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The Generational Effects of Fiscal Policy in a Small Open Economy

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Abstract

The reform of the fiscal system has for many years occupied center stage in policy discussions in developing countries. The authors employ a simple overlapping generations (OLG) model in a small open economy setting to study the impact of fiscal policy reform on the welfare of various generations and on the country's growth rate. The authors find that while reallocating public expenditures from transfers to productive expenditures has sizable positive growth effects, individuals who are retired at the time of the policy change experience a welfare loss. However, younger generations experience *larger* welfare gains. The authors also find that running a public debt to finance transfer payments can decrease growth substantially and only slightly increase welfare of retirees. However, if debt is used to finance education expenditures or infrastructure investment, growth and welfare increase but only in the short run.

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In developing countries, the reform of the fiscal system has for many years occupied center stage in policy discussions. It is now widely recognized that public finances have played and continue to play an important role for the economic performance of those countries. Issues of sustainability of the fiscal system, the composition of the government budget, and their interaction have commanded substantial of attention. Furthermore, fiscal policies were prominently discussed and implemented in many countries to counteract the adverse effects of the financial crisis of 2008–09.

One important component of the public finances in developing countries is transfer payments (like pensions and welfare payments). Transfer payments are widely regarded as the foundation of the safety net provided by developing country governments. Reductions in transfer payments usually carry heavy political costs, while increases in transfers have implications for the budget, perhaps leading to cuts in other expenditures like infrastructure or education. For example, in Brazil, transfer payments, especially public pensions are a relatively large share of gross domestic product (GDP). According to the OECD (Organisation for Economic Co-operation and Development) Economic Surveys: Brazil (2001), public pension expenditures in Brazil are higher than OECD averages.[1] In this article, we address the questions, What are the growth and welfare effects of increasing (or reducing) transfer payments? and How do these changes affect retired individuals, working-age individuals, and youths?

While policy makers in developing countries have in the last two decades paid more attention to the overall size of the budget, public infrastructure investment has decreased significantly. For example, the relatively low level of public investment in infrastructure capital in Latin American countries has raised concern among policy makers in those countries, in the World Bank, in the International Monetary Fund (IMF), and other organizations. Easterly and Serven (2003) conclude that the cut in Latin American infrastructure investment "does not make sense in either macroeconomic or microeconomic terms" since these infrastructure projects often have very high rates of return. The IMF (2004) also documents low infrastructure investments and raises concerns about the adequacy of such low-investment levels. Calderon and Serven (2003) estimate that a large part of the difference in output between Latin American countries and

East Asian countries is due to low investment in infrastructure. Fay and Morrison (2005) claim that it would take an additional infrastructure investment of 4 to 6 percent of GDP over a twenty-year period to catch up with East Asian countries. We will also address the questions, What are the growth and welfare costs of such low investments in public infrastructure? and How are different generations affected? We specifically address the desirability of the proposed reform of massively raising infrastructure investment to 5 percent of GDP for a long period like twenty to thirty years and compute the resulting growth and welfare implications.

Hence, we study the effects of different fiscal policies that have been of high relevance for developing countries in the world. In this article, we use quantitative theory to answer the questions posed previously. We employ a simple overlapping generations (OLGs) model of a small open economy. We chose to calibrate the model to the Brazilian case due to its prominence as one of the leading emerging countries and because fiscal policy has played a central role in policy discussions for many years. While we use Brazil for our calibration, the model's trade-offs and results are likely to generalize quite easily to other small open economies.

Most of the literature that uses quantitative economic theory to assess the impact of fiscal policy on growth has studied closed economies. Examples of this research include Barro (1990), Lucas (1990), Glomm and Ravikumar (1998), Cassou and Lansing (1998, 2001), Rioja (1999, 2003), Baier and Glomm (2001), and Agénor (2008). We extend this literature and focus on an open economy version of the model. By studying an open economy version, we can conveniently incorporate risk premia that have been suggested by the research of Edwards (1984), Eichengreen and Mody (1998), and World Bank (2003).

Lucas (1990) finds that the growth effects of tax reform are small. There are a few articles that study growth effects of public expenditure reform mostly in the US context. This article is thus intended to complement both the empirical literature on this issue and the theoretical literature that has hitherto focused on rich countries like the United States. In the existing literature, two articles are particularly related to ours. First, Baier and Glomm (2001) use a closed economy, infinitely lived agents model and find that expenditure reform can have larger growth effects than tax reform. Our article differs from Baier and Glomm (2001) in that (1) we study a small open economy, (2) we use an OLG model that allows us to study transfers and how different generations are affected by policy changes, and (3) we formally model human capital accumulation and how it is affected by public schooling expenditures. The second related article is by Ferreira and

Nascimento (2005), who calibrate a neoclassical growth model with infinitely lived individuals and public infrastructure investment to Brazil. They find that a simultaneous increase in taxes and a decrease in public investment in infrastructure can replicate the observed decline in growth rates. However, neither do they model public education expenditures nor do they consider the potential adverse effects of transfers to the old.

While some of these questions, like the effects of raising infrastructure investment, have also been examined in the empirical literature, massively increasing public expenditures for one particular item such an infrastructure investment for a twenty- to thirty-year period would represent a very unique and distinct policy reform. The effects of such a reform are likely to be experienced far into the distant future. It is then not clear to what extent econometric studies with existing data can reveal the effects of such policy reform. Furthermore, the effects of fiscal policy reform are likely to be nonlinear and in some cases nonmonotonic. Much of the empirical literature concerned with the effects of fiscal policy reform on growth has ignored these nonmonotonicities (see, e.g., Barro 1990; Levine and Renelt 1992). We view our work here and the other work on using quantitative theory mentioned above as a complement, not a substitute for the vast empirical literature on the fiscal policy effects on growth.

The model, which is presented in the Model section, is an open economy version of the diamond OLG model, augmented with human capital and a relatively rich description of the government. The government taxes labor and capital income to use tax revenue to fund investment in infrastructure, public education expenditures, and transfers to the old. The model also allows for government borrowing. The model is also solved in the Model section. In the Calibration section, we calibrate the model to the Brazilian economy. The Policy Experiments section contains the results. The most important findings are reducing transfers and expanding productive expenditures have reasonably large growth effects. However, the generation that is already retired at the time of the policy change experiences a welfare loss. Subsequent generations experience welfare gains that are larger in magnitude than the loss of the retired. Running a public debt to finance additional productive public investments can increase growth by over 0.3 percent per year. The massive increase in infrastructure investment suggested by Fay and Morrison (2005) increases annual growth to about 1.8 percent for a thirty-year period. Conclusion section contains concluding remarks.

