



Analysis

The effects of government spending on deforestation due to agricultural land expansion and CO₂ related emissions



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ABSTRACT

This paper examines the effect of changes in government spending level and composition on deforestation due to agricultural land expansion and related carbon dioxide emissions. Our theoretical model shows an unintended consequence from increased government spending and widening social safety nets in developing countries where agricultural land expansion significantly affects forest cover: there is an increase in deforestation and carbon dioxide emissions from land use change. Our empirical tests show that an increase in total government spending significantly increases forest land clearing for agricultural production in the short run leading to more carbon dioxide emissions. However, there is no long-run statistically significant effect on the steady-state forest cover and carbon dioxide emissions.

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1. Introduction

The recent global recession affected the level and composition of public expenditures in developing countries. Historically, developing countries tended towards procyclical spending where spending is cut during recessions but increased during expansions. However, over the past decade, fiscal policies in emerging markets with good quality institutions shifted towards countercyclical spending where spending rises during recessions to counter the effects of the business cycle (Frankel et al., 2011). The composition of fiscal spending also changes during recessions as more social safety nets are put in place (Williams et al., 2012).

Fiscal policy plays a key role in the accumulation and allocation of an economy's resources (López et al., 2010). Government expenditures comprise about 25% of the GDP of developing countries, on average, between 2010 and 2012 (The World Bank, 2015), and therefore can be influential in stimulating the growth of the rural economy. A cross-country study by López et al. (2010) found that the composition of government spending significantly affects poverty levels and economic growth. Fan et al. (1998) and Fan (2002) find similar results, where government spending in India and China on investments such as irrigation, agricultural R&D and rural infrastructure not only contributed to a reduction in poverty levels in the rural areas but also growth in agricultural productivity.

Recent empirical work showed that changes in the level and composition of fiscal spending significantly affect pollution levels (Bernauer and Koubi, 2006; Halkos and Paizanos, 2013; López et al., 2011; López and Palacios, 2014). Also, expenditures from different levels of the government can have different impacts. For instance, Islam and López (2015) examined the environmental impact of a change in the composition of government spending, particularly federal spending versus combined state and local government spending. They show that reallocation in the state and local spending led to a reduction in air pollution but the change in the composition of federal spending did not have any significant effect.

Most of the pollution analyzed occurs as a by-product during the production process such as sulfur dioxide and lead. We are only aware of one study that linked the effect of fiscal spending on carbon dioxide (CO₂) (Halkos and Paizanos, 2013), a leading contributor to greenhouse gas emissions, but this study also focuses on carbon dioxide through the production process. Given that the main contributors of greenhouse gas emissions in the developing world is land use change (Crutzen and Andreae, 1990; Naughton-Treves, 2004), it is surprising that the connection between fiscal policy spending on greenhouse gas emissions through deforestation has not yet been systematically analyzed.

This article fills this gap in the literature by determining the long-run and short-run effects of fiscal policies on deforestation due to agricultural land expansion and related CO₂ emissions in developing countries. We develop a dynamic model that links the effect of the level and composition of fiscal spending on the transition and steady-state paths of agricultural land clearing in forested areas. This model allows us to understand the mechanism relating fiscal policies and CO₂ emissions due to deforestation in developing countries. Using the theoretical results,

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we empirically measure the effect of changes in public expenditure size and composition on deforestation-induced CO₂ emissions in the short run and long run. We contribute to the growing literature on fiscal policy and environmental quality by showing the differences by which government spending affect deforestation-induced CO₂ emissions as opposed to CO₂ emissions from other sectors of the economy. Our results have significant policy implications because we are able to predict the effects of fiscal policy changes on forest cover in developing countries which may lead to policies that ameliorate negative impacts.

There are direct and underlying factors of deforestation where the former refer to those that immediately cause deforestation while the latter are those that influence the severity of direct factors. In developing countries, one of the most common direct factors is agricultural expansion (López, 1997).¹ Two-thirds of forest cover change in tropical areas can be explained by agricultural expansion. Encroachment of large scale agricultural production, small scale agricultural production and shifting cultivation account for 32%, 26% and 15% of forest cover change in tropical areas, respectively (FAO, 2001).

Public expenditure level and composition are examples of underlying factors affecting agricultural expansion. The composition of public expenditure can be delineated based on a taxonomy proposed by López and Galinato (2007) that classifies two types of spending based on their effect on market efficiency. The first type is called *expenditures on public goods* which are government expenditures that alleviate market failure. Spending on health and education to alleviate credit market constraints, environmental protection expenditures to reduce pollution, spending on property rights to protect natural resources, research and development expenditures to internalize positive spillover effects and spending on the provision of public goods are examples of this type of expenditure. On the other hand, *expenditures on private goods* refer to government expenditures that do not alleviate market failure and may even increase market inefficiency. Agricultural subsidies and fossil fuel production incentives are examples of such expenditures. We use the López and Galinato taxonomy on spending throughout the study.

