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by

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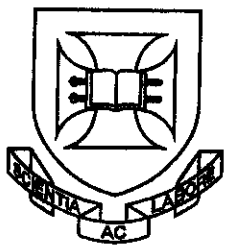

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and
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DEFORESTATION MECHANISMS: A SURVEY

D.H. Wibowo and R.N. Byron[1]

INTRODUCTION

The future of tropical forests has in recent decades become an issue of international concern. There are ample evidence that, despite some degree of disagreement about the "true" rate of deforestation, depletion of the world's tropical forests continues at a very alarming rate. Prior to the 1980s, it is estimated that about 27.5-31.0 million hectares of tropical forest disappear every year (Myers, 1981). In 1989 alone some 14.2 million hectares were cleared (Myers, 1991). FAO (1993) estimates a deforestation rate of 15.4 million hectares annually, or about 1.2 per cent/year between 1981-1990.

Unlike deforestation of temperate forests where most causes are internal to the forestry system, tropical deforestation involves many external forces (Vanclay, 1993). It is a very complex social economic process, that may stem from a complex interaction between many factors. As most countries in the tropics are developing nations, these external factors often intertwine with the development process these countries are undergoing. In most cases it is often difficult to single out a specific factor(s) that influence(s) tropical deforestation. Moreover, there exists a certain degree of disagreement among economists about the directional impact each of these factors, and/or their interactions, have on

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deforestation. Thus, there are no straightforward answers as to how social and economic factors such as social values, religious belief, property rights, contract period and timber prices influence deforestation.

In this article, we present a critical review on various analysis about the underlying cause(s) of deforestation and under what mechanisms deforestation takes place. We categorise these analysis into four groups, i.e. Neo-Malthusian, government-failure, microeconomic and macroeconomic approaches. The article is organised as follows. First we present the definition of deforestation and reviews whether or not deforestation is undesirable economically. A detailed review of the four approaches above is then presented. Finally we summarise evidence from the Kerinci-Seblat National Park (KSNP), Indonesia, where deforestation is associated with farmers' capital accumulation behaviour.

WHAT IS DEFORESTATION AND IS IT UNDESIRABLE?

In principle the term "deforestation" refers to a process where forests are cleared by human activities or destroyed by natural disasters, and then converted into other land uses or left as abandoned land. In this study, we shall be concerned mainly with deforestation resulting from human activities. Following Myers (1991), deforestation occurs if all trees have been removed and the land is converted into agricultural or other non-forest uses, or if the remaining trees no longer qualify as a forest, regardless of their proportion to the initial forest covers.

In general, economists are willing to tolerate certain forms of deforestation, provided that

they bring net development benefits and satisfy both social cost-benefit analysis and economic efficiency criteria. From the development benefits viewpoint, it is argued that not all forms of deforestation can be regarded as economic "bads". Deforestation projects that increase the long-term social welfare of the community, such as constructions of dam, road and irrigation canals, are generally desirable. It is then important to distinguish between unintended deforestation and measured conversion of forests for development purposes. The former is generally undesirable, while the later is acceptable as long as negative externalities such as species extinction are compensated for. See for example Byron (1994), Kaimowitz *et al.* (1997) and Mendelsohn (1994).

Deforestation is also acceptable if it satisfies the feasibility criteria applied in a social cost-benefit analysis (SCBA). Many deforestation projects, however, appear to satisfy the criteria while in fact they do not. In the case of a logging project, for example, conventional SCBA implicitly assumes that negative externalities will be offset by benefits flowing from reinvestment of logging taxes. As a consequence, these externalities are not counted in the cost-side of the analysis. Price (1990), however, argues that this assumption does not necessarily hold because not all revenues from deforestation are available for reinvestment, or if available, are not reinvested. Thus, the project may in fact less, or even not, feasible economically.

Economists also justify deforestation because it is economically efficient to do so. Making

analogy to Clark's bio-economic model of extinction[2], Swanson (1994) categorises deforestation into an economic activity called "stock disinvestment" or "resource mining". It refers to the liquidation of high-valued-but-with-low-growth resources. To liquidate the forests for their high value and to invest the funds in assets with higher growth rates are then seen as economically efficient.

Ecologists generally disagree with these "apologetic" views of economists, especially on the basis of species extinction and sustainable development arguments. Tisdell (1990) presents an extensive review about this debate. While it is true that deforestation projects do to some extent improve the current social welfare of the society, in some cases forest conservation (as opposed to deforestation) can even bring greater and more sustainable economic benefits (Tisdell and Xiang, 1996). Moreover, it should be noted that the Hartwick's rule for reinvesting rents from resource extraction, as assumed in the conventional SCBA, is not a recipe for sustainability (Tisdell, 1997). As a consequence, economic criteria alone cannot provide decision makers with sufficient basis for deciding whether a deforestation project is desirable. Biophysical and political criteria also need to be taken into account in this case (Kaimowitz *et al.*, 1997).

ECONOMIC MECHANISMS OF DEFORESTATION

[2]Clark's (1973) model is in fact related to the extinction of animal species. It builds upon the assumption of an open access regime, which implies that a resource will be harvested until the average cost of harvest equals the resource's price. Under Clark's model, bioeconomic equilibrium is extinction because resources with high price-cost ratio and low growth rate will be harvested until the point of extinction.

Neo-Malthusian Approach

Under the Neo-Malthusian approach, population pressure is seen as the underlying cause of deforestation. While many agree to this argument (see for example Sandler, 1993, and Vanclay, 1993), only a few have presented a plausible mode of action or tested this hypothesis empirically. One example is Deacon (1994), which shows that deforestation is associated with population growth five years earlier. Surprisingly, the results also show that if higher- and lower-income countries have the same rate of population growth, the former would exhibit a higher deforestation rate.