The Model

The economy we study is of the overlapping generations variety with each generation alive for three periods which we call youth, adulthood, and old age. During youth, the individual is endowed with one unit of time which is allocated to learning time n_t or to the production of a nontradable good $(1 - n_t)$. The nontradable good can be thought of as leisure or as goods produced in the informal sector or on the family farm, which are consumed by the family only and which escape taxation completely. During adulthood, labor is supplied inelastically. During old age, the individual is retired. There is no population growth, population size is normalized to unity (an innocuous assumption in the presence of constant returns to scale) and within a generation all individuals are identical. The setup is similar to Glomm and Ravikumar (1992, 1998).

Preferences are given by

$$\ln(1 - n_t) + \ln(c_{t,t}) + \beta \ \ln(c_{t,t+1}),$$

where $(1 - n_t)$ is a nontradable good like leisure of the child, $c_{t,s}$ denotes consumption of generation t (those becoming adults at the beginning of period t) in period s, $s = t, t + 1$.

The aggregate production technology for the single nonstorable consumption good is given by

$$Y_t = AG_t^{\psi} K_t^{\theta} H_t^{1-\theta}, \quad 0 < \psi, \quad 0 < 1, \quad A > 0, \tag{1}$$

where Y_t, G_t, K_t, and H_t are, in order, aggregate output, publicly provided infrastructure capital, physical capital, and human capital. Both physical and human capitals are privately provided and the technology exhibits constant returns to scale in the private factors, so that profits are zero in equilibrium. Versions of this technology have been used by Barro (1990), Baier and Glomm (2001), Cassou and Lansing (1998, 2001), Glomm and Ravikumar (1994, 1998), Fischer and Turnovsky (1995), Rioja (1999), and others.

Human capital of the child h_t is accumulated according to

$$h_t = Bn_t^{\phi} E_{t-1}^{\mu} h_{t-1}^{\rho}, \quad 0 < \phi, \quad \mu, \quad \rho < 1, \quad B > 0, \tag{2}$$

where n_t is learning (schooling) time, E_{t_1} represents the publicly provided educational inputs, and h_{t-1} is parental human capital. Learning technologies similar to the one used here have been used by Benabou (1996), Fernandez and Rogerson (1998), and Kaganovich and Zilcha (1999). Our formulation of how human capital enters the aggregate production function is also similar to the specification in Mankiw, Romer, and Weil (1992).[2] In order to make the model an endogenous growth model that generates a balanced growth path, Glomm and Ravikumar (1998) show that overall constant returns to scale to augmentable factors is necessary. This restriction follows from substituting the human capital production function into the goods production function.

Public infrastructure capital evolves according to

$$G_{t+1} = (1 - \delta_G)G_t + I_{G,t},$$

where δ_G is the rate of depreciation and $I_{G,t}$ is public investment. Infrastructure is a public good and completely financed by the government.

The government raises taxes on labor income at rate $\tau_{L,t}$ and on capital (interest) income at rate $\tau_{K,t}$. The government budget constraint is given by

$$D_{t+1} + \tau_{L.t}w_tH_t + \tau_{K,t}r_tK_t = (\Delta_{G,t} + \Delta_{E,t} + \Delta_{T,t} + \Delta_{P,t})Y_t + (1 + r_t)D_t,$$

where D_t is the government stock of debt and r_t is the net interest rate. In the government budget constraint above, all government expenditures are expressed as fractions of GDP; for example, $\Delta_{G,t}$ is the fraction of GDP allocated to investment in infrastructure in period t.

We solve the problem of the individual recursively, starting with the problems faced by adults. At this stage, the learning/schooling decision has been made, and thus, the stock of human capital h_t is given. Thus, the representative adult in generation t solves the problem

$$\begin{aligned}
&\max \quad \ln c_{t,t} + \beta \ln c_{t,t+1},\\
&\text{s.t.} c_{t,t} + s_t = (1 - \tau_{L,t})w_th_t,\\
&c_{t,t+1} = (1 + (1 - \tau_{K,t})r_{t+1})s_t + T_{t+1},\\
&\text{given}(w_t, r_{t+1}, \tau_{L,t}, \tau_{K,t}, T_{t+1}, h_t,
\end{aligned}$$

where w_t is the real wage rate and T_{t+1} are the transfer payments received during old age.

The savings decisions are given by

$$s_t = \frac{\beta}{1+\beta}(1 - \tau_{L,t})w_th_t - \frac{1}{1+\beta}\frac{T_{t+1}}{1 + (1 - \tau_{K,t+1})r_{t+1}}. \quad (3)$$

We typically restrict parameters and policy variables so that savings in equation (3) is positive. This problem yields an indirect utility function for the adult which is of the form

$$(1 + \beta)\ln[(1 + \tilde{r}_{t+1})\tilde{w}_th_t + T_{t+1}],$$

where $\sim$s denote after tax factor prices. Given this value function the Young solves the problem:

$$\max_{\{n_t\}} \quad \ln(1-n_t) + (1+\beta)\ln[(1+\tilde{r}_{t+1})\tilde{w}_t h_t + T_{t+1}]$$
$$\text{s.t.} \quad h_t = Bn_t^{\phi} E_{t+1}^{\mu} h_{t-1}^{\rho}.$$

The solution to this problem is given by

$$\begin{aligned}&(1+\phi(1+\beta))(1+\tilde{r}_{t+1})\tilde{w}_t B n_t^{\phi} E_{t-1}^{\mu} h_{t-1}^{\rho} + T_{t+1}\\ &= \phi(1+\beta)(1+\tilde{r}_{t+1})\tilde{w}_t B n_t^{\phi-1} E_{t-1}^{\mu} h_{t-1}^{\rho}.\end{aligned} \tag{4}$$

The firm's profit maximization together with the no-arbitrage condition yields

$$w_t = (1-\theta)\frac{Y_t}{H_t},$$

$$1 + r_t = q_t = \theta\frac{Y_t}{K_t},$$

where q_t is the rental price of capital.

