PUBLIC POLICIES AND DEFORESTATION IN THE BRAZILIAN AMAZON*

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Abstract

The question of land tenure is a major issue in the development debate in Latin America. Recently, one new dimension has been added to the discussion with the increasing concern with environmental issues: the link between rural migration and deforestation. This paper analyses this problem, focusing on the Brazilian Amazon experience. The first part briefly reviews past and present policies that encouraged migration to the region (according to the slogan "peopless" land to "landless" people) as a way to avoid proper agrarian reforms. The role of economic policies in this process is highlighted, particularly the

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connection with structural adjustment objectives. The second part of the paper presents empirical results showing that, in the Brazilian case, policy-related variables are positively related to land clearing. The opportunity cost of labour (represented by rural wages) plays a major role in this process, affecting decisively the determination of how much land to be cleared. This establishes a link between deforestation and poverty: the lower the opportunity cost of labour, the higher is the incentive to deforest.

1 The causes of migration and deforestation in the Brazilian Amazon

The literature on Brazilian development has consistently emphasised the damaging social and economic consequences of land tenure concentration. Production on tiny properties - 'minifúndios' -tends to be insufficient to afford subsistence levels of well-being to all members of the family. Extra income, obtained from labouring in cash-oriented farms, is often necessary to complement the household budget. On the other hand, very large estates - 'latifúndios' - are not labour intensive. Seasonal demand for extra labour during planting and harvesting is easily covered by landless agricultural workers, hired on a daily basis (*bóias-frias*). As a consequence of both effects, the rural labour market tend to be unstable and seasonal, unable to employ all the labour surplus. Squatting and other forms of land conflict, and migration to open access land in the frontier or to urban centres, become the ultimate options for the landless agricultural work force.

Historically, the expansion of the agricultural frontier into forest areas has been used as a 'safety valve' to accommodate landless farmers. Therefore, forest areas have been reduced considerably in the Southeast, South and part of Northeast regions, where agricultural activities have been established for a long time. The strategy of 'peopleless land for landless people', rather than agrarian reform in already occupied land, was pursued with particular intensity during the military regime (1964/85). Consequently, there was a considerable population increase in the North and Centre-West regions, which embraces almost all of the Brazilian Amazon. Because of internal migration, these regions presented population growth rates considerably higher than the national average. This 'solution' was important for two crucial problems faced by the national security strategy: it would enforce Brazilian sovereignty over the Amazon and it would decrease the political instability caused by land conflicts in many places in the country.

The migration boom corresponded to the acceleration of deforestation in the Amazonian states. In spite of the fact that there has been a reduction in the speed at which the forest has been converted into agricultural areas, the total area being deforested is still alarming. For a better comprehension of this process, it is important to understand the contribution of specific govemmental policies that direct or indirectly resulted in the acceleration of deforestation.

Export promotion policies

Export promotion policies had a decisive influence on the process of pushing migrants to the Amazon (Ozório de Almeida, 1992). One important strategy for increasing export revenues was the expansion of large-scale modem crop cultivation in the traditional family-based agriculture in the South and in the more recently occupied Centre-West *cerrado* (savannah) region. Large-scale modemisation reduced the demand for labour: the regions with higher level of mechanisation presented negative rates of rural population growth in the periods 1960/70 (Southeast) and 1970/80 (Southeast and South).

At the same time, export incentives and other support to the expansion of commercial production resulted in a considerable increase in land prices in the South and Southeast. This constituted an incentive to small farmers to sell land in the South and buy larger properties at the agricultural frontier. This led to a speculative boom in land prices, which only stopped with the explosion of the real interest rate in the late 1980s. During the 1970s and early 1980s, the agricultural rental ratio to land prices fell systematically. This is an indication that the appreciation of land prices cannot be entirely explained by increasing retums of productivity which are usually captured in the value of the rental: much of the land price appreciation was a result of speculation about future prices, combined with the macroeconomic uncertainty which led to an increasing demand for real (non-monetary) assets.

Moved by the possibility of buying much larger properties with the profits obtained from selling their original farms, southern settlers first moved to the *cerrados* in the Centre-West region, which proved to be particularly suitable to soybean cultivation, a major export crop. After some time, land prices in this region also increased following the grain production boom. More recently, areas in the south of the North region were occupied, especially in Rondônia.