It is, however, still too premature to draw firm conclusion from the study. This is because the results are clouded by a number of technical and empirical deficiencies. For example, doubts arise over the accuracy of the results because the 1985 data on forest cover for about one-third of the 129 countries analysed are actually estimated from a regression between *total forest* and *forest and woodland area*. Data expansion to about a half of the total observations actually available can only produce "estimates". It is unfortunate that Deacon presents no regression results for the 84 countries where the data are *actually* available, so that a comparison can be made.

Also, if high income countries are excluded from the analysis, the regression coefficient for the 1975-80 population growth declines from 0.1860 to 0.1247. Its significance level "drops" to above the 10 per cent level. Thus, the inclusion of high-income countries alters the results considerably. Because low deforestation rates in these countries can be attributed to many factors (e.g. higher income and better law enforcement), it raises

serious doubt about the importance of population growth in the model.

Question also arises as to whether Deacon's choice of dependent variable, D_i, is the best proxy for deforestation. Defined as the change in the log of forest area between *t-1* and *t* in country *i*, the formal form for D_i is $D_i = log(A_{i,t-1}) - log(A_{i,t})$, which can be rewritten as $e^{Di} = A_{i,t-1}/A_{i,t}$, where *A* is the land area identified as forests. There are of course some other alternative forms for D_i, such as $e^{\tilde{D}i} = (A_{i,t-1} - A_{i,t})/(A_{i,t-1} + A_{i,t})$ or $\tilde{D}_i = log(A_{i,t-1} - A_{i,t}) - log(A_{i,t-1} + A_{i,t})$, where $\text{Var}(\tilde{D}_i) < \text{Var}(D_i)$. With a lower variance, use of $\tilde{D}_i$ might yield different results.

All criticisms above are not intended as a repudiation to Deacon's results, nor to the hypothesis that population pressure induces deforestation. Rather they highlight the enormous difficulties faced when one tries to obtain satisfactory econometric results from a cross-country analysis. Data on forest covers and deforestation rates are often incompatible from one country to another, making the analysis even harder. For this reason, one should not overlook micro-level studies, which despite their "local" scope may enable researchers to better understand how deforestation occurs.

Government Failure

The term "government failure" refers to, first, misdirected policies that result in unintended deforestation, and secondly, inability to preclude preventable deforestation due to the failure of government institutions to function effectively.

Log-export bans and timber prices. Log export bans are probably the most commonly cited "misdirected" policies. Developing countries impose the bans as a means to promote the development of their export-oriented processing industries. The policy is thought to have led to a larger deforestation because it forces domestic timber prices to decline[3]. The most common explanation is that, lower domestic prices encourage wasteful logging, diminish processing efficiency, and as a result, increase deforestation rates. This view can be found in Reppeto and Gillis (1988) and in a number of World Bank reports cited by von Amsberg (1994). Note that implicitly, and without any justification, these studies use logging as a synonym for deforestation. There is however ample evidence throughout Asia and the world that many areas have been deforested without ever having been commercially logged, and conversely, many areas have been commercially logged but are still quite reasonable (but not pristine) forests.

Another explanation is that, lower timber prices reduce the value of standing timber, and thus lead to a reduction in forest owners' profit. At one point, timber prices become low enough to make alternative land uses (e.g. agriculture) more economically profitable. This will then encourage conversion of forest standing into other land uses (Vincent, 1990). This view, however, assumes away the most common situation where the forest owner is a government forestry agency, which rarely behaves as a profit maximising owner and is

[3]Another effect the bans have on timber market is that they restrict the amount of logs available for international supply. This in turn leads to the collapse of timber processing industries in countries where domestic log supply is limited. The collapse of the Japanese plywood industry in the 1970s and 1980s, for example, is associated partly with log-export ban imposed by its major supplier, i.e. Indonesia. Other evidence suggests that Japan, Korean and Taiwan had already recognised that their comparative advantage had radically changed, and had already decided to phase out the wood industries based on imported logs (Byron, 1980)

rarely interested in converting reserved forests to agriculture.

There exist however opposing views, which argue that lower domestic prices can in fact discourage deforestation. This is because, as lower prices reduce profits from logging operations (assuming a constant logging cost), loggers have less incentives to continue their operations. Moreover, given that logging costs usually increase with increased remoteness of the areas to be harvested, lower timber prices may even act as a deterrent to the harvesting of remote forests.

Von Amsberg (1994) reconciles these conflicting views by distinguishing two different types of forest, i.e. unmanaged- and managed-forests. Unmanaged forests include old-growth and secondary forests that have not been logged until they are mature for harvest. Managed forests include forest plantation and other forests established for periodic harvests. Making use of the classical von Thunen's land-use model, the results show that because unmanaged forests are seen as timber storage, the profit-maximising response to lower timber prices is to leave the forests unlogged until the prices rise to a more profitable level. Thus, lower timber prices discourage the logging of unmanaged forests. Managed forests, on the contrary, are seen as inputs for timber production. Reductions in timber prices will result in a lower amount of land allocated for development of the forests. While this does not in any way mean a higher deforestation level, it is obvious that lower timber prices lead to lower forested areas.

In our view, all these analysis are concerned mainly with the supply side of log export

bans, with little attention given to the price elasticity of domestic log demand. Basic microeconomics state that, if demand is price-elastic, assuming constant production costs, the profit maximising response is to sell more at a lower price; and *vice versa*. Figure 1a shows how this simple principle explains the effect of log-export bans. In this analysis "the volume of commercial logging" may or may not equate to "deforestation level".

TAKE IN FIGURE 1A

An export ban will shift the demand curve from D_1 to D_2, and reduce domestic log price from P_1 to P_2. Note that D_2, which represents domestic log demand, needs not have the same slope as D_1, which represents the sum of domestic and overseas demands. If the short-run supply curve stays at S_1, the quantity of log traded declines from Q_1 to Q_2. This means a lower volume of commercial logging.