We will distinguish between two subcases. In the first subcase, the real interest rate is fixed exogenously at the level $r_t = \bar{r}$. In the second subcase, following evidence in Edwards (1984), Eichengreen and Mody (1998), Banco Central do Brasil (2001), and World Bank (2003), we assume that the real interest rate prevailing in Brazil is a function of the government debt to GDP ratio. In that case, we write

$$r_t = \bar{r}_t + R\left(\frac{D_t}{Y_t}\right),$$

where R is an increasing function with $R(0) = 0$.

In the small open economy case, the private stock in physical capital is determined completely by the firm's profit maximization condition

$$K_{t+1} = (\theta A)^{\frac{1}{1-\theta}} G_{t+1}^{\frac{\Psi}{1-\theta}} H_{t+1}(1+r_{t+1})^{\frac{1}{\theta-1}}.$$

The asset accumulation decisions by households are irrelevant for growth of GDP since firms can always satisfy their demand for capital from abroad. This equation, together with the laws of motion for infrastructure capital and for human capital fully determines the equilibrium law of motion for GDP. In this case, foreign bond holdings soak up the rest

Table 1. Parameter Values for Calibration

Discount Factor β	$(.97)^{30}$
Capital's share of GDP θ	.4
Public capital Elasticity Ψ	.2
Public education expenditure elasticity μ	.1
Total factor productivity *A*	2.253
Learning time elasticity ϕ	Calibrated to get $n = .15$
Parental human capital elasticity ρ	Calibrated to get balanced growth
Tax revenue as a fraction of GDP	17.5 percent
Transfers as a fraction of GDP	8.0 percent
Public education expenditure as a fraction of GDP	5.0 percent
Public capital expenditure as a fraction of GDP	1.0 percent
Labor income tax rate	26 percent
Capital income tax rate	12 percent
World interest rate	8 percent

Note: GDP = gross domestic product.

of private assets held. The complete solution algorithm for the model is described in the appendix.

Our model is a direct extension of Glomm and Ravikumar's (1992, 1998) models. In Glomm and Ravikumar (1998), the decision rules and growth rate can be computed in closed-form solution by focusing on one type of public expenditure at a time (either public infrastructure or public spending on education). Our model is richer because it simultaneously includes three types of public expenditures (infrastructure, education, and transfers) as we are interested in the effects of changing the composition of the budget. Furthermore, our model allows for debt and a country risk premium. Both of these are important features of economies that are not modeled in the articles mentioned previously. Given these innovative features, we cannot compute closed-form solutions for the growth rate or for the welfare changes for each generation. The solutions must be computed numerically; the solution algorithm described in the appendix may clarify the process that must be followed.

Calibration

In this section, we calibrate the model to the Brazilian economy. Table 1 presents the parameters for preferences, technology, fiscal policy, and the world interest rate. A few comments on the choice of these parameter values are in order. The discount factor β has been estimated using quarterly data for Brazil by Da Costa, Rogerio, and Ferreira (2001); Rosal and Ferreira (1998); and Araujo (1997), who obtain values between .96 and .98. Our choice for the benchmark for the discount factor is .97. In this type of long-run growth OLG model, one period is typically taken to be equal to about thirty years. Hence, β is set to $(.97)^{30}$.

The estimates for capital's share of national income for Brazil by Da Costa, Rogerio, and Ferreira (2001); Araujo (1997); Rosal and Ferreira (1998); Barro and Sala-i-Martin (1995); and Gomes, Pessou, and Velosa (2003) are between .4 and .55. We use a value of .4 which is in their range of estimates. The public capital elasticity Ψ has been estimated for Brazil by Florissi (1996), Ferreira and Malliagros (1998), and Blanco and Herrera (2003). Their estimates range from .29 to .63. These values seem high relative to some estimates for the United States (see Ai and Cassou 1995; Holtz-Eakin 1994; Hulten and Schwab 1991). We choose a conservative value of .2 for our benchmark case, which is an average estimate for developing countries from Fay (2001) and Canning and Fay (1993). Concerning the public expenditure elasticity in the learning technology μ, we use a value of .1, which is in line with an estimate for the United States from Card and Krueger (1992) and which, according to Rangazas (2000), is a reasonable parameter value for growth models. This value may be on the low side for developing countries since Betts (1996) documents that in the US estimates of μ are higher the older the data set used; presumably, for older data sets, average income is lower and public education expenditures may be more effective. The parameter value on parental human capital in the learning technology ρ is chosen so that we get balanced growth. The learning time elasticity parameter ϕ is chosen so that individuals in the first period of life spent 15 percent of their available hours learning rather than working.[3]

The labor and capital tax rates are set to 26 percent and 12 percent according to the computations for Brazil by Araujo (1997). Regarding public expenditures, transfers in Brazil are about 8 percent of GDP according to Government Finance Statistics (2003). Public infrastructure investment since the 1990s has been about 1 percent of GDP, while education expenditures are about 5 percent of GDP. Concerning the world interest rate, we set it equal to 8 percent annually, which is much higher than the interest rate in Rebelo and Vegh (1995) but closer to real interest rates for Brazil reported in Da Cunha and Ferreira (2003).

Table 2. Shifting Public Funds from Transfers to Education

	−4 percent	−3 percent	−2 percent	−1 percent	Benchmark	1 percent	2 percent	3 percent
Growth effects[a]								
Period								
1	0.46	0.69	0.83	0.92	1.00	1.06	1.12	1.16
2	0.26	0.58	0.76	0.90	1.00	1.09	1.16	1.22
3	0.25	0.57	0.76	0.89	1.00	1.09	1.16	1.22
4	0.24	0.57	0.76	0.89	1.00	1.09	1.16	1.23
Level effects[b]								
Period								
1	3,936	4,218	4,394	4,523	4,626	4,713	4,787	4,853
2	4,256	5,014	5,520	5,911	6,235	6,514	6,761	6,983
3	4,582	5,943	6,925	7,721	8,404	9,009	9,558	10,061
4	4,929	7,044	8,686	10,084	11.327	12,461	13,513	14,499
Welfare effects[c]								
Generation								
0	0.96	0.70	0.45	0.20	0.00	−0.31	−0.57	−0.82
1	−29.9	−18.5	−10.9	−4.96	0.00	4.01	7.61	27.2
2	−52.6	−36.0	−22.5	−10.7	0.00	9.63	18.7	46.5
3	−65.5	−60.7	−32.4	−16.1	0.00	15.7	31.3	68.8

[a]Annual per capita growth rate during the period.
[b]Real income per capita at the end of the period.
[c]Percentage change in lifetime consumption required to achieve “new” utility level.