This expansion of the commercial agriculture frontier northwards results in a similar movement of the social frontier, i.e. the subsistence or small-scale farming settlements which occupied the land previously. Given their lower opportunity costs, subsistence farmers were willing to sell their plots of land to the newcomers, and move into the Amazon.

Regional development programmes

From the government perspective, there was no separation of the goals of intensifying national integration, promoting regional development and the economic benefits expected from such policies. Population growth and economic expansion were seen as synonymous, and the historical vocation of the Amazonian economy was considered to be one of serving international markets. Therefore, it is not surprising that the objectives of improving exports or attracting foreign capital were always used as justifications for the policies carried out. The adopted framework of infrastructure, land concessions, fiscal and credit subsidies followed the typical approach of Brazilian industrialisation since the 1930s: public incentives were anticipated in order to attract private investment.

The most important incentives to the Amazon region were the establishment of a road building network (the Belém-Brasília road being the North-South axis and the Transamazônica road the East-West axis), colonisation projects (governmental and private), investment in regional development programmes (POLONOROESTE, Carajás), and economic incentives to agricultural, ranching and logging activities.

The relationship between agricultural policy and deforestation is not as simple as usually presented in the literature. Policies supporting agricultural production may increase the demand for land, encouraging the expansion of the agricultural frontier through the incorporation of previously forested land. Nevertheless, the economic failure of agriculture in settlement areas, together with increasing rural poverty, may result in migration towards unoccupied forest areas.

This problem is referred to by many authors discussing the problems of colonisation, particularly in Rondônia (Mahar, 1988; Wilson and Alicbusan-Schwab, 1991; Redwood III, 1993). Coffee, cocoa and other perennial crops were considered a good protection for fragile soils against leaching and erosion. Planners believed that perennial plantations would provide a solid foundation for a mixed small farm agriculture incorporating food and cash crops, avoiding the need for further migrations. Therefore, special credit lines were set up for coffee cultivation, to compensate the lag between planting and the first harvest (3-5 years), and the high costs in terms of labour and non-labour inputs. However, before the coffee could be harvested, these credit lines were cut. At the same time, the costs of non-labour inputs increased, and tough monetary policies resulted in very high interest rates for normal credit operations. Because of the high costs involved and the fall of the international price, many coffee plantations were abandoned after some years, being converted to annual plantations or replaced by pastures.

The same dilemma is present in the debate about road building and other infrastructure programmes affecting settlements in the Amazon. Roads are an important incentive to migration to areas recently cleared, since it lowers considerably transportation costs. But, again, there is another side in the debate. The lack of infrastructure reduces the incentive to the settler to invest in farming practices that present results in the long term, such as soil conservation and erosion control. Thus, impoverished farmers may be encouraged to 'mine' the natural resource allowance of their plots -- selling timber extraction

rights and slash-and-burn cultivation of annual crops provide profits only in the first years of occupation. Once the resource allowance is depleted to the point where subsistence can no longer be assured, they sell their plots (if they have property rights) to buy cheaper land, or just move to 'mine' new plots of unoccupied forest land.

This point of view is highlighted mainly by the authors studying the colonisation process:

"In addition to constraints of an ecological nature, the small farmers in the Marechal Dutra project had also to cope with a lack of feeder roads or the lack of maintenance of these roads once they are constructed. Poor transport infrastructure is a problem that has been cited in nearly all case studies of settlement projects throughout the Amazon". (Wilson and Alicbusan-Schwab, 1991, p.9)

Austerity measures and their implication over the labour market

Migration flows were also affected by the economic slowdown and successive recession periods in the last twenty years. Workers suffered from declining real wages and increasing unemployment caused by policies to reduce real wages, particularly in the 1980s. The urban poor were the most affected by redundancies, falling real income and cutbacks in social expenditure. Therefore, the traditional destination of the Southern and North-eastern rural exodus became less attractive than the Northern 'Eldorado', where people were believed to succeed very quickly. This phenomenon, aggravated by the expansion of mineral prospecting activities (*garimpo*) in areas such as the gold-rich Serra Pelada, allied to the official propaganda, disseminated the image of 'getting rich' in the Amazon at a time most Brazilians were severely affected by the economic crisis.

Another consequence of restrictive monetary policies was the gradual withdraw of subsidised credit to agriculture, resulting in a significant growth in the number of indebted farmers. Selling land to pay financial arrears also contributed to move farmers

northwards. This point is closely connected to the issue of agricultural policy, discussed in the next sub-section.