Now assume that lower timber prices induce producers to extract more timber to compensate for their declining revenue. As a result the short-run supply curve will shift to S_2. If D_2 is inelastic, at a constant logging costs, producers will maximise profit by supplying logs at Q_2, with a price of P_2 and a revenue of OP_2BQ_2. This will result in a lower volume of commercial logging because $Q_2<Q_1$. However, if D_2 is elastic, producer will receive a higher revenue of OP_3CQ_3 by supplying log at Q_3, albeit at a price $P_3<P_2$. The question is then how elastic is the demand. If it is elastic enough to force producers to significantly increase the quantity sold, then $Q_3>Q_1$, which means a higher volume of commercial logging. But if the demand is not elastic enough, then it is possible to have $Q_3 \leq Q_1$. How much is "elastic enough" is of course an empirical issue.

TAKE IN FIGURE 1B

If producers are unable to harvest more timber, say because the government implements effective monitoring and control policies, the short-run supply curve is likely to stay at S_1. Lower timber prices will only increase the volume of commercial logging if the supply curve is backward-bending[4]. It is shown by an increase in the quantity of log traded from Q_1 to Q_2 in Figure 1b. Whether or not domestic log supply is backward-bending is again an empirical question.

In many cases, however, deforestation is related mostly to household demand for farm land, rather than to demand for timber. As a consequence, timber prices have little, if not zero, effects on deforestation rate. This is because farmers do not sell timber from the cleared land. Instead they use the timber as raw materials for farm buildings and/or as fuelwood for their own consumption. Because a large portion of the global deforestation rate can be attributed to farm household activities (Myers, 1981, 1991; Sandler, 1993; Singh, 1994), this demand-for-farm-land type of deforestation may have subdued the effect of timber prices.

Corruption. In addition to forest clearing by farm households, another major cause of deforestation is unsustainable logging practice. Citing a report from a Papua New Guinean Commission of Inquiry, Vanclay (1993) argues that unsustainable logging is only a symptom rooted from more serious problems such as corruption and greed.

Corruption makes bureaucrats and government institutions unable to perform their

[4]We owe this point to Professor Clement A. Tisdell.

supervisory duties effectively. In theory such a failure, combined with the concession holders' decision myopia, could lead to excessive logging. Analytical proofs for this point is provided by Walker and Smith (1993). Using a sequential-decision model, Walker and Smith defines a concession holder's annual decision problem as "whether or not to remain in compliance with the terms set in the logging contract"(p.388). Assuming that the contract terms are consistent with sustainable logging regime, compliance means the adoption of "sustained-harvest" by the logger, while on the contrary, non-compliance means a "liquidation-harvest".

The results show that with a zero detection probability, at a discount rate of 5 to 15 per cent, and with a contract length of 5 to 20 years, concession holders tend to violate the terms of the contract throughout its entire period. If detection probabilities fall below a given threshold that ensures compliance to the contract (for example, the threshold at a 5 per cent discount rate and a 10 year-contract length is 0.1238), it is economically rational for concession holders to choose liquidation harvest.

Given these results, to minimise deforestation governments need to determine the most cost-effective inspection policy, that is, a policy with the highest probability for the successful detection of contract violations at the lowest possible costs. If a country is plagued by rampant corruption, government institutions tend to fail to perform such a policy. This is because resources that should have been used to make these institutions better-equipped with staff, equipment and operational budget are diverted into personal uses by the corrupt officials. And if a contract violation is detected, the corrupt officials

often turn a blind eye on it, in return for personal favours offered by the violating companies. Following Walker and Smith's results, it can be inferred that since corruption makes inspection policy ineffective, logging companies become more inclined to adopt unsustainable logging.

Empirical evidence that show the link between corruption and deforestation are however difficult to obtain. Not only because to prove corruption involves complex judicial proceedings, in many developing countries corruption are so widespread, implicating executive, judicative and legislative officials that it is almost impossible to expose even a tiny portion of the problem. With such a limited information available, analysts cannot perform an accurate study on the effects of corruption on deforestation[5].

Despite this limitation, we present as an indication the case of deforestation in Indonesia. Transparency International, an anti-corruption body, ranks Indonesia among the ten most corrupt countries from a group of 54 countries it surveyed in 1996, along side with India, Russia and China (Pitman, 1996). In the forestry sector, examples of corruption include the allocation of logging concessions to military, political and business elites without transparent procedures available for public scrutiny. They also include some forms of collusion between logging companies and bureaucrats responsible for logging supervision.

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[5]Analysts often use subjective corruption data collected from surveys amongst business persons and economic leaders with business experience in each of the countries surveyed. These data are available from, for example, *World Competitiveness Report*, *Business International* and various reports published by Transparency International. Ades and Di Tella (1997) show how corruption is defined differently from one survey to another, and between surveys conducted by the same agency in different years. Such inconsistencies indicate that data on corruption are still far from adequate.

Under such an environment, and worsened by the lack of technical capacities *vis-a-vis* the vast areas of logging concessions to be supervised, detection policy has become minimal. As a result many logging companies are involved in "illegal logging". Current estimates show that the actual levels of logging may exceed 40 million cubic meters per year (mcm/y), well above the reported log production of about 32 mcm/y (World Bank, 1994). Given the current consensus, that to be sustainable the rate of log harvest in Indonesia should be set at 31.4 mcm/y, declining to 25 mcm/y in year 2000, this illegal logging clearly threatens the long-term sustainability of the country's forest resources.

Microeconomic Approach

The microeconomic approach attempts to provide explanations on how, under various forms of market failure, an agent's economic behaviours lead to deforestation. The frequently cited forms of market failure are poorly defined property rights, poorly designed logging contract and undervaluation of forest benefits, either at the local, regional or global level. Many of these works follow the classical work of Gordon (1954) and Hardin (1968) on common-property resources.

Property rights and the tragedy of the commons? Many point to poorly-defined property rights as the main form of market failure that causes deforestation (Barbier *et al.*, 1991; Deacon, 1994; Hodson *et al.*, 1995; Mendelsohn, 1994; Mendelsohn and Balick, 1995; Sandler, 1993; and Tietenberg, 1992). In this case the contrast between properly defined rights (whether in the form of fee-simple ownership, or recognised and established common property rights) on the one hand, and the absence of defined rights ("open

access") or contested claims to property rights on the other hand, is often highlighted.

