick field owners. As government claims, despite the existence of laws, many unauthorized brickfields across the country are operating in conventional methods (DoE 2017). These brick kilns are mostly using wood and some cases using coal to burn bricks (The Financial Express 2019). Its emission level has been damaging arable land by cutting earth and polluting the air. The DoE headquarters, however, has no specific data on the number of brickfields currently operating in the country and the extent of pollution -- the amount of emitted smoke and impact of its contents on human, and crops, vegetation and land. However, a World Bank study released last year found that in the North Dhaka cluster, brick kilns are the city’s main source of fine particulate pollution, accounting for nearly 40 percent of total emissions during the 5-month operating period. The regulator says the harmful brick kilns operating around Dhaka city and other places across the country had been set up after securing approvals through muscle power. Though the DoE officials conduct drives against the illegal brickfields flanked by law enforcers, they fear reprisal from those affected owners at other times.

In a recent global survey, Bangladesh ranked 131st among 132 countries in controlling air pollution with regard to its effect on human health. India holds the very last position (The Financial Express 2019).

Compliance and Enforcement

The Ministry of Environment and Forest (1995, 1997) outlines the environmental regulatory regime to establish environmental administration in Bangladesh and give the Department of Environment (DoE) mandate for their enforcement. The DoE officials are often engaged in different activities to enforce the provisions of laws and rules as provided in the Ministry of Environment and Forest (1995).

DoE routinely conducts compliance monitoring of industries and development projects to ensure that they have been established or undertaken after having Environmental Clearance Certificates (ECC) from DoE as mandated by DoE 1995). The DoE also enforces environmental quality standards and management of those industrial units and project as stipulated in the Environment Conservation Rules, 1997 and conditions set out in the ECC.

As per section 7 of the Bangladesh Environment Conservation Act, 1995, compensation is realized from polluting, non-conforming enterprise for the environmental damage caused by them. Under this regulatory provision, from June 2016 to June 2017 the Department of Environment carried out enforcement drive against 38 brick fields in which a total of Taka 120 million as compensation was assessed and out which approximately Taka 8.5 million was realized.

In addition enforcement activities were carried out against illegal brick kilns under the Mobile Court Act, 2009 under which penalty is imposed instantly by taking cognizance of the offences. During last year mobile court fined a total of 27 brick fields Taka 8.3 million for operating the kilns without having ECC and Brick Manufacturing Licenses. At the same time, a total of 29 brick kilns established without environmental clearance certificates were knocked down by the Department of Environment. However, may newspaper media reported that a significant number of brick kilns are not registered (The Financial Express 2019, The Daily Star 2020).

Objectives of the Study

The objectives of this study are in two folds. They are: first - to communicate on guidance for policy design curtailing the magnitudes of CO_2 emission from brickfields in Bangladesh using welfare analysis in Bangladesh perspective. Secondly, to communicate and facilitate for laying out reforestation techniques in place underpinning ethical-responsibility by doing it so that CO_2 sequestration can be enhanced in the atmosphere.

Methodology

The basic methodologies used in this study are Marginal Damage Analysis and the Standard Partial Equilibrium Models. This study advances based on assumptions, which are crucial establishing factual arguments for the findings.

Assumptions of the Study

i. CO_2 emission is external. It pollutes environment. In other words environment quality is priced like a regular public good.
ii. There are n competitive markets for the emission free environment
iii. For simplicity both export and import of this good (bricks) are small or nonexistent.
iv. Rivalry exists in case of consumer preferences for better environment.
v. Exclusivity exists.
vi. The changes in production level of emission caused by changing the input (wood or coal) and productivity and the change in demand for improved environmental quality (less pollution) by increasing income, population and life style or preferences over time are ignored. There are empirical evidences that increase in population, income and life style preferences increased the supply and demand for better quality of environment.

What Do These Assumptions Guarantee?

All these assumptions ensure that the aggregate demand for improved environment can be viewed as a negatively sloped schedule of the demand for improved environment at various prices holding income and tastes being constant.