Expenditures on public goods can affect the choice to clear forest land through the cost of land clearing and agricultural productivity. Expenditures on public goods allow for the creation of institutions that enforce laws that protect property rights (Polinsky and Shavell, 2000; Williamson, 2000) and are essential to sustainable use of natural resource stocks. Furthermore, the provision of public goods complements other inputs in different sectors (López et al., 2011) thereby augmenting agricultural productivity. Expenditures on private goods are usually targeted towards specific sectors. Agricultural subsidies such as irrigation subsidies and input subsidies in South America (Bulte et al., 2007) are classic examples of such types of spending and also tend to increase agricultural productivity.²

¹ Road building and logging are two other important direct factors of deforestation. Recent estimates by Galinato and Galinato (2012, 2013) show that the effect of underlying factors through roads such as corruption and political stability are significantly smaller in magnitude than through forest land clearing for agricultural production. However, we do recognize that government infrastructure spending can have a significant impact on increasing road development not only in urban areas but in rural areas thereby reducing transportation cost and increasing deforestation (Pfaff et al., 2007, Weinhold and Reis, 2008). Also, since initial logging is often followed by agricultural production in developing countries (López and Galinato, 2005), it is difficult to empirically separate the two direct factors on deforestation. Thus, we opt to focus our analysis on only one direct factor: agricultural production. Note that we only focus on crop production and not livestock production because the mechanisms by which public spending affects deforestation may differ between the two production technologies.

² It must be noted that not all expenditures on private goods increase productivity of firms. In other cases, they may simply subsidize consumption of certain groups. For example, energy subsidies that go to the rich or education subsidies that benefit individuals that do not face borrowing constraints are examples of expenditures that merely substitute for private spending.

Early empirical work relied on reduced form estimation using cross-country forest cover data (Antle and Heidebrink, 1995; Cropper and Griffiths, 1994; Shafik, 1994;) to allow for a broad measure of the effect of underlying factors on deforestation. However, the mechanisms by which those factors affect forest cover are not elucidated which hinder accurate policy prescriptions to reduce deforestation. Also, FAO data on forest cover that are used for these types of analysis have been deemed unsatisfactory for econometric estimation (Angelsen and Kaimowitz, 1999).

More recent empirical estimates from micro studies rely on data from local surveys, remote sensing and satellite images (Chomitz and Thomas, 2003; Cropper et al., 2001; López, 1997, 2000). Using detailed forest data allows for accurate measures of the direct factors affecting deforestation but given the local nature of the forest cover data and limited observations over time, measuring the effect of the underlying factors is difficult.

López and Galinato (2005) bridged the link between underlying factors with estimates from micro studies by combining elasticities from microstudies with elasticities from regressions explaining the determinants of direct factors of deforestation. Galinato and Galinato (2013) extended the analysis by including more countries and focusing on the short-run and long-run effects of political stability and corruption control on deforestation. Galinato and Galinato (2012) simulated the effects of the two governance variables on deforestation-induced carbon emissions.

We add to the literature by focusing on the effect of the level and composition of public spending as our main underlying factors affecting deforestation due to agricultural production. Using these estimates we simulate the effect of changes in fiscal policy on CO₂ release from deforestation. This is the first study we are aware of that distinguishes the long-run and short-run effects of government spending on deforestation due to agricultural land expansion and related CO₂ emissions.

Our model illustrates mechanisms by which a change in the size and composition of fiscal spending affects deforestation-induced CO₂ through changes in land use from forest cover to agricultural land in developing countries. An increase in *expenditures on public goods* has two effects. First, it increases the cost of agricultural land conversion, and, second, it increases agricultural productivity which may offset the first effect. When total government spending increases, both *expenditures on public goods* and *expenditures on private goods* rise making it more likely that the effect of agriculture productivity overwhelms the effect of the cost of forest land conversion leading to more deforestation and CO₂ emissions. Our empirical model finds support for our theoretical results. We show that *expenditures on public goods* alone have a positive but insignificant effect on forest land clearing for agricultural production. However, total government spending significantly increases forest land clearing and related deforestation-induced CO₂ emissions in the short run. Interestingly, government spending does not have any significant lingering effects in the long run because long-run forest land clearing reverts back to its steady-state optimal level.

Our results highlight two important contributions. First, we show the difference in the mechanisms by which government spending affects production-based pollution versus pollution from land use change. López et al. (2011) showed in their static general equilibrium model that a change in the composition of government spending towards *expenditures on public goods* significantly reduces production-based pollution but increasing total spending alone has no significant effect. In contrast, we find the opposite result where a permanent change in government spending composition has no effect on deforestation-induced CO₂ emissions because of a simultaneous increase in the marginal cost and marginal benefits of land clearing. However, a permanent change to the level of government spending significantly increases pollution from forest land clearing. Second, we find an unintended consequence from increased fiscal spending and broadening safety nets: more pressure may be placed on clearing forest land to produce crops leading to more CO₂ emissions in the short run but it dissipates in the long run.

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