Recession depressed wages and reduced employment, thus lowering the opportunity cost of labour. This induced migration to the Amazon because, despite the hardship of life in the frontier, the settlers were more likely to succeed and accumulate wealth there than if they had decided to risk their chances in the urban labour market or stayed in the poorer rural areas in the Northeast.[1] This view is supported by empirical evidence showing that the probability of a settler being economically successful was considerably higher in the Amazon than in most of the other places migrants were likely to move in, considering the level of education and capital allowance (FAO/UNDP/MARA, 1992) However, there were many problems to be faced conceming the lack of assistance and the hardship of getting established, and health risks were especially higher.

The adjustment objective of reducing the public deficit implied higher constraints faced by the public agencies responsible for controlling encroachment in protected areas. For example, in the POLONOROESTE programme, colonisation projects were expanded at the same time the official agencies responsible for the control of Amerindian and ecological preservation areas suffered drastic cutbacks.

A considerable part of the Amazon is officially designated as either reserves or parks (over 1.1 Million km^2 if Indigenous reserves are included). However, it was estimated that, in the early 1990s, only one park guard was available, on average, for 6,161 km^2 of parks and reserves (World Bank 1992). The evident lack of control results in poaching or even clearing of preserved forest land, and the continuation of illegal trade of endangered fauna and flora species. The violence surrounding

[1] *An indirect indication that small scale agricultural production has been successful in the Amazon relatively to other regions is the fact that the Gini coefficient for land concentration in the North region is smaller than the Brazilian average, and fell systematically between 1975 and 1985 (Schneider, 1994).*

the encroachment of protected areas and indigenous reserves has become widely known by the tragic assassination of Chico Mendes, a leader of rubber tapers in the state of Acre. Because of his fight for the establishment of extractivist reserves in areas coveted by local landowners, there was a plot which resulted in his murder.

The lack of control over protected areas is part of a larger problem of law enforcement in the Amazon. The issue of privatisation of land ownership is particularly important, and is a major issue on the debate about the institutional causes of deforestation. As discussed previously, the formal or informal colonisation of the Amazon was a safety valve against claims for proper agrarian reforms. One instrument was the concession of tenure rights after the occupation of state-owned land (*terras devolutas*). According to the legislation, one year was usually enough to assure the land title and after a few more years the land could be sold. The possibilities of capital gains with re-selling the land added fuel to the race for property rights, and deforestation was a main source of enforcing land claims: the actual productivity of the economic activity carried out after deforestation might be low, but the asset value was increased by the expectation of higher land prices (Ozório de Almeida and Campari, 1994). In other words:

"Rather than the agricultural suitability of land and settlers, the problem is better understood by focusing on the supply and demand for property rights" (Mueller *et al.*, 1994, p.274)

2 Empirical exercise: the contribution of adjustment policies to deforestation, Brazil: 1970/85

The discussion in the previous section provides the theoretical background for an empirical exercise that tests the contribution of adjustment-related variables to the process of deforestation. The selected policies refer, directly or indirectly, to the economic incentives to land clearing in Brazil. Two are directly

related to the profitability of agriculture: agricultural pricing and agricultural credit. The link between road building and deforestation is more indirect, through changes in transportation costs. Finally, two other variables were chosen because of their strong connection with the macroeconomic management: rural wages and land prices. Rural wages are related to the official stipulation of minimum wages and the overall performance of the economy (in the sense that recessionary policies depress labour markets, therefore reducing the opportunity cost of labour and favouring migration to the frontier). Land price increases in the 1970s and 1980s were connected to the boom in the agricultural export sector, which resulted in the expansion of the 'economic' frontier, notably the cultivation of soybeans in the South-westem borders of the Amazon.

2.1 Selected policies

Agricultural credit and pricing policies

The existence of special credit lines with negative real interest rates has been frequently pointed out as a major cause of deforestation (see the discussion on section 1). Furthermore, considerable incentives were directed to one of the most damaging activities in environmental terms: cattle ranching. The consequences were doubly perverse: it represented an additional direct source of deforestation (forest being converted into pastures), and changed the existing pattern of land use in areas already cleared, encouraging the shift from less damaging activities, such as perennial plantations. The introduction of tighter monetary policies in the 1980s has reduced both the total amount of credit and the implicit subsidy of the real interest rate. Therefore, a positive relationship between credit and deforestation would provide an argument in favour of the hypothesis that adjustment policies tend to favour the preservation of the forest.