Following Hardin's (1968) "tragedy of the commons", the conventional wisdom is that forests held under common property will almost certainly be severely deforested. Gordon's (1954) and Clark's (1973) models of open access over-exploitation in the fishery sector provide the basis for later works conducted under this wisdom. In general these models suggest that under an open-access environment, the bioeconomic equilibrium is extinction (See also Clark, 1976, 1990; and footnote #3). With an open-access, anyone can utilise the resources at a very low cost. Thus, no one has the incentives to control over-exploitation and/or to maintain the quality of the resources. Individuals can also use the resources to satisfy their needs with no regards being paid at the damages inflicted upon others, both in the present and future periods. Such a view has led many to argue that the first-best solution to the open access problem is to establish a secure property rights (e.g. Mendelsohn, 1994).

Poorly-defined property rights also increases long-term risks and uncertainty for forest users. Deforestation produces higher short-run income and consumption for the users, while on the contrary, sustainable forest utilisation requires that some, may be a large, portion of these short-run benefits be sacrificed in return for a stream of *expected* future income and consumption. As the future is full of uncertainty, poorly-defined rights make the users increasingly uncertain whether or not, at a given rate of time preference, their foregone short-run benefits will be compensated for in the long-run. Under such a risky environment the users become more inclined to over-exploit the forests.

Moreover, poorly-defined property rights discourage the establishment of long-term forest investments such as timber plantation. The users feel insecure because there are some probabilities that they will be evicted from their land by other users or government officials. Mendelsohn (1994) shows that even at a very low probability of eviction, the destructive agricultural practices are found to be economically more attractive than sustainable forest harvest.

The above discussion obviously underlines the importance of property rights for forest management. Some analysts go even further by claiming that "no conservation strategy is likely to succeed without the recognition of properly defined property rights" (Hodson *et al.*, 1995, p.1321). In this case, Hodson *et al.* associate exclusively the term "properly-defined" to "fee-simple (private) ownership" or "a conditional ownership (e.g. utilisation contract) with enforceable strings to ensure that the forests are to be preserved". The underlying assumption for this argument is that only these kinds of ownership guarantee minimum risks for investors. However, there is ample evidence throughout Asia of effective long-term, sustainable and equitable forest management as managed common property. It is the confusion between open access and a managed commons that has led Hodson *et al.* to make the demonstrably false claim that common ownership is a recipe for natural resources "to be harvested so intensively that they will decline to less-than-viable populations" (p. 1320), unless they have "extraordinary powers of reproduction". Thus, while it is true that for an open access resource "there is little reason to expect a commercial incentive to preserve the use of the land as rain forest" (p.1320), this must not be extended to managed commons.

One example which clearly repudiates the claim that any resources held in common property would always be over-exploited is the existence of *hutan adat*s within the Kerinci-Seblat National Park area in Indonesia. A *hutan adat* is a commonly owned and managed forest considered to be sacred by a traditional society (e.g. a tribe). Members of the society are allowed to collect non-timber products from the forest and to do hunting or fishing. But nobody is allowed to clear the forest. The continuing existence of *hutan adat*s for decades indicates the capacity of local society to utilise common forests sustainably. Berkes and Folke (1992) cites some other examples, including communal land tenure in Torbel, Switzerland and common land management in Hirano, Japan. Pinedo-Vasquez *et al.* (1990) show how a Northeast Peruvian community manages communal forests sustainably by putting self-restrictions on forest harvests.

Outside the forestry sector, other resources such as water, grazing lands, catch fish and wildlife have also been sustainably utilised under common property rights (Feeny *et al.*, 1990). An example for this is the traditional *Subak* irrigation system in the island of Bali, Indonesia, where common water resources are shared and utilised sustainably.

From these examples, some analysts appear to have under-estimated the capacity of traditional social controls (e.g. religious values, customs and taboos) to ensure sustainable utilisation of common resources. This may stem from economists' failure to recognise the interdependencies between natural, human-made and cultural capitals as the basis for

guiding society toward sustainable uses of natural resources (Berkes and Folkes, 1992)[6].

Logging contracts and follow-on farmers. Deforestation may result from establishment of permanent farms by follow-on farmers on abandoned logging plots. Walker (1987) argues that this form of deforestation is caused by suboptimal contract length. Assuming constant prices and linear costs, Walker shows that if the length of the logging contract is less than the number of plots to be harvested (termed as "the time-constrained case"), logging companies have no incentive to exercise exclusionary rights. They will tend to abandon their logging plots and let follow-on farmers to move in. Evidence from large logging companies in Indonesia and Columbia indicate that the companies do exhibit the time-constrained case, and hence have little incentive to exclude follow-on farmers. In the later work, however, Walker and Smith (1993) appear to be in favour of a shorter contract period because it discourages short-run liquidation harvest.

In our view, whether or not concessionaires have incentives to prevent follow-on farmers needs not be influenced by contract length. Concessionaires might not care whether follow-on farmers arrive, especially if they are not required to prevent it by the state who actually owns the forest. As in a lease, the maintenance of the capital asset is the landlord's (owner's) responsibility. It would be unrealistic to expect the tenant to care for someone else's property if he or she is not required to.

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[6]Cultural capital refers to "factors that provide human societies with the means and adaptations to deal with the natural environment and to actively modify it ... includes the wide variety of ways in which societies interact with their environment" (p.2). Included in *cultural capital* are environmental philosophy and ethics (including religion), cultural diversity, traditional ecological knowledge and social/political institutions.

What clearly emerge from these studies is that there is no simple straightforward answer about the directional impact of the length of logging contract on deforestation. As with the earlier discussion *re.* property rights, security of tenure is a necessary but not sufficient condition for sustainable forest management. Even with secure tenure, ownership, a long-term contract or lease, many managers may well decide that rapid liquidation of the asset is the optimal strategy, especially if they do not bear the social and environmental external costs of their decisions.