Policy Experiments

Changes in the Composition of Fiscal Expenditures

In this section, we carry out our policy experiments. We begin with the case where the government budget is balanced each period. We start with the benchmark case and then shift resources from one kind of public expenditure to another. This kind of policy experiment is crucial in determining public spending priorities, especially in poor countries with very limited public budgets. Brazil’s per capita growth rate during the 1990s was about 1.0 percent annually. In each case, we run the economy until a balanced growth path with 1.0 percent annual growth is reached. Then we impose the policy reform. We report growth rates for the following four periods. Once the growth rate converges to a new balanced growth path, it is constant for all future periods. Since a period is thirty years, our results cover more than a century, so we only report effects up to the fourth period.

Similarly to Baier and Glomm (2001), we find that such expenditure reallocations have sizable growth implications. Table 2 describes the results of reallocating funds between transfers and education. Columns to the right of the "Benchmark" column shift resources from transfers to education, while columns to the left shift resources from education to transfers. For example, shifting 2 percent of GDP away from transfers and reallocating them to public expenditures on education raises the yearly growth rate from 1 percent to 1.12 percent in the first period and to 1.16 percent in the subsequent periods. Conversely, reducing education expenditures and allocating them to transfers imposes substantial costs in terms of lower growth. A 2 percent of GDP shift from education to transfers reduces the per capita growth rate from 1 percent to 0.76 percent per year.

The effects of these policy changes on the level of income are shown on the second panel of table 2. The benchmark level of income is the actual income per capita in Brazil in 2000 ($4,626), which is at the end of what we call period 1. We use this benchmark level along with the growth rates generated by the model to compute subsequent income levels. The level effects of shifting public expenditures from transfers to education are large, especially for later generations. For example, an increase of 3 percent of GDP raises the level of income by about $1,600 for generation 3 and by about $3,000 for generation 4. On the other hand, even a relatively small cut of the education budget of 1 percent of GDP in favor of transfers decreases the level of income for generation 4 by about $1,200.

The last panel of table 2 computes welfare effects of policy changes. The welfare effects are important since they present a clear picture of how individuals are affected beyond the change in the growth rate of output in the economy. They are computed using an approach similar to Chari, Christiano, and Kehoe (1994). The welfare change is defined as the percentage change in lifetime consumption required to achieve the postreform utility level. We report the effects for four generations beginning with generation 0 who are the old in period 1. Reducing transfers to spend on education affects generation 0 adversely. This is expected since the cut in transfers affects the "old" directly. A 1 percent reduction in transfers would require a compensating increase in lifetime consumption of the old by 0.31 percent if the old were to be left equally well off. Generations 1 through 3 are positively affected by the change, however, given the increase in the education budget. In fact, the positive welfare impact on these individuals is large: about 4 percent of lifetime consumption for generation 1 and about 16 percent of lifetime consumption for generation 3. Conversely, policy experiments reallocating from education to transfers show small welfare gains for generation 0, but large welfare losses for subsequent generations. These welfare losses increase with subsequent generations.[4]

Table 3 presents the effects of reallocating public funds from transfers to infrastructure investments. Again, reallocating public funds away from

Table 3. Shifting Public Funds from Transfers to Infrastructure Investment

	−0.50 percent	Benchmark	1 percent	2 percent	3 percent	4 percent
Growth effects[a]						
Period						
1	0.66	1.00	1.34	1.54	1.68	1.79
2	0.82	1.00	1.18	1.28	1.36	1.42
3	0.84	1.00	1.17	1.26	1.33	1.39
4	0.84	1.00	1.16	1.26	1.33	1.38
Level effects[b]						
Period						
1	4,186	4,626	5,113	5,422	5,653	5,839
2	5,354	6,235	7,265	7,947	8,472	8,905
3	6,873	8,404	10,284	11,579	12,602	13,463
4	8,825	11,327	14,553	16,864	18,735	20,338
Welfare effects[c]						
Generation						
0	−20.6	0.00	26.6	45.4	60.5	73.2
1	−32.1	0.00	50.1	91.2	127	159
2	−38.2	0.00	67.4	127	183	235
3	−43.3	0.00	86.0	169	249	327

[a]Annual per capita growth rate during the period.
[b]Real income per capita at the end of the period.
[c]Percentage change in lifetime consumption required to achieve “new” utility level.

transfers to infrastructure has large and positive growth effects. The 1 percent shift raises growth from 1 percent to 1.34 percent in period 1. These effects are larger than those from the reallocation to education discussed above. This finding certainly reflects the initial public allocations with a relatively low share of GDP going to infrastructure investment. This finding also depends on the size of the respective coefficients on education and infrastructure. Sensitivity analysis scenarios are available from the authors upon request.

The welfare effects on table 3 are also quite large. Interestingly, even generation 0 has a welfare gain from more infrastructure investment. While there is a reduction in the percentage of GDP that they receive as pension, the size of overall GDP expands during period 1 with the doubling of infrastructure spending (going from 1 percent to 2 percent of GDP). Hence, the pensions they receive are higher and they experience a welfare gain of about 26 percent of lifetime consumption. Future generations experience even larger welfare gains.