However, this position should be balanced by the consideration of pricing policies as a main incentive to agricultural

production. One of the most important elements of adjustment policies refers to the removal of the bias against agriculture through the realignment of relative prices. In the Brazilian case, this has been done through the adoption of more 'realistic' indexation instruments to defend agricultural prices against rampant inflation. This has more than compensated the retraction of credit lines and incentives, and was a major factor in the agricultural boom in the 1980s. Therefore, a positive relationship between agricultural prices and deforestation reverses the previous conclusion, in the sense that adjustment had indeed contributed to forest land clearing.

Road building

The previous discussion shows that deforestation is expected to increase in areas where the road network is expanded, despite some controversy about the impacts on other regions. The cutbacks in public spending affected the completion of the planned road structure for the Amazon. This would have represented a positive contribution of adjustment policies to curb the process of deforestation .

Rural wages

The Brazilian govemment adopted explicit measures to reduce real wages during much of the 1980s. This policy was part of the stabilisation strategy of reducing aggregate demand and import requirements. The policy of reducing real wages combined with the overall recession induced by very high interest rates resulted in a contraction of the labour market. The reduction of employment opportunities and the depreciation of the minimum wage, a main reference for the unskilled labour force, represented a double incentive to the deforestation process: directly because it reduced the labour cost, particularly important in land clearing decisions, and indirectly because it restricted the possibilities of landless rural workers to succeed in the labour market, tuming into migration to the frontier a more attractive option. In other words, the reduction in real wages and other stabillsation policies contributed to the increase in the level of poverty, which resulted in extra pressure

for consumption of quasi-open natural resources (forests): the expansion of deforestation is the other side of the same process of increasing social exclusion and violence which exploded in urban centres in Brazil since the 1980s.

Land prices

Land prices are not directly determined by govemmental action, but the role of agricultural and other govemment policies is essential to their formation. The adjustment objective resulted in export incentives and other agricultural promotion policies have influenced positively land prices. Since most of the boom was concentrated in the South and Southeast regions, it initially resulted in an increasing discrepancy between property prices in different regions. This process has added fuel to speculation in the land market, which is also blamed as a major cause of deforestation.

2.2 Description of the variables

Deforestation (dependent variable)

There is a wide controversy about the proper measurement of deforestation in the Amazon (Feamside, 1993a,b). The most precise method is based on screening satellite images. However, many difficulties undermine the use of direct estimates of deforestation. First, there are considerable discrepancies in the way the images are obtained and interpreted. Second, systematic observations exist only for the period 1987-1991, with just one observation in the 1970s (1978).

Instead, a proxy based on the expansion of agricultural density (DE: total agricultural area divided by the total state area) according to the agricultural censuses has been used to estimate deforestation (similar proxies were used by Reis and Margulis, 1991; and Reis and Guzmán, 1994). These censuses were carried out in the years 1970, 75, 80 and 85. Therefore, it was possible to estimate deforestation as the expansion of

agricultural area during these years according to the same methodological principles.

One important consideration refers to the use of observations for states outside the Amazon. This procedure was adopted for two main reasons: the expansion of the frontier in the Amazon is the final stage of the land conversion process started in the other regions of the country; and the use of data for other states increases the number of observations, therefore improving the statistical quality of the analysis.

Another problem concerned the states which suffered partition or fusion during the period. To avoid this problem, the following states and territories were kept unified: Rio de Janeiro and Guanabara, Mato Grosso and Mato Grosso do Sul, Pernambuco and Fernando de Noronha, and Goiás and Tocantins. Given its very small size, the Federal District (Brasília) was also considered part of Goiás.

Agricultural credit

Agricultural credit density (CR) was estimated by the total credit destined to agricultural activities divided by the total area of the state. The primary source of data was the Brazilian Central Bank, and the values were deflated by the general price index (IGP-FGV).

Agricultural prices

An index for agricultural prices (PA) was built using data from the agricultural censuses (1970 to 1980) and the statistical yearbook (1985), both published by IBGE. The index considered the four more important crops to small farmers: beans, rice, cassava and corn. Market prices for each crop were obtained dividing the total value of production by the total output (in physical units). A (Paasche) nominal price index was created, assuming the national average in 1980 as the basis. Finally, a real price index was estimated dividing the nominal indices by the implicit GDP deflator.