These assumptions also ensure that the aggregate supply curve could be drawn as a positive sloped function, holding other prices, cost and technology unchanged. Given the assumptions, the 'n' demand functions of Bangladeshis for improved environment, are the function of n prices which are completely determined. In other words, Bangladesh can be considered as a single market for quality of the environment.

The concept of consumer surplus is used to capture consumer welfare changes resulting from a price change in bricks. The Marshallian demand curve is used to approximate change although the Hicksian demand curve would be theoretically better. However, the difference between Marshallian measurement and Hicksian measurement is not important if the following three conditions are satisfied (Pindyck et al. 2012, Marshall 1895):

1. Identical consumer when it comes clean air facilitation being a part of the society.
2. There is only one price change in one market.
3. Since bricks are products of manufacturing, the income effect is small. If these conditions are met, then the observed demand behavior can be used to construct a measure of welfare change.

The assumption of n identical consumers is an approximation of Bangladeshis where the "traditional match up behavior" makes consumption patterns more or less homogeneous (Pindyck and Daniel 2012, Marshall 1895).

Therefore, for a single price change, the percentage of error resulting from using consumer surplus (CS) in the order of CY/2M which is likely to be small (CY=consumer income, M=consumer's constant income). So, in the static partial equilibrium model, the size of the inefficiency of the efforts modernizing brick kilns for the improved environment purchase and supply system can be measured by the deadweight loss.

CO_2 Emission from Brickfields in Bangladesh under the Framework

In above sections, we used the concepts of "social cost or abatement costs" and "damages" etc. without explaining in any detail how we might measure their magnitudes in particular situations. In this section, this question is addressed. The focus is on welfare analysis as one of the tools economists use to find efficient outcomes and methods available for estimating benefits and costs that can be used to estimate marginal damages and marginal abatement costs relevant to environmental policy decisions. This section advances with two subsections:

Setup the Problem in-terms of Cost-Benefit Framework

Considering the problem of CO_2 emission in Bangladesh from brickfields into my framework, the problem has been represented in Figure 4. I assume here that brickfield 'A' produces Q_1 number of bricks. This production generates wood, coal and other input costs which are costs for both producer and society. In addition, there is a set of costs attributable to the pollution generated by this brickfield which is borne by Bangladeshis society and not by brickfield 'A'. This situation or *scenario* creates a divergence between private and social costs, which are also shown in Figure 4.

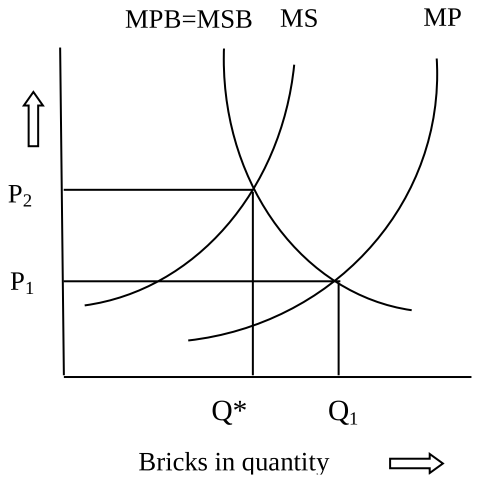
Results and Discussion Underpinning the Setup

Here social cost includes additional costs consisting of the damages generated by effluent gases emitted by the brickfield A while producing bricks. In Figure 4, Q_1 number of bricks is total production corresponding to marginal private cost (MPC) equal to marginal private benefit (MPB). This Q_1 is greater than socially optimal level of output Q^* corresponding to marginal social cost (MSC) equal to marginal social benefit (MSB).