The next experiment we perform speaks to the correct mix of productive government expenditures. As is evident from table 4, reallocating from 2 percent to 3 percent of GDP from education to infrastructure appears to be growth

Table 4. Shifting Public Funds from Education to Infrastructure Investment

	−0.50 percent	Benchmark	1 percent	2 percent	3 percent	4 percent
Growth effects[a]						
Period						
1	0.70	1.00	1.26	1.36	1.36	1.24
2	0.87	1.00	1.07	1.05	0.93	0.67
3	0.88	1.00	1.06	1.02	0.90	0.63
4	0.88	1.00	1.06	1.02	0.90	0.62
Level effects[b]						
Period						
1	4,227	4,626	4,999	5,149	5,154	4,966
2	5,477	6,235	6,887	7,034	6,809	6,074
3	7,127	8,404	9,447	9,538	8,906	7,328
4	9,276	11,327	12,954	12,925	11,638	8,833
Welfare effects[c]						
Generation						
0	−20.6	0.00	26.9	46.2	61.8	75.0
1	−30.7	0.00	42.5	69.6	82.7	76.6
2	−35.4	0.00	48.8	73.4	73.6	42.0
3	−39.4	0.00	54.5	75.7	62.9	12.6

[a]Annual per capita growth rate during the period.
[b]Real income per capita at the end of the period.
[c]Percent change in lifetime consumption required to achieve "new" utility level.

maximizing in period 1 as it raises growth rates to 1.36 percent. However, looking at the effects in subsequent periods, the growth effects are maximized by a 1 percent of GDP reallocation from education to infrastructure, yielding a 1.06 percent yearly per capita growth rate in periods 2 through 4.[5] In a sense, this should not be too surprising since the coefficient on infrastructure is much larger than the coefficient on education. The sensitivity analysis available from the authors of the appendix shows that the growth maximizing mix of infrastructure investment and public education does not vary much with the productivity parameters but also that modest changes in policy influence the growth maximizing mix only slightly and that the resulting effects on growth are relatively small.

Tax-Financed Public Expenditure Changes

We next study the effects of increasing public expenditures financed by taxation. Both permanent and temporary increases are presented. Tax rates on capital (τ_K) and on labor income (τ_L) are increased in equal proportion to finance increased

Table 5. Tax-Financed Public Expenditure Increase

Period	Benchmark	Transfers	Education	Infrastructure
Growth effects[a]				
Permanent increase of 1 percent				
1	1.00	1.00	1.06	1.34
2	1.00	1.00	1.08	1.18
3	1.00	1.00	1.08	1.16
4	1.00	1.00	1.08	1.16
Temporary increase of 1 percent				
1	1.00	1.00	1.06	1.34
2	1.00	1.00	1.02	0.84
3	1.00	1.00	1.00	0.99
4	1.00	1.00	1.00	1.00
Level effects[b]				
Permanent increase of 1 percent				
1	4,626	4,624	4,710	5,111
2	6,235	6,230	6,465	7,610
3	8,404	8,392	8,931	10,806
4	11,327	11,305	12,345	15,288
Temporary increase of 1 percent				
1	4,626	4,624	4,711	5,114
2	6235	6,230	6,465	7,620
3	8404	8,396	8,772	9,794
4	11327	11,317	11,829	13,151
Welfare effects[c]				
Generation				
Permanent increase of 1 percent				
0	0	−1.74	−2.00	24.3
1	0	−1.85	2.19	47.4
2	0	−1.95	7.57	64.2
3	0	−2.00	13.4	82.0
Temporary increase of 1 percent				
0	0	−1.74	−2.00	24.3
1	0	−0.17	4.22	18.0
2	0	−0.22	5.13	10.9
3	0	−0.15	5.28	10.4

[a]Annual per capita growth rate during the period.
[b]Real income per capita at the end of the period.
[c]Percentage change in lifetime consumption required to achieve "new" utility level.

expenditures. As table 5 shows, raising education or infrastructure by 1 percent of GDP paid for with increased taxation has positive growth effects. For instance, raising infrastructure investment permanently by 1 percent of GDP increases the per capita growth to 1.34 percent per year in the first period. This effect diminishes over time but converges to 1.16 percent by period 3. Temporary increases, on the other hand, converge back to the original 1 percent growth rate.

The welfare effects of the tax-financed public expenditure increases are interesting. First, the increase in transfers affects all generations negatively. Hence, the adverse effect of tax increases to fund more transfer payments yield a welfare loss for all generations. Second, an increase in education negatively affects the welfare of generation 0. It is too late for the "old" to benefit from more education, so they are only affected by the tax increase that reduces their welfare. Generations 1 through 3 do experience positive welfare effects of about 2 to 13 percent of lifetime consumption. Third, given the scarcity of infrastructure, increasing this expenditure has sizable positive effects on the welfare of all generations shown.

Debt-Financed Public Expenditure Changes

Next, we study whether government deficits matter for the effects of raising public expenditures. First, we performed the same kinds of reallocations of government resources, but we assume that the government can issue debt. It turns out that the presence of public debt does not affect the growth effects of the expenditure reallocations. This is true since we are considering a small open economy in which local firms can rent as much capital as they find profit-maximizing at the going world interest rate. In this economy, there is no crowding out of private by public capital. Moreover, so far the prevailing interest rate has been assumed to be independent of the size of public debt.

In the next few policy experiments, we study the growth effects of debt-financed public expenditures. We consider both permanent and temporary public expenditure increases. We assume that the debt is rolled over perpetually. To this end, we begin with an exogenous world interest rate of 8 percent per year and, following Edwards (1984), Eichengreen and Mody (1998), and World Bank (2003), we allow the interest rate prevailing in the Brazilian economy to be an increasing function of the government debt to GDP ratio. More precisely, the government runs a deficit of 1 percent of GDP in period and in period $(t+1)$, the prevailing interest rate rises from 8 percent to 8 percent plus a risk premium. As described in the model section, $r_t = \bar{r}_t + R(D_t/Y_t)$. The risk premium is linear in the debt to GDP ratio with the slope, R, running from .1 to .3. This slope coefficient has been estimated by the World Bank (2003) at about .1.

In table 6, we show the growth effects of raising debt of 1 percent of GDP and using the proceeds to finance one of the three expenditure items:

Table 6. Debt-Financed Public Expenditure Increase

Period	Benchmark	Transfers	Education	Infrastructure	Transfers	Education	Infrastructure
		Interest rate markup 0.1			Interest rate markup 0.3		
Growth effects[a]							
Permanent increase of 1 percent							
1	1.00	1.00	1.06	1.34	1.00	1.06	1.34
2	1.00	0.96	1.05	1.15	0.90	0.99	1.09
3	1.00	0.80	0.90	1.01	0.38	0.52	0.68
4	1.00	−0.24	0.02	0.30	−3.63	−2.85	−1.94
Temporary increase of 1 percent							
1	1.00	1.00	1.06	1.34	1.00	1.06	1.34
2	1.00	0.97	0.99	0.80	0.90	0.92	0.73
3	1.00	0.83	0.84	0.80	0.49	0.51	0.40
4	1.00	0	0.05	−0.16	−2.67	−2.43	−3.33
Level effects[b]							
Permanent increase of 1 percent							
1	4,626	4,624	4,711	5,111	4,624	4,711	5,111
2	6,253	6,167	6,446	7,196	6,043	6,322	7,073
3	8,404	7,826	8,438	9,718	6,768	7,385	8,672
4	11,327	7,277	8,480	10,629	2,234	3,100	4,815
Temporary increase of 1 percent							
1	4,626	4,624	4,711	5,114	4,624	4,711	5,114
2	6,253	6,169	6,330	6,503	6,045	6,208	6,363
3	8,404	7,913	8,144	8,249	6,991	7,240	7,165
4	11,327	7,903	8,269	7,858	3,107	3,456	2,592