Road building

Road density (RO) was calculated by dividing the total extension of roads (as presented in the IBGE censuses) by the total area of the state.

Rural wages and land prices

The (nominal) indices for land prices (PL) and agricultural wages (WA) were taken from the agricultural survey, carried out every semester by the Fundação Getúlio Vargas. The values were taken from the series of prices for cultivated land and the cost of hiring temporary labour, respectively. The year value was obtained by the average value observed during the year (usually, one observation per semester).[2] The implicit GDP deflator was again used to convert the series into real values.

2.3 Estimation procedures and results

The contribution of the selected variables to the deforestation process, as discussed above, is summarised by equation 1.

$$DE = f(CR^{+},\ PA^{+},\ RO^{+},\ WA^{-},\ PL^{+}) \qquad (1)$$

A panel data regression was carried out in order to test the impact of policy-related variables to deforestation, according to the data described in the previous sub-section. Equation 2 presents the functional form chosen for the demand for agricultural land in state i at time t, considering A_i as a constant referring to the specific conditions of state i.

$$DE_{i,t} = A_i \cdot PA_{i,t}^{\alpha_1} \cdot PL_{i,t}^{\alpha_2} \cdot WA_{i,t}^{\alpha_3} \cdot CR_{i,t}^{\alpha_4} \cdot RO_{i,t}^{\alpha_5} \qquad (2)$$

The deforestation problem is essentially a flow problem, therefore the dependent variable is better expressed in terms of change in time. Applying logarithms, and using the notation x_t

[2] *After their partition, it was considered the average value between Mato Grosso and Mato Grosso do Sul, and Golás and Tocantins.*

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frontiers, through improving transportation, commercialisation and other infrastructure investments, should be combined with direct measures against deforestation and land speculation. Taxation of the capital gains on land transactions, higher stumpage fees, levying fines and other measures would provide a mix of economic and legal discouragement to speculative land clearing.

Another suggestion in favour of forest conservation is the introduction of payments for carbon sequestration and biodiversity preservation, in a way that the international community compensates local farmers for the benefits which are globally captured. If compensations are paid to landowners who decide to preserve forested areas, the foregone revenues with deforestation are increased. The user cost of deforestation becomes higher, thus establishing more incentive to reduce land clearing. However, this system can only operate properly if the issue of land rights is clearly settled.

provide detailed assessment of selected regions, where land uses are to be defined, and present corrective actions designed to protect specific areas under critical pressure.

Nevertheless, given the interests involved, it is not surprising that the conclusion of the ecological-economic zoning is well behind schedule. The delay in the completion of the zoning and many bureaucratic problems has resulted in the persistence of the concessions on an *ad hoc* basis to ranching and sawmill activities. Moreover, it is important to consider that most of these advances refer to the federal government, which lacks capacity or will to enforce them. State and municipal governments are much slower in terms of incorporating considerations about the environment and indigenous population, and even less concerned about the effective application of the new legislation .

Another important point that has yet to be properly addressed refers to legal enforcement. In legal terms, there is no open access land in the Amazonian territory. However, the government practice of land concessions and the widespread corruption and falsification of land titles resulted in a situation of 'quasi-open' access land. This uncertainty about land rights is repeatedly referred to as a main contributor to deforestation. When land rights are not well defined, the time horizon of the farmer is reduced considerably. The capital losses caused by the 'mining' of natural resources are not incorporated as profit losses, and the deforestation cost is reduced only to short term expenditures that assume monetary values. Long term losses and non-market values are ignored in this equation.

The conclusion is that institutional reforms are essential to correct this failure. The concession of land to large projects should be stopped, and only the entitlement of small farmers should continue, but with mechanisms to reduce turnover and speculative claims on land. This would contribute to the slowing down of deforestation and the promotion of social justice if the conditions are provided to agriculture to perform better than land speculation. Promoting agriculture in the old

The nature and motivations behind the occupation of the Amazon are not static but change over time. The importance of government intervention that directly favoured settlements, such as subsidies and infrastructure facilities, gradually decreased. Instead, the interference became more indirect but no less important: the economic incentives posed by the rent seeking possibilities were enough to dispense with the direct facilities structure elaborated in the early years of the military regime. Empirical studies clearly indicated that cultivation, ranching and logging activities became far more profitable than usually thought (for a review see Young and Fausto, 1998).