The excess cost (EC) = $(Q_1 - Q^*) * (P_2 - P_1)$ represents the cost to Bangladeshis society for having this higher level of output than optimal level. Considering all brickfields in Bangladesh, the total excess cost is $EC_{BD} = n * (Q_1 - Q^*) * (P_2 - P_1)$. This is considered as the total damages i.e., pollution generates from n number of brickfields by degrading the environment in Bangladesh. In Figure 5, the area e represents total damages in Bangladesh by the brickfields. The total resource costs are examined in Figure 6. Here resource cost associated with Q_1 is area OBQ_1. Area OP_1BQ_1 represents the benefit gained by Bangladesh society from having the resources utilized in 'n' brickfields in Bangladesh. Area OQ_1B represents opportunity cost. Here, net value = area OBE, PS = P_1OB and CS = EP_1B. Considering Figure 4, Q^* pieces of bricks production guarantees Bangladeshis a pollution free environment but they will have to spend as a whole $n * (P_2-P_1)$. The welfare loss for this higher cost is shown in Figure 7.

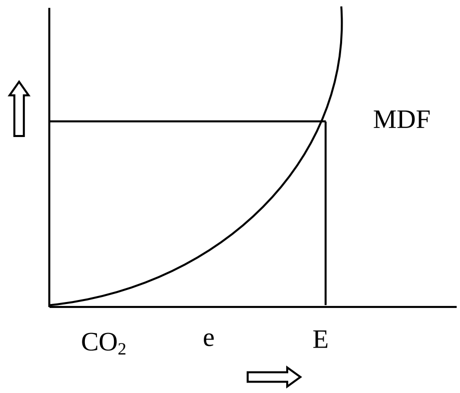
In this case, the changes in price cause changes in CS. Price changes from P_1 to P_2 causes CS drops equal to the area (A+B+C+D). On the other hand, PS increases by area A which directly goes to brickfields' owners. Area B represents variable input cost. Area (C + D) is "deadweight" usages loss because consumers allocate this expenditure away from now more expensive Q_1 number of bricks usages. It can also be represented as Bangladeshi's real income loss for having a pollution free environment. It is noted that the relative size of (C + D) depends on the magnitude of the induced price change and price elasticity of supply and demand.

Figure 4. *Market Failure when Brickfields are Free from Regulation*



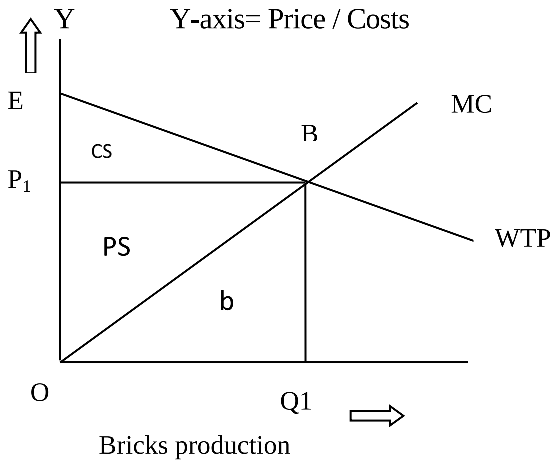
MSC= Marginal social cost
MPC= Marginal private cost
MPB= Marginal private benefit
MSB= Marginal social benefit
Q^*= Bricks production in emission free situation
Q_1= Bricks production with emission

Figure 5. *CO_2 Emission from Brickfields*



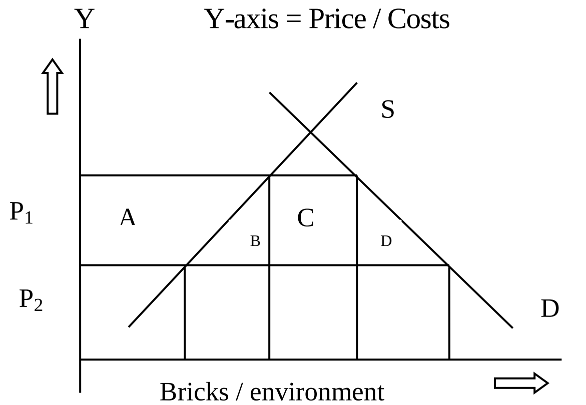
MDF = Marginal damage function

Figure 6. *Resource Cost for Producing* bricks



MCP=Marginal cost for the kiln
WTP = Willingness to pay
CS = Consumer surplus
PS = Producer surplus
B = Resource cost or Opportunity cost