(continued)

Table 6. (continued)

Period	Benchmark	Transfers	Education	Infrastructure	Transfers	Education	Infrastructure
		Interest rate markup 0.1			Interest rate markup 0.3		
Welfare effects[c]							
Generation							
Permanent increase 1 percent							
0	0	0.20	−0.06	26.9	0.20	−0.06	26.9
1	0	0.25	4.64	18.4	1.08	5.47	19.6
2	0	0.63	5.97	12.1	2.56	7.86	14.8
3	0	5.26	10.6	17.7	29.0	33.4	52.1
Temporary increase 1 percent							
0	0	0.20	−0.06	26.9	0.20	−0.06	26.9
1	0	0.50	4.64	50.9	1.32	5.47	52.1
2	0	1.24	11.0	69.2	5.79	13.7	72.6
3	0	7.18	22.4	93.9	41.8	53.2	128

[a]Annual per capita growth rate during the period.
[b]Real income per capita at the end of the period.
[c]Percentage change in lifetime consumption required to achieve "new" utility level.

transfers, education, or infrastructure investment. What is evident from table 6 is that (1) financing additional transfers through public debt is detrimental to growth. This is especially true for more distant generations and when the risk premium is large. The change in transfers itself has absolutely no effect on growth at all. In the small open economy, the entire demand for physical capital can be satisfied from abroad if necessary, so that a change in transfers, even though it impacts private asset accumulation, is powerless to influence growth. The only channel at work here is that increasing the debt to GDP ratio raises the interest rate, which causes the quantity of capital demanded to fall. It is important to note that this decline in physical capital also has a general equilibrium effect on schooling time. Overall, the growth effect is negative and of large magnitude. (2) Financing extra public education initially has modest positive growth effects. These growth effects decline over time and reduce growth below the benchmark for generations 3 and 4 as higher interest charges accrue.

Using a higher interest rate markup of .3 results in the growth effects decreasing faster as expected compared to the benchmark interest rate markup of .1. The channels at work are increasing public education spending increases learning time and future human capital. Higher human capital increases the marginal product of physical capital and hence the demand for physical capital. The result is an initial positive growth effect, which is overcome by a negative interest rate effect after generation 2.

The largest positive growth effects occur when the public debt is used to finance infrastructure investment permanently. In that case, the growth rate resulting from a permanent growth in public debt jumps from 1 percent to 1.34 percent in the first period, to 1.15 percent in the second period and to 1.01 percent in the third period only to fall to 0.3 percent in the fourth period. As table 6 illustrates, this policy increased the level of income in the first three periods relative to the benchmark case. When permanent public debt is used to fund additional public education any initial gains in the level of income are eroded by the fourth period.

We also study the case of a temporary (one period) increase in public debt. These results are also contained in table 6. It is clear from this table that the positive growth effects only arise in the first period. Already in the second period, growth rates are lower than in the benchmark case. The temporary deficit generates a lower level of income from period 2 onward in the case of extra transfers, from period 3 onward in the cases of extra public education expenditures and public infrastructure investment.

The message for policy makers here is clear. The use of temporary debt to finance additional expenditures at best has limited short-term benefits. In

Table 7. Temporary Increase in Public Infrastructure Investment from 1 Percent to 5 Percent of Gross Domestic Product (GDP)

	Benchmark	Debt financed	Tax financed
Growth effects[a]			
Period			
1	1.00	1.79	1.79
2	1.00	0.47	0.63
3	1.00	0.01	0.97
4	1.00	−7.16	1.00
Level effects[b]			
Period			
1	4,626	5,838	5,838
2	6,235	6,721	7,046
3	8,404	6,740	9,413
4	11,327	726	12,679
Welfare effects[c]			
Generation			
0	0	75.0	60.9
1	0	50.6	47.6
2	0	35.8	27.3
3	0	−24.5	25.9

[a]Annual per capita growth rate during the period.
[b]Real income per capita at the end of the period.
[c]Percentage change in lifetime consumption required to achieve "new" utility level.

the long term, these benefits are completely eroded. In the case of permanent debt, the benefits are only long lasting when additional debt is used to finance extra infrastructure investment.

Catching Up: A Large Increase in Infrastructure

The final experiment we perform corresponds to a policy reform suggested by Fay and Morrison (2005), who recommend a massive increase in infrastructure investment from 1 percent of GDP to 4 to 6 percent of GDP for a period of twenty years in order to catch up with East Asian economies. In table 7, we increase public investment in infrastructure for one generation from 1 percent to 5 percent, a period of roughly thirty years. This massive increase is financed by a corresponding increase in either debt or taxes. After this period, public infrastructure investment drops back to the previous investment rate of 1 percent of GDP.

The punch line from table 7 is that this massive prolonged increase in infrastructure investment increases the annual growth rate from the benchmark case of 1 to 1.79 percent in the first period. Income per capita is 26 percent higher (about $1,200 higher) at the end of the first period under either financing scheme. Under debt financing when debt is rolled over into the future, interest rates rise with the risk premium resulting in declining growth rates after period 2 (and even negative in period 4). This is not surprising since the debt accumulates and balloons over four generations. Under the tax-financing scheme, growth falls in period 2 due to the drastic reduction in infrastructure investment from 5 percent to 1 percent of GDP in that period. Subsequently, growth converges back to its benchmark of 1 percent. The welfare effects of this experiment are positive for the first three generations in the debt-financed case and for all four generations in the tax-financed case. These effects are larger initially for the debt-financed experiment since the tax-financed affects labor income and capital income and hence consumption, but decline relative to the tax-financed case since ultimately the effect of the increased risk premium will dominate. We also run the experiments spreading out the tax increases over many periods, but this does not greatly affect the results.