Undervaluation of the full benefits of a forest. Humans can derive a variety of economic and non-economic values from a forest. *Direct-use value* refers to the commercial values of forest products, including timber, fuelwood, and non-timber products (NTPs) such as fruits, rattan and resins. *Indirect-use value* involves various environmental benefits such as global ecological services (e.g. carbon sequestration), protection of watershed area, conservation of land and water resources, exports of energy and nutrients, and various amenities that support ecotourism. *Option value* refers to the future use of biodiversity as potential sources for biological and medicinal inventions. *Existence value* is associated with a community's willingness-to-pay to keep the existence of a forest, regardless of whether or not they actually utilise the resource.

Nevertheless, humans often put greater emphasis on the direct-use value of a forest, and undermine the other values. In addition to lack of knowledge, poverty and ignorance, such a bias stems primarily from the controversy as to how these benefits are distributed among various sections of the world community. For farmers living in poverty, for example,

forests are seen mainly as a source of fertile land and fuelwood. As they do not directly enjoy the other benefits of a forest (e.g. a forest's option value), they tend not to internalise these benefits into their decision making process. So do logging companies, who view forests mainly from their timber value.

The fact that it is difficult, and sometimes controversial, to quantify the full benefits of a forest can only favour this undervaluation. Direct-use value is probably the easiest one to measure. On the contrary, attempts to measure the other values have so far yielded unsatisfactory results. In the case of indirect-use value, controversies arise from difficulties in estimating intangible externalities. For example, it remains unclear how to measure the economic benefits of carbon sequestration and to determine what section(s) of the global community that actually enjoy these benefits[7]. Measurement of option value is also hampered by the high risks and uncertainty involved in scientific inventions. The absence of "actual" market makes estimates of willingness to pay, and hence existence value, highly subjective and hypothetical. Such an undervaluation could then result in tropical forests being over-exploited for their direct value only.

The undervaluation of tropical forests also reflects a "collective action problem" (Sandler, 1993). While tropical forests produce global public goods (e.g. biodiversity and carbon sequestration), the onus for preserving the forests often fall into the countries where the

[7]An example of work in this area is Adger *et al.* (1995), who attempt to measure the full benefits of Mexican Forests. While it is obviously a commendable attempt, one can question the accuracy of the results that show almost ninety per cent of the benefits are enjoyed by the global communities.

forests are located. Unfortunately these countries usually have limited financial capability *vis-a-vis* their huge needs for development funding, and are often plagued by rampant corruption and inefficient bureaucracy. It is then rather unrealistic to expect these countries alone to conserve their forests, without global cooperation (Gluck *et al.*, 1996).

Macroeconomic Approach

The macroeconomic approach attempts to establish the link between foreign debt and deforestation. The main hypothesis is that, faced with high level of indebtness, developing countries may adopt various debt servicing schemes that increase deforestation. In general these schemes include any export-promotion and import-reduction programs related to the liquidation of forests, such as the promotion of timber products export and the subsidisation of forest conversion to agricultural land to increase (reduce) agricultural exports (imports).

Gullison and Losos (1993) test this hypothesis on nine Latin American countries for the period of 1976-1985. If the hypothesis is true, level of foreign debt should increase export of timber products. And because Latin American forests are converted mostly into cattle ranches (Myers, 1981), debt should lead to increased export of beef. Initial evidence suggests a very strong correlation between log of foreign debt and log of deforestation ($r=0.75$). But after the data were corrected by population level, the correlation disappear. Gullison and Losos also find no evidence that foreign debt induce deforestation through increased exports of timber products and beef. The fact that earnings from forest product export form only a tiny portion of Latin America's long-term debts (1.00 and 0.43 per

cent in 1980 and 1985, respectively) casts further doubt on the hypothesis.

Other authors suggest indirect links between debt and deforestation. World Resources Institute (1992) argues that debt repayments, which often constitute a large portion of national budget, reduce investments in environmental programs. As funding for programs such as forest conservation and reforestation shrink, level of deforestation increases. High level of debt is also thought to worsen poverty level, resulting in increased deforestation. Because spending in environmental programs has traditionally been very low, Gullison and Losos (1992) question whether budget cuts in these areas can significantly increase deforestation. However, Gullison and Losos produce no evidence to show that cuts in forest conservation and reforestation budgets do not increase deforestation. Thus, their doubt is more of intuition rather than build upon solid empirical results.

Despite this lack of empirical evidence, there is compelling argument to question whether budget cuts caused by debt repayment do increase deforestation. If the cuts are across-the-board, the net effect might not necessarily be increased deforestation. As spending for projects such as road and dam constructions decline, less forested areas are then converted. Hansen (1989) shows that because debt payments reduce capital investment, they could actually lower the level of deforestation.

In relation to poverty as an intermediate variable between foreign debt and deforestation, the argument is neither clear nor convincing. Economists remain divided as to whether poverty is a cause or a result of large foreign debt. As for its effect on deforestation, in

some cases poverty even act as a deterrent to deforestation. To support this point we present empirical evidence from Wibowo *et al.* (1997) in the next section. A similar case is reported from Northern Madagascar, where after acquiring adequate capital, poor farmers move from subsistence farming to cash crop cultivation, resulting in higher rate of deforestation (Gullison and Losos, 1993).

Notwithstanding the above criticisms, Kahn and McDonald (1995) find a positive link between debt and deforestation, even after the data are corrected by population or real GNP in US dollar. Building their model on the hypothesis that foreign debt induces myopic behaviour (because it affects social discount rates), Kahn and McDonald show how optimal level of deforestation changes according to changes in production inputs and competing uses of GNP. A 10 per cent reduction in total or relative debt service is shown to reduce deforestation by 1.7 to 3.1 per cent.