Figure 7. *Welfare Aspect of Producing Bricks with CO_2 Emission*



BS = Brick supply
BD = Brick demand

Feasible Options for CO_2 Emission Reduction from Brickfields in Bangladesh

It is well recognized that policy decisions require information, although the availability of good information does not automatically mean that decisions also will be good, its unavailability will almost always contribute to bad decisions (Rahman 2018). There are a variety of alternative frameworks for generating and presenting information useful to policy-makers, calling for different skills and research procedures. We focus on benefit-cost analysis as one such method of quantifying the theoretical concepts addressed thus far and as a decision tool that governments may use to evaluate policy options and environmental infrastructure investments. On priority preferences, cost effectiveness analysis can be instrumental choosing option in policy-design.

Accordingly, the primary goal of this section is to look for feasible options abating CO_2 emission from brickfields in Bangladesh underpinning Kyoto Protocol requirement. Here each policy-option is cross-examined individually using welfare analysis particularly benefit-cost underpinning assumptions separately for each policy-option.

Reforestation

Reforestation is an act of restoring indigenous or exotic forests to lands originally covered by forest. Many studies found that reforestation is one of the important options in reducing the level of CO_2 in the atmosphere because it significantly mitigates CO_2 emissions (Busch 2019). Plants can be used to control or sequester CO_2 in the atmosphere.

Hence, increasing the number of trees or plants and thus increasing the rate of photosynthesis may increase biological fixation of CO_2 and other effluent gases emit from brickfields. Applying this reforestation idea into welfare analysis which is shown in Figure 8, let us assume brick-kilns or government makes tree planting decision setting MPC = MPB.

Figure 8. *Welfare from Reforestation*

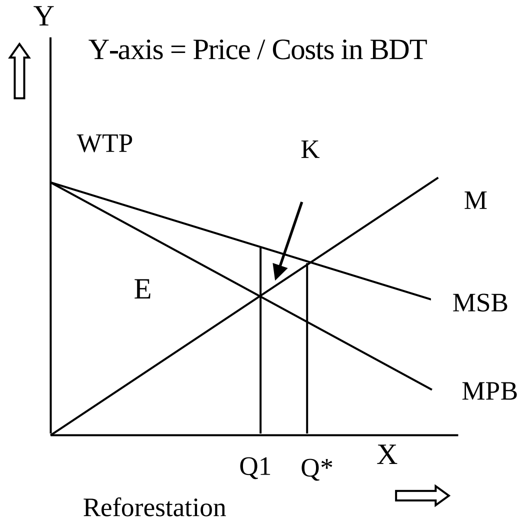
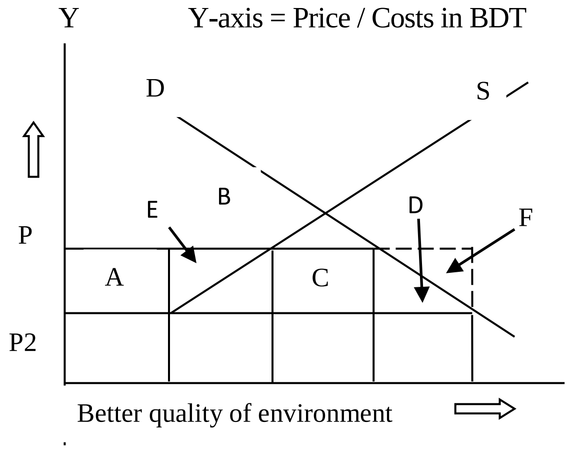


Figure 9. *Welfare Aspect from Better Quality of Environment via Government Subsidies/Company Charity*



The corresponding market level of reforestation planting is Q_1 and optimal level is Q^* (for Bangladeshis) that are generated by reducing soil erosion, higher degree of better environment. Area K represents net social gains that are generated by planting trees. The following three approaches can be considered.