The problem is that this shift in the orientation of public policies has not reverted the mechanisms that lead to the land clearing process. In that sense, despite the differences between them, both the market-oriented policies adopted since the 1980s and the previous interventionist policies can be considered responsible for setting up economic motivations that intrinsically favours deforestation.

To understand this apparent paradox, it is important to highlight the role of institutional failures. There has been some improvement in the environmental legislation, mainly caused by the 1988 Brazilian Constitution and the increasing domestic and international awareness with environmental issues, reached its peak during the 1992 Rio Summit (see Serôa da Motta, 1993). Legislation conceming land taxation has been modified, in order to accept forest areas as productive land, reducing the respective tax rate. The concession of fiscal incentives has been altered by the introduction of a new law in 1991, which restricts the application of the remaining incentives to areas approved by the ecological-economic zoning, and under consent of IBAMA, the National Indian Foundation (FUNAI) and other federal agencies. The ecological-economic zoning is a (federal) constitutional requirement to discriminate areas to be devoted to preservation or to sustainable economic use. The zoning is intended to orient the application of incentives and public investment in the region, harmonising the govemment actions conceming the Amazon. The zoning procedure would

agricultural prices, credit, road building and land prices, and inversely related to the variation of rural wages. Both time dummies are positively related to deforestation, suggesting that there were other factors contributing to deforestation in the 1975/80 and 1980/85 periods which were not captured by the model. All results are significative at the 5% level of confidence.

4 Conclusion

The empirical exercise confirms that the relationship between deforestation and the objectives of structural adjustment and stabilisation is not straightforward. Table 2 summarises the inferred linkages between both: there are pros and cons

TABLE 2

Public policies and deforestation

Policies which favoured deforestation	Policies which discouraged deforestation
• Appreciation of agricultural prices	• Reduction of subsidised agricultural credit
• Depreciation of the real minimum wages and other policies aimed at the reduction of labour costs	• Reduction of road building
• Export and other incentives which led to land price appreciation	

It is very difficult to deduce from quantitative analysis the total 'net' impact of such policies because there is no overwhelming support for the hypothesis that adjustment programmes tend to favour natural resource conservation, or the other way round. Perhaps a better way to conclude this chapter is through a qualitative interpretation of the deforestation problem, focusing the debate on the policy makers' perspective over the Amazon.

to represent $\ln(X_t/X_{t-1}) = \ln X_t - \ln X_{t-1}$, this equation can be transformed into a linear relation:

$$de_{i,t} = \alpha_1 \cdot pa_{i,t} + \alpha_2 \cdot pl_{i,t} + \alpha_3 \cdot wa_{i,t} + \alpha_4 \cdot cr_{i,t} + \alpha_5 \cdot ro_{i,t} \quad (3)$$

The regression was based on equation 3, with the addition of a constant term, time dummies for the periods 1975/80 and 1980/85, and the stochastic error. The results are presented in Table 1 and are consistent with the conclusions from the theoretical analysis.[3]

TABLE 1

Regression results

Variable	Coeficient	Std. Error	t	P>|t|	[95% Conf. Interval]	
pa (agric. Prices)	.1604414	.061041	2,628	0.011	.0380088	.2828741
pl (land prices)	.1681642	.0679067	2,476	0.016	.0319606	3043679
wa (rural wages)	-.4117057	.2002435	-2,056	0.045	-.8133432	-.0100682
cr (rural credit)	.3752031	.0658824	5,695	0 000	.2430598	.5073464
ro (road bulding)	.4072768	.0799577	5,094	0.000	.246902	.567516
dummy 75/80	.4374081	077124	5,671	0.000	.282717	.5920992
dummy 80/85	.3933003	.1236985	3,180	0.002	.1451936	.641407
constant	-.2514704	.1016744	-2,473	0.017	-.4554304	-.0475373
Number of observations	61					
R-square	0.5526					
Adj. R-square	0 4935					
Root MSE	0.1573					

The variation in time of the agricultural area (proxy for deforestation) is positively related to the change in time of

[3] *Because of heteroscedasticity problems, White's method was used to produce robust standard errors (Greene, 1993). This made possible appropriate inferences based of the results of least squares without actually specifying the type of heteroscedasticity. If the ordinary standard errors, the coefficient estimates would be the same, but the confidence level would be sligthly different: 10% for rural wages, and 5% to all other variables. For methodological details, see Young (1997).*

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