Conclusion

This article analyzes the growth and welfare effects of fiscal policies in a small open economy using an OLG model. The model is calibrated to Brazil, where fiscal policy has played a key role in the country's economic performance. We find that reallocating public expenditures from transfers to productive expenditures has sizable growth effects. However, individuals who are retired at the time of the policy change experience a welfare loss, while younger generations experience *larger* welfare gains. Conversely, raising transfers at the expense of productive expenditures reduces growth rates and welfare. In the last two decades, international financial organizations have encouraged budget tightening for developing countries. In many countries, this has been achieved by reducing infrastructure expenditures drastically, while the more politically sensitive transfers remain high or increase. Our results show that reducing infrastructure expenditures in favor of transfers has large adverse growth and welfare effects which are increasing in the long term.

We also find that running a public debt to finance transfers decreases growth substantially even though it increases the welfare of older generations. On the other hand, running a public debt to finance education or infrastructure expenditures can increase growth and welfare. However, these positive growth effects diminish over time and can become negative due to increase in the real interest rate caused by higher debt.

One caveat that has to be acknowledged is that transfers in our model have exclusively been defined as pensions for the old. Clearly, there are other components to transfers in the real world such as welfare payments that do not solely benefit the retired. For example, ‘‘conditional cash transfers’’ programs provide cash to poor families conditional on their investments on health and human capital (see Gertler, 2004; Schultz, 2004). Adding this type of transfer to the model is left for future work.

Appendix A

Solution Algorithm

1. Given initial values K_0, G_0, and H_0 guess n_1. The following equations determine G_1 and H_1:

$$G_{t+1} = (1 - \delta_G)G_t + I_{G,t}, \tag{A1}$$

$$H_{t+1} = Bn_{t+1}^{\phi}(\Delta_{E,t}Y_t)^{\mu}H_t^{\rho}. \tag{A2}$$

2. The following equation determines K_1:

$$K_{t+1} = (\theta A)^{\frac{1}{1-\theta}} G_{t+1}^{\frac{1}{1-\theta}} H_{t+1}(1 + r_{t+1})^{\frac{1}{\theta-1}}. \tag{A3}$$

3. w_1 is determined by

$$w_t = (1 - \theta)\frac{Y_t}{H_t}.$$

4. Guess T_2. Then n_1 is determined by

$$(1 + \phi(1 + \beta))(1 + \tilde{r}_{t+1})\tilde{w}_t Bn_t^{\phi} E_{t-1}^{\mu} h_{t-1}^{\rho} + T_{t+1} = \phi(1 + \beta)(1 + \tilde{r}_{t+1})\tilde{w}_t Bn_t^{\phi-1} E_{t-1}^{\mu} h_{t-1}^{\rho}.$$

5. Change guess of n_1 in step 1 until n_1 from steps 1 and 4 agree. This depends on guess for $T_2 = \Delta_{T,2}Y_2$.
6. Given K_1, G_1, H_1, and guess $n_2 = n_1$ for balanced growth. Equations (A1) and (A2) determine G_2 and H_2.
7. Equation (A3) determines K_2.

8. $T_2 = \Delta_{T,2} Y_2$.
9. Change the guess in step 4 for T_2 so that T_2 in steps 4 and 8 are equal.
10. Verify that n_1 is consistent with this T_2.
11. Repeat.

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Notes

1. This is because an extremely generous pension system was adopted in Brazil in the past. For some time, new entrants into the system were automatically entitled to full benefits. This resulted in many individuals that were close to retirement age joining the system and receiving full benefits upon retirement (OECD Economic Surveys: Brazil 2001).
2. The Mincerian formulation is one possible alternative for the human capital formation technology. Ferreira, Issler, and Pessoa (2003) test both specifications and find that the Mincerian formulation may fit the data better. However, their model abstracts from public infrastructure investment.
3. The rationale is as follows. Schooling on average involves about 6 hr of schoolwork per day during a 200 day school year. This yields a percentage of total time spent on schooling at about $(6 \times 200)/(24 \times 365) = 15$ percent.
4. We run a battery of robustness checks changing various parameters within the range of conventional estimates in the literature. These robustness tables are available from the authors upon request.
5. This does not imply that it is the optimal expenditure on education and public investment. In fact, raising one or both by reducing transfers increases growth.

References

Agénor, Pierre-Richard. 2008. "Fiscal Policy and Endogenous Growth with Public Infrastructure." *Oxford Economic Papers, Oxford University Press* 60:57–87.

Ai, C., and S. Cassou. 1995. "A Normative Analysis of Public Capital." *Applied Economics* 27:1201-9.

Araujo, Carlos H. V. 1997. "Reforma Tributaria do Brasil. Efeitos Alocativos e Impactos de Bem-Estar." Dissertação de Mestrado, EPGE/FGV, Rio de Janeiro.

Baier, S. L., and G. Glomm. 2001. Long-Run Growth and Welfare Effects of Public Policies with Distortionary Taxation." *Journal of Economic Dynamics and Control* 25:2007-42.

Barro, R. 1990. "Government Spending in a Simple Model of Endogenous Growth." *Journal of Political Economy* 98:S103-25.

Barro, Robert, and Xavier Sala-i-Martin. (1995). *Economic Growth*. McGraw-Hill, New York.

Benabou, R. 1996. "Heterogeneity, Stratification, and Growth: Macroeconomic Implications of Community Structure and School Finance." *American Economic Review* 86:584-609.

Betts, J. 1996. "Is There a Link Between School Inputs and Earnings? Fresh Scrutiny of an Old Literature." In *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success* (pp. 141-143), edited by G. Burtless. Washington, DC: Brookings Institution Press.

Blanco, Fernando, and Santiago Herrera. 2003. "The quality of Brazilian fiscal adjustment, 1999-2001." Working paper, The World Bank, Washington, DC.

Calderon, C., and L. Serven. 2003. "The Output Cost of Latin America's Infrastructure Gap." In *The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America* (pp. 95-117), edited by W. Easterly and L. Serven. Washington, DC: The World Bank.

Canning, D., and M. Fay. 1993. "The Effect of Transportation Networks on Economic Growth." Columbia University Working Paper, New York.

Card, D., and A. Krueger. 1992. "Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States." *Journal of Political Economy* 100:1-40.