However, as the models exhibit a very low explanatory power (unadjusted R^2=0.286-0.310 for the third column of Tables 3-6), while at the same time Kahn and McDonald recognise that the results are correlative (rather than causative), the results raise more questions than they answer. For example, can one rule out the possibility that the positive correlation between debt and deforestation is a mere coincidence? Why do the evidence gathered so far point to no causative relations between foreign debt and exports of timber and agricultural products? And given that the link between debt, poverty and deforestation is still unclear, under what mechanisms debt leads to increased deforestation?

These puzzles lead to serious questioning over the merit of the debt-for-nature swap to reduce deforestation. Proponents of the swap build their argument on the perceived link between debt and deforestation. It seems that more empirical evidence are required to prove their case. These puzzles, however, need not necessarily derail North-South cooperation to arrest deforestation rate. Viewing tropical forests as global public goods, many have modelled the need for global cooperation to preserve the resources, including financial transfers to compensate property rights (Sandler, 1993) and equal protection of old-growth forests between developed and developing nations (Kohn, 1995).

Another study that can be grouped into the macroeconomic approach, yet it does not deal exclusively with the level of foreign debt is Capistrano and Kiker (1995). The study tests the hypothesis that forest depletion is affected by macro-scale economic factors arising at the global and national levels. Data on 45 countries from 1967 to 1985 are analysed. The results show that real exchange rate devaluation, debt service ratio, food self-sufficiency, per capita income and export prices of forestry and agricultural outputs are significant regressors for forest depletion, while population pressure and the ratio of arable land to rural population are shown to have ambiguous effects.

These results, however, should be interpreted with caution. Capistrano and Kiker use "the area of tropical broadleaved forest industrially logged" as the indicator for deforestation and overall forest depletion. But as discussed before, commercial logging cannot be used automatically as a synonym for deforestation. Thus, it is the "area of industrial logging", which does not always mean "the level of deforestation", that the authors actually use as

the dependent variable. With this in mind, the result that variables such as export prices of forestry products are shown to be statistically significant should come as no surprise.

EVIDENCE FROM THE KERINCI-SEBLAT NATIONAL PARK, INDONESIA

In this section we summarise micro-level evidences from Wibowo *et al.* (1997). The article presents a report on our fieldwork in 1995 in the Kerinci-Seblat National Park (KSNP), the province of Jambi, Sumatera, Indonesia.

Declared as a national park in 1982, the KSNP, which covers an area of about 1.56 million hectares, is being constantly intruded by nearby farmers. Our fieldwork indicates that the commonly cited factors such as government failure do affect deforestation. For example in the district of Kerinci, which is known as the production capital of cinnamon in Indonesia, poor policing and failure to clearly determine national park boundaries create a "cinnamon farming enclave". Consisting of about 16,500 households, the enclave becomes a major origin of forest intrusion.

Our study also shows that, unlike in other deforestation cases, poverty is a deterrent to, not a cause of, deforestation. This is because, unless they have adequate family labourers, poor farmers and tenants cannot afford the minimum capital required to clear a forest. The costs of clearing a hectare of forest in 1995 was about Rp 300,000, while the subsequent land clearing adds another Rp 450,000 (Rp 2100/US$ in 1995). These costs are far beyond the financial capacity of poor farmers and tenants. Even if they have adequate capital to finance forest clearing, they are unlikely to gain adequate cash to support themselves

during the idle period, that is, the period between forest clearing and annual crop harvests. This period normally spans for more than a year, including a drying period of 9.6 months on average, a land-clearing period of 2 to 4 weeks, and a cultivation period of about 4 months[8]. As a result, poverty precludes these farmers from clearing a forest.

Consequently, the decision to clear a forest rests mostly with rural capitalists and more established farmers. They are the most likely groups of farmers that have adequate capital to finance forest clearing and to support themselves during the idle-period. Wibowo *et al.* (1997) find that while all land owners and rural capitalists had in the past cleared a forest, only 3 per cent of poor tenants did so, on a family grant. While young tenants are financially incapable of clearing a forest, in the later years, after accumulating adequate capital the tenants are likely to clear a forest.

These fact lead to the conclusion that deforestation can be associated with farmers' capital accumulation behaviour. There are two mechanisms that facilitate this behaviour. First, previous forest clearings generate adequate surpluses to finance the next rounds of deforestation[9]. Secondly, farmers use surpluses from other sectors, e.g. the trading sector,

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[8]In the study area, forest burning is not commonly adopted. It relates partly to the technical difficulty faced by the farmers to control the fires. As farmers normally build a wooden house on the cleared land for their residence during farming period, burning the forest might endanger their lives and houses.

[9]Forest clearing and the subsequent agriculture are shown to produce high financial returns, and more importantly, provide farmers with large cash surpluses in the final year of a 12-year cinnamon farming cycle. Without getting involved directly in cinnamon plantation, a land owner receives a financial return (IRR) of 24.5% or an NPV of Rp 846 191 ha^{-1} (US$ 403 ha^{-1}). More importantly, the land owner receives a lump sum of Rp 9.2 million at year 12, which in today's value is equal to Rp 1.3 million. For tenants, from year 1 to 5 they obtain an annual net income of Rp 4.0 to 4.3 million ha^{-1}. Because the average

to clear a forest.

Several factors explain why farmers accumulate capital via deforestation and the subsequent agriculture. The social values held in the study area, which result in greater land ownership giving a higher social status, provide farmers with strong motivation to own a land or to increase their land ownership. Also, deforestation and the subsequent agriculture offer high financial returns, while on the contrary, other attractive investment portfolios are not widely available at the village level. Farmers also feel more of ease with the technical details of deforestation than those of other investments. Finally, deforestation enables farmers to own a "long-term maturity bond" in the form of cinnamon plantation. By clearing a forest, farmers acquire a parcel of land where they can invest their time and cash-capital. It takes 4 years before the investment starts producing financial return, mostly from bark harvests from tree branches. Normally farmers do not liquidate the plantation for another 8 years. Thus, the plantation acts as a long-term "financial" asset for the farmers, which will be liquidated after at least 12 years. The timing of the liquidation depends not only on the prevailing prices of cinnamon bark and the age of the plantation, but also on whether or not the farmer is in need of cash for large expenses, for example to finance another forest clearings, children's education costs, pilgrimage to Mecca and the building of a house.