i) If brick-kiln industries are involved in planting, then the companies can pay the planting cost as a charity (public service) to the society where DoE will monitor the actuality.
ii) On the other hand, if government is involved in planting, then government will collect these environmental costs or taxes from the companies responsible for emitting CO_2 from individual brickfield in Bangladesh. In this case environmental clean- up or pollution prevention is a task for the government like any other public infrastructure (road, telecommunications etc.). This dual approach ratifies sharing the cost among Bangladeshis for the better environment.
iii) Government can encourage its populations in different ages to celebrate individual birthday by planting a tree(s) beside roads & highways and near train-lines with the approval of local assigned officer(s) under DoE. In this process, authority(s) can issue Celebration Certificate. This message can be communicated *via* schools, colleges and universities for effective and continuous outcome.
iv) Motivation is to be strengthened that a forestation is a social and moral obligation for every citizen. It should begin with introducing the message in institutional education system i.e., part of curriculum in classroom.
v) Research on identification of fast growing species of trees, having better fuel and timber values shall be strengthened keeping local climate and social condition in view. Also research on utilization the technique of using sugarcane

<u>Welfare Analysis of Reforestation</u>

Considering government subsidies or brick kilns' charity in Figure 9, area (A+B+C+D+E) is consumer surplus. Company pays area (A+E) as charity. Government subsidies are area (E+B+C+D+F) that is collected from Bangladeshis as taxes. Net loss to Bangladeshis is (E+F). Area E reflects a net loss of producer surplus, underutilized resources, subsidies or charity. Area F is deadweight loss that is just lost (Rahman 2018).

Taxation

Taxation is one of the most important means by which the growth of an economic activity can be controlled. This is because the imposition of a tax can act as a catalyst to create incentives for investment in curtailing CO_2 emission (Hahn and Stavins 1991). The basis of taxation may differ. Addressing CO_2 emission reduction in Bangladesh, new taxes can be based on the rate of emission instead of taxes on number of bricks produced. Taxes on bricks usages do necessarily cause a reduction of CO_2 emissions from the brickfields. This study examines only the option "taxes on emission". The term "taxes on emission" can also be represented as an abatement cost.

Emission abatement level can be determined by setting marginal damages (MD) equal to marginal abatement cost (MAC) as it is shown in Figure 10a. Here, emission level is set at E_1 and it is curtail-able via CO_2 sinks in atmosphere. Brickfield 'A' abates E1/n units via regulation.

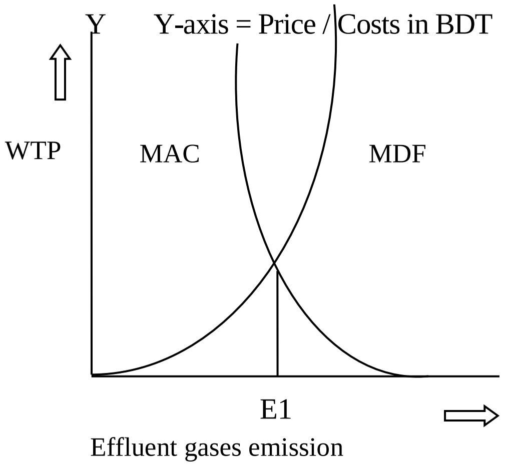
Assumptions under Taxation Policy-Option

i) Government (the DoE) intensively monitors each brick kiln's CO_2 emission level.
ii) Government does not know brick kiln industries marginal cost (MC). It is ambiguous measuring in BDT of both marginal damages caused for CO_2 emission and marginal abatement cost required for abating it. The idea of optimal level of emission need not be static but may change or be adjusted over time and it assists to overcome this constraint.
iii) Government sets the target at 'a' in Figure 10b but brick kiln say A's emission level is at E_2. As $E_2 > E_1$, therefore, brick kiln 'A' pays taxes for $(E_2 – E_1)$ in a certain fashion.