Cassou, S. 1998. "Optimal Fiscal Policy, Public Capital, and the Productivity Slowdown." *Journal of Economic Dynamics and Control* 22:911-35.

Cassou, S., and K. Lansing. 2006. Tax Reform with Useful Public Expenditures, J*ournal of Public Economic Theory* 8:631-676.

Chari, V. V., Lawrence J. Christiano, and Patrick J. Kehoe. 1994. "Optimal Fiscal Policy in a Business Cycle Model." *Journal of Political Economy, University of Chicago Press* 102:617-52.

Da Costa Val, Paulo Rogerio, and Pedro Cavalcanti Ferreira. 2001. "Modelos de Ciclos Reais de Negocios Aplicados a Economia Brasileira." *Pesquisa e Planejamineto Econômico* 31:213-48.

Da Cunha, Barbara Vasconcelos Boavista, and Pedro C. Ferreira. 2003. "Custo de Ciclo Econômico no Brasil em um Modelo com Restrição a Credito." Working paper, EPGE-FGV, Rio de Janiero.

Easterly, W., and L. Serven, eds. 2003. *The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America*. Washington, DC: The World Bank.

Edwards, S. 1984. "LDC Foreign Borrowing and Default Risk: An Empirical Investigation 1976-80." *The American Economic Review* 74:726-34.

Eichengreen, B., and A. Mody. 1998. "What Explains Changing Spreads on Emerging-Market Debt: Fundamentals or Market Sentiment." NBER working paper no. 6408.

Fay, M. 2001. "Financing the Future: Infrastructure needs in Latin America, 2000-05." Working paper no. 2545, The World Bank, Washington, DC.

Fay, M., and M. Morrison. 2005. "Infrastructure in Latin America and the Caribbean: Recent Developments and Key Challenges." Report No. 32640-LCR, The World Bank, Washington, DC.

Fernandez, R., and R. Rogerson. 1998. "Public Education and Income Distribution: A Dynamic Quantitative Evaluation of Education-Finance Reform." *American Economic Review* 88:813-33.

Ferreira, P. C., J. V. Issler, and S. deAbreu Pessoa. 2003. "Testing Production Functions Used in Empirical Growth Studies." Ensaios Economicos da EPGA, Fundacao Getulio Vargas, Brazil.

Ferreira, P. C., and T. G. Malliagros. 1998. "Impactos Produtivos da Infra-Estructura no Brasil: 1950-1995." *Pesquisa e Planejamiento Economico* 28:315-38.

Ferreira, P. C., and L. G. do Nascimento. 2005. Welfare and Growth Effects of Alternative Fiscal Rules for Infrastructure Investment in Brazil. FGV Working Paper, No. 604.

Fischer, W. H., and S. Turnovsky. 1995. "The Composition of Government Expenditures and its Consequences for Macroeconomic Performance." *Journal of Economic Dynamics and Control* 19:747-86.

Florissi, S. 1996. "Infrastructure, Public Capital and Growth in the Brazilian Economy." Texto para discussão no. 96/15, Universidade Federal do Rio Grande do Sul.

Gertler, Paul. 2004. "Do Conditional Cash Transfers Improve Child Health? Evidence from Progresa's Control Randomized Experiment." *American Economic Review* 94:336-41.

Glomm, G., and B. Ravikumar. 1992. "Public versus Private Investment in Human Capital Endogenous Growth and Income Inequality." *Journal of Political Economy, University of Chicago Press* 100:813-34.

Glomm, G., and B. Ravikumar. 1994. "Public Investment in Infrastructure in a Simple Growth Model." *Journal of Economic Dynamics and Control* 18:1173–87.

Glomm, G., and B. Ravikumar. 1998. "Flat-Rate Taxes, Government Spending on Education, and Growth." *Review of Economic Dynamics* 1:306-25.

Gomes, Victor, Samuel de Abreu Pessoa, and Fernando Veloso. 2003. "Evolução da Produtividade dos Fatores na Economia Brasileira: Uma Analise Comparativa." Working Paper EPGE/FGV, Rio de Janeiro.

Government Finance Statistics, CD-ROM. 2003. Washington, DC: The World Bank.

Holtz-Eakin, D. 1994. "Public Sector Capital and the Productivity Puzzle." *Review of Economics and Statistics* 76:12-21.

Hulten, C., and R. M. Schwab. 1991. "Public Capital Formation and the Growth of Regional Manufacturing Industries." *National Tax Journal* 44:121-34.

International Monetary Fund. 2004. "Public Investment and Fiscal Policy," Report Prepared by the Fiscal Affairs Department and the Policy Development and Review Department.

Kaganovich, Michael, and Itzhak Zilcha. 1999. "Education, Social Security, and Growth." *Journal of Public Economics, Elsevier* 71:289-309.

Levine, Ross, and David Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economics Review* 82:942-63.

Lucas, R. E., Jr. 1990. "Supply-Side Economics: An Analytical Review." *Oxford Economic Papers* 42:293-316.

Mankiw, N. G., Romer D., and D. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics* 107:407-37.

OECD Economic Surveys: Brazil, 2001. OECD Publications, Paris.

Rangazas, P. 2000. "Schooling and Economic Growth." *Journal of Monetary Economics* 46:397-416.

Rebelo, S., and C. A. Vegh. 1995. "Real Effects of Exchange Rate-Based Stabilization: An Analysis of Competing Theories." NBER working paper no. 5197, National Bureau of Economic Research, Cambridge, MA.

Rioja, Felix. 1999. "Productiveness and Welfare Implications of Public Infrastructure: A Dynamic Two-Sector General Equilibrium Analysis." *Journal of Development Economics* 58:387-404.

Rioja, Felix. 2003. "Filling Potholes: Macroeconomic Effects of Maintenance vs. New Investments in Public Infrastructure." *Journal of Public Economics* 87:2281-304.

Rosal, João M. L., and Pedro C. Ferreira. 1998. "Imposto Inflacionario e Opções de Financiamiento do Setor Publico em um Modelo de Ciclo Reais de Negocios para o Brasil." *Revista Brasilera de Economia* 52:3-37.

Schultz, T. Paul. 2004. "School Subsidies for the Poor: Evaluating the Mexican Progresa Poverty Program." *Journal of Development Economics* 74:199-250.

World Bank. 2003. *Brazil Stability for Growth and Poverty Reduction*. Report No. 25278-BR.

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