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farm size operated by a tenant is 0.2 ha, this means he or she receives a monthly net income of Rp 67 488 to Rp 71 595 (US$ 32-34 month^{-1}). By rural Indonesian standard, such a level of monthly income is adequate to support a family of 2-3 persons. More importantly, the tenant receives a lump sum equivalent to Rp 1.3 million in today's value in year 12, which can be used to finance future forest clearing, and thus, to raise his or her social status to a land owner.

CONCLUSION

Certain forms of deforestation, as long as they bring net development benefits and satisfy both social cost-benefit analysis and economic efficiency criteria, are generally economically desirable. Nonetheless economic criteria alone cannot provide decision makers with sufficient basis for deciding whether a deforestation project is desirable. Biophysical and political criteria need to be taken into account simultaneously.

This study presents a critical review on various analysis about the cause(s) and mechanisms of deforestation. We categorise these analysis into four general groups, i.e. Neo-Malthusian, government-failure, microeconomic and macroeconomic approaches. The Neo-Malthusian approach sees population pressure as the underlying cause of tropical deforestation. Because of data inadequacy, it is enormously difficult to obtain satisfactory econometric results to support this hypothesis from a cross-country analysis.

The government failure approach looks at, first, misdirected policies that result in unintended deforestation, and secondly, government's inability to preclude preventable deforestation due to the failure of its institution to function effectively. We focus on the effects of log export bans and corruption on deforestation. Previous studies present conflicting analysis on the directional impacts log export bans have on deforestation. Moreover, little attention is given to the possible impacts of the price elasticity of domestic log demand. We propose a graphical analysis to show how this elasticity influences the volume of commercial logging, provided that there is an induced-shift in the short-run supply curve or the supply curve is backward-bending.

Corruption makes bureaucrats and government institutions unable to perform inspection policies effectively. This induces logging companies to adopt unsustainable logging practices, which in turn result in excessive deforestation. While empirical evidence that show the link between corruption and deforestation are difficult to obtain, we present an indicative case where corruption can lead to illegal logging in Indonesia.

The microeconomic approach attempts to provide explanations on how, under various forms of market failure, an agent's economic behaviours can lead to deforestation. The frequently cited forms of market failure are poorly defined property rights, poorly designed logging contract and undervaluation of forest benefits at the local, regional or global level. While poorly-defined property rights may encourage the adoption of destructive forest utilisation practices, there are ample evidence that repudiate the claim that any resources held in common property would always be over-exploited. Economists appear to have under-estimated the capacity of traditional social controls (e.g. religious values, customs and taboos) to ensure sustainable utilisation of common resources. There is also no simple straightforward answer about the directional impact of the length of logging contract on deforestation. Difficulties and controversy that arise in attempts to quantify the full benefits of tropical forests can lead to the undervaluation of the forests.

The macroeconomic approach explores the possible links between debt and deforestation, with debt-servicing schemes, budget cuts, reduced investment in environmental programs and poverty act as the intermediate variables. While a positive correlation between debt and deforestation has been found, there are inadequate evidence to suggest that debt, the

intermediate variables and deforestation have causative relations. These puzzles leads to serious questioning over the merit of the debt-for-nature swap to reduce deforestation rate in developing countries.

We present micro-level evidences to show the case where deforestation can be associated with farmers' capital accumulation behaviour, while poverty is a deterrent to, not a cause of, deforestation. In this case farmers are influenced by factors such as social values (which result in greater land ownership giving a higher social status), financial returns, technical familiarity, and the fact that deforestation enables them to own a "long-term maturity bond" in the form of cinnamon plantation.

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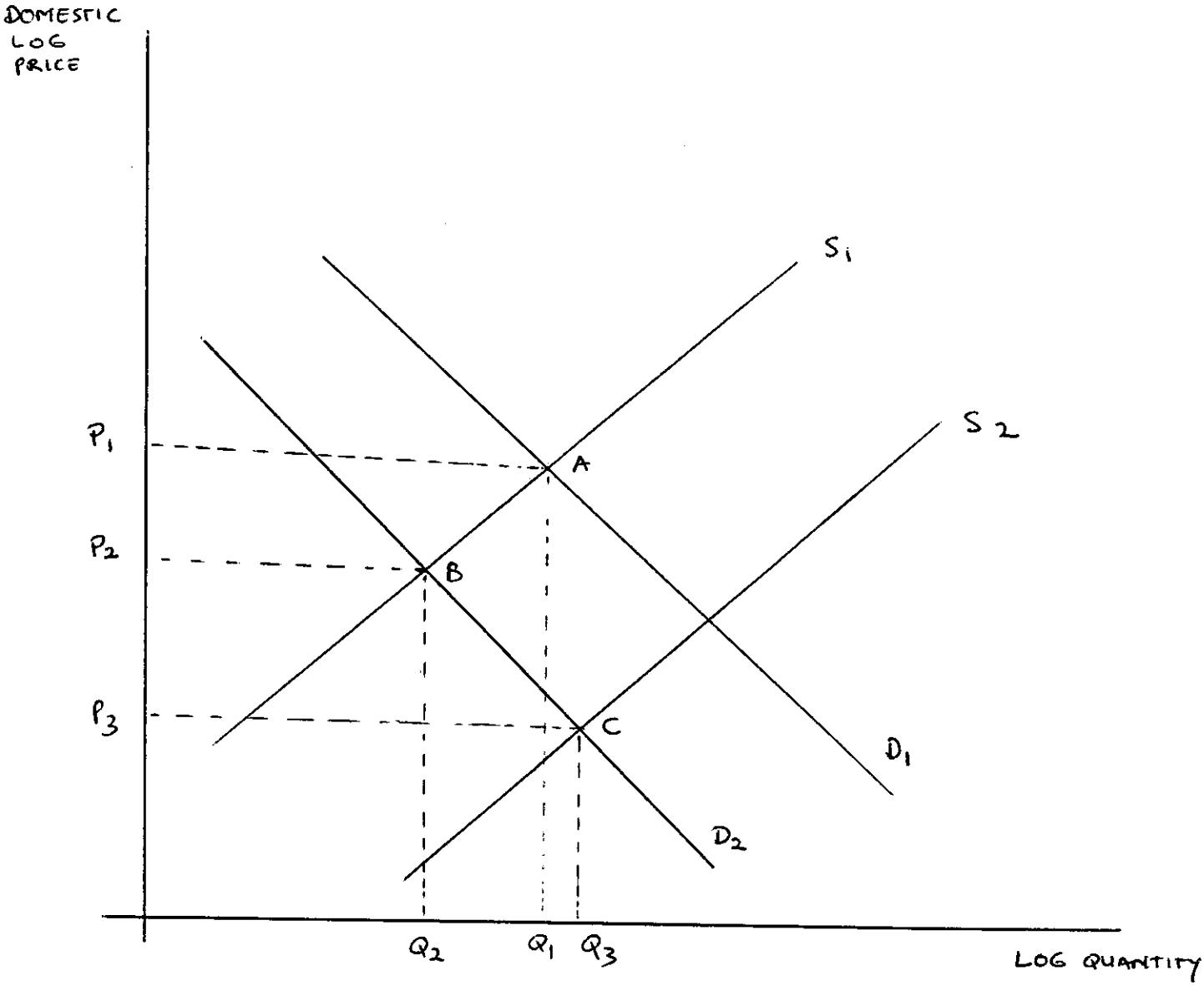