Welfare Analysis of Taxation Policy-Option

This policy maneuver reduces producer (kiln A's) surplus by (A+B+C+D) in Figure 10c. Variable inputs in this illustration move into other competitive technology or inputs to improve plant's performance and energy efficiency to minimize the losses of producer surplus. Now the question is: how does PS loss spread throughout economy of Bangladesh. The value (A + B) becomes an increase in CS which can be interpreted as the improvement of environment comparing other environment where "command and control" is not in practice. The value D picked up as tax revenue to the government collected on the volume of $(E_2 – E_1)$. This leaves the triangles C and E to be accounted for. Here C represents loses to the society and it will be equal to zero by adjusting the target level over time. Area E is deadweight loss that can't be picked up by any economic entity.

Figure 10a. *CO_2 Emissions after Regulations*

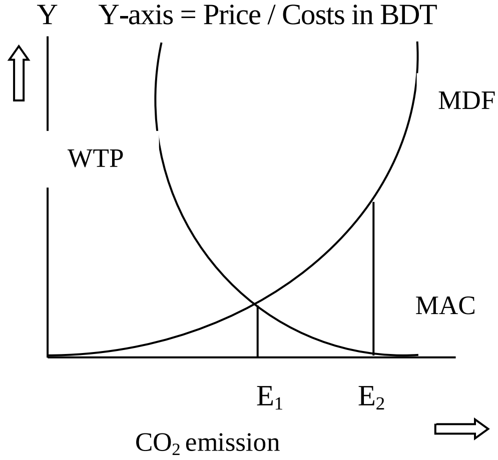


MAC= Marginal abatement cost

MDF= Marginal damage function

E_1= Optimal level of emission, which is consistent with protection of health

Figure 10b. *CO_2 Emission under Command & Control*



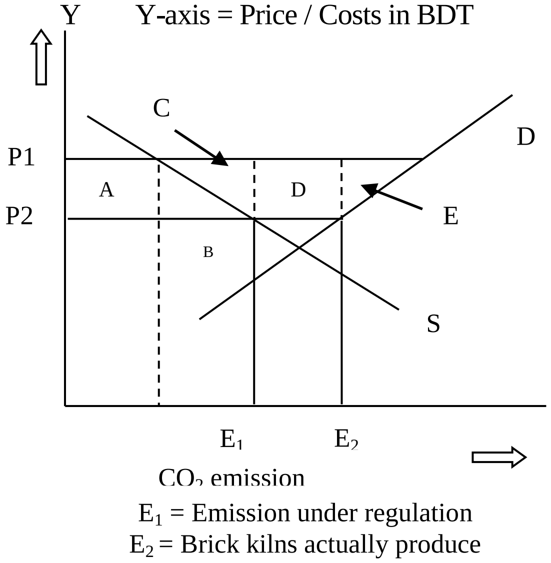
E_1 = Emission under regulation

Usages of CO_2 Emission Control Technology

The Clean Air and Sustainable Environment (CASE) project supports a whole range of activities including introduction of energy-efficient brick making technologies and also is demonstrating the viability of alternative building materials.

Such technologies as Improved Fixed Chimney Kiln (IFCK), Improved Zigzag Kiln (IZigzag), the Vertical Shaft Brick Kiln (VSBK), and Hybrid Hoffmann Kiln (HHK) are substantially cleaner, consume less energy and emit lower levels of pollutants (Sarraf and Croiltoru 2012). In most of the methods, other than HHK, coal is used as fuel to burn the bricks. The regulator also suggests that the production of hollow block bricks needs to be prescribed, even though it is costlier, as the method contributes nothing harmful to the environment. Bricks are made with silt, cement and stone crush, and later are dried in the sun. These bricks are sound proof and earthquake-friendly.

Figure 10c. *Welfare Analysis under Command and Control*



Fuel Switching and Reappearing Power Plants

Furthermore, CO_2 emissions may also be reduced by fuel switching brickfields (Hahn and Stavins 1991). But the question of cost effectiveness is a serious concern in this regard. It is very expensive to "scrub" carbon from combustion waste gases. It was determined, in one study that the collection and disposal of brickfields, the effluent gases emissions would at least double the cost of coal-fired brickfield (Biswas et al. 2009).

Clean Coal Technology

Clean coal technology refers to new and advanced coal utilization technologies, which are more efficient (in most cases), resulted lower cost and are more environmentalism sounds comparing traditional coal burning exposure. The use of quality raw materials may facilitate better kiln firing process in overall. The development of green belt around the brick kiln industries may be an effective mitigation mechanism. Furthermore, with clay, usages of sugarcane bagasse ash have been recommended as brick materials in literature (Tonnayopas 2013). It can be an instrumental curtailing the magnitudes of emission from brickfields in Bangladesh where government's inspirational efforts are important.

Monitoring Number of Brick Kilns and Conducts Mobile Court Drive

Bangladesh Government report entitled: National Strategy for Sustainable Brick Production in Bangladesh (DoE 2017), clearly shows that there are total 7,000 brick kilns in Bangladesh. However, report on total number of brick kilns in Bangladesh varies from government information to private information. Like many private entities, the Financial Express reported that there are more than

11,000 brick kilns that currently in operation in Bangladesh where a significant numbers are not registered with the government (The Financial Express 2019).

To overcome this dilemma along with immediate efforts for curtailing the magnitudes of CO_2 emission level from brickfield, government should play active roles conducting Mobile Court Derives. This policy and effective efforts will be a win-win for the society as a whole where it can ensure generating adequate revenues as well curtailing magnitudes of CO_2 emission, which can be appreciated by the relevant international organizations including UNO where it would not be hesitated granting monetary support underpinning Kyoto Protocol Agreement.

Future Research

If research grants are available, multi-faucets studies can be conducted examining the possibility of utilization of green tech in brick industry using opinion-survey of management & employees in brick kilns in Bangladesh. Factor Analysis and hypothesis development & testing can be carried out so that the expected findings can be educational enhancing the growth of utilizing green tech meeting the challenges. Welfare analysis can be carried out for clean bricks users, brick kilns and the society of Bangladesh. Lastly, cost effectiveness or efficiency cost analysis can be carried out in priority decision when it comes choosing policy option(s) from the recommended ones in this study.

Conclusion

Since the beginning of civilization, bricks have been playing important roles for construction of houses and other infrastructure, which are major catalysts for economic progress in Asian countries where Bangladesh is no exception. In recent years, rapid urbanization and then rural to urban migration in Bangladesh has created an increasing demand of usages bricks. However, brick-kilns largely use inefficient, dirty technology, informal seasonal employment methods and haphazard growth. Thus, it emits huge volume of CO_2 and other gases in environment, which depletes atmospheric O_2. For policy guidance, this study analyzes the basic issues of CO_2 from brickfields in terms of MD analysis and the neoclassical partial equilibrium demand & supply theory. It further analyzes the reasons of disparity between social and private cost by conventional marginal damage analysis. Findings show that because of CO_2 emission from brickfields, the marginal social costs are higher than marginal private (producer of bricks) costs. Brick kilns are benefiting itself with the expense of Bangladeshi society as a whole. Continuation of increasing number of brick production under traditional fuels (woods and coal) in Bangladesh, it results higher welfare loss incurred from higher social costs. Also, because of high rise demand of bricks due to continuation of rising per capita income, prices of bricks are becoming upward trends in Bangladesh, which have been dominating the increases of producer surplus. By using inefficient fuels in brick industry, producers continue generating higher revenues and consumers facing higher prices, which creates higher deadweight loss year after year.

Under national strategies and policy actions for cleaner and sustainable brick production in Bangladesh, few proposals are put forward. Reforestation efforts can be achieved in multi-faucets including brick-fields' charity, govt. policies on planting trees, govt.'s policies on motivational efforts inspiring citizens of this country. These efforts can be in multi-faucets: a) Inspiring celebration of individual's "Birthday, Having 1st Child in family and Event of a marriage" by planting trees b) Forcing to utilize green tech in brick kilns and c) Conducting research in both phases including govt. and academic arena where financial supports are in need.

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