FIGURE 1a THE EFFECT OF LOG EXPORT BANS ON DOMESTIC LOG MARKET IF THERE IS AN INDUCED-SHIFT IN THE SUPPLY CURVE

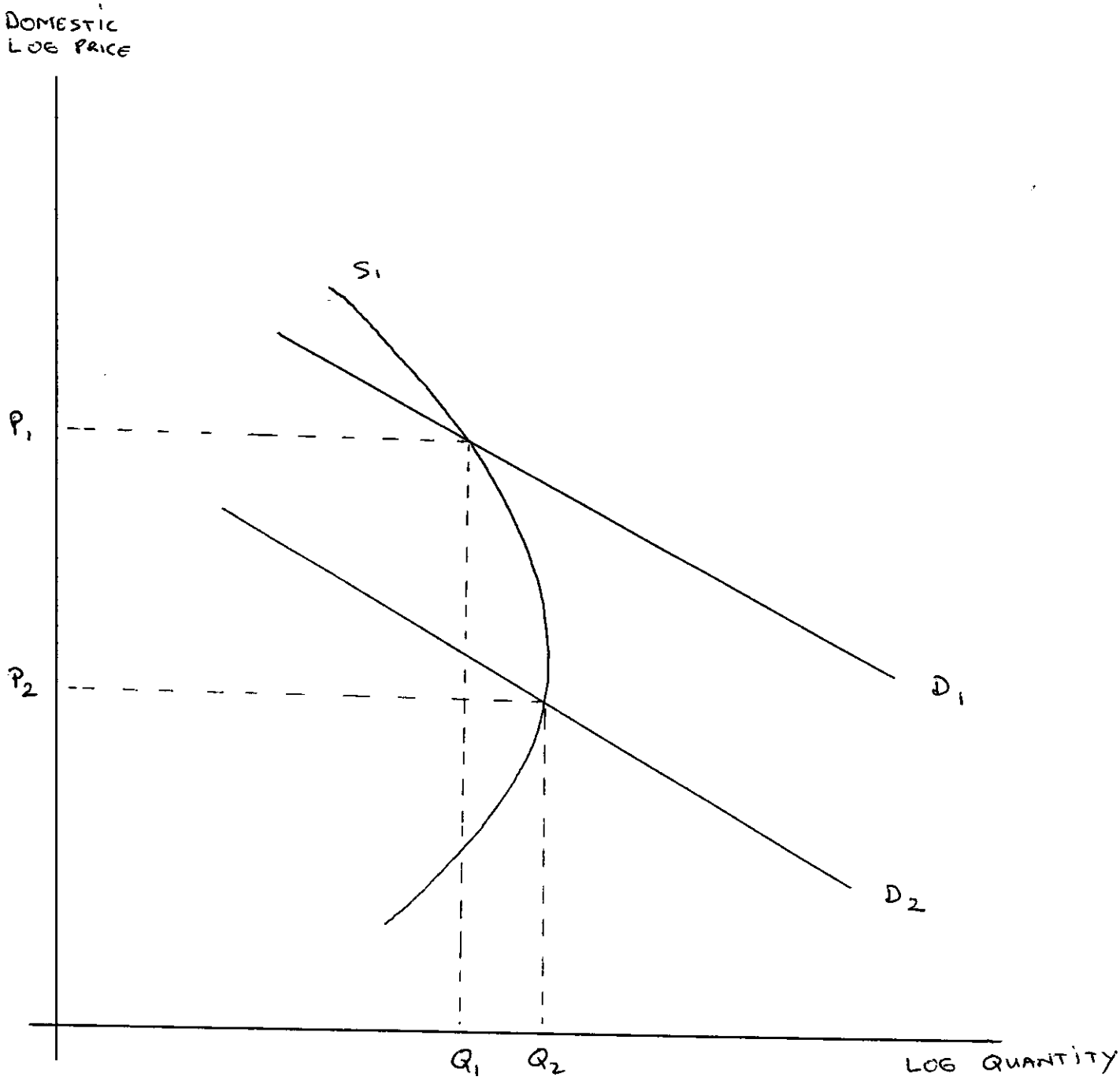

FIGURE 1b THE EFFECT OF LOG EXPORT BANS ON DOMESTIC LOG MARKET IF THE SUPPLY CURVE IS BACKWARD BENDING

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