

Terms-of-trade shocks and sector labor reallocation:  
The case of Jamaica, Guyana, and Trinidad and Tobago\*

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Abstract

This paper quantifies the long-run impact of terms-of-trade shocks on real gross domestic income growth of Jamaica, Guyana, and Trinidad and Tobago and relates these effects to the reallocation of labor across sectors in response to such shocks. The paper also discusses broadly defined fiscal policy responses that may mitigate or exacerbate the incidence of terms of trade shocks on income growth via the sector labor reallocation channel.

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# 1 Introduction

Recent developments in international commodity markets demonstrated the vulnerability of the Caribbean economies to terms-of-trade shocks. For instance, the standard deviation of the terms of trade (the U.S. dollar price of exports divided by the U.S. price of imports) was 5% per year in Jamaica, 8% in Trinidad and Tobago, and 14% in Guyana, on average, from 1990 to 2007.<sup>1</sup>

Jamaica, Trinidad and Tobago, and Guyana are representative not only of the different degree of vulnerability to terms of trade shocks, but also the different ways in which this vulnerability comes about. Jamaica, is an energy and a food importer but also an exporters of tourist services. Trinidad and Tobago is an energy exporter. And Guyana is an importer of energy and exporter of food. As we can see from Table 1, there are large differences across these three economies in the distribution of labour and output between the tradable and the non-tradable sector, as well as the degree of openness to trade. First, although all they are all have very open to international trade, Guyana stands out in terms of its exposure with exports and imports are at par with GDP. Second, in Trinidad and Tobago, employment is highly concentrated in the non-tradable sector. Finally, the output share of agriculture is very low in both Jamaica and Trinidad and Tobago, but output is concentrated in industry in Trinidad and Tobago and in services in Jamaica.

The objective of this paper is twofold. First, the paper aims at quantifying the impact on long-term gross domestic income growth of terms-of-trade shocks in these three countries. Second the paper relates this incidence to the sector reallocation of labor (or lack thereof) triggered by such shocks, as well as to the structural characteristics and the fiscal policy responses that may mitigate or exacerbate the adverse effects of such shocks via labor reallocation across sectors.<sup>2</sup>

To quantify the long-term effect of terms of trade changes on gross domestic income, we use the novel accounting framework of Kohli (2004). This accounting framework allows us to examine the contribution of terms-of-trade shocks to real domestic income, which, compared to real GDP, is an economically more relevant concept for understanding changes in economic well-being. Thus, this framework provides a natural setting to assess the significance of terms-of-trade shocks, as well a starting point to discuss to what extent the effects of these shocks might been mitigated or magnified through fiscal policy responses that can affect factor substitution in production and sector labor reallocation.

To investigate the consequences of the terms-of-trade shocks in the economies we consider, we set up a static general equilibrium, small open economy model with two production sectors (traded and non-traded sectors) and multiple goods: a domestically produced traded good that

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<sup>1</sup>To put these numbers in perspective, using a sample of 66 developing countries, Bidarkota and Crucini (2000) find that the standard deviation in the country quartile with the most volatile terms of trade was 25% per year. It was 16%, 12.5%, and 8.5%, respectively, in the next three quartiles in country distribution.

<sup>2</sup>There are at least three other important additional channels of transmission of terms of trade shocks omitted from the analysis for simplicity. First, there are effects through asset price changes, which are affected by the degree of international financial market incompleteness and capital mobility. Second, there are important effects through physical capital mobility across sectors. Third there is monetary and exchange rate policy. The role of physical capital mobility across sectors and of exchange rate policy could in principle be examined in the context of an extension of the framework used in this paper, but are beyond the scope of this paper. The role of competition and industrial policies is studied by IDB (2009). The role of financial market development and policies is investigated in related studies by the Burger et al (2009).

can either be exported or consumed at home, a non-traded good that can only be consumed at home, and an imported good, which is an intermediate input in the production of both traded and non-traded goods.

In this relatively simple framework, the key determinant of the long-term impact on income of terms of trade changes is the elasticity of substitution in production between labor and the imported intermediate goods (in both the nontraded and traded good sector).<sup>3</sup> This elasticity contributes to determining the magnitude of relative price changes and hence the income and substitution effects that in turn determine the responses of aggregate consumption and production to the shocks, and associated reallocation of labor across sectors.<sup>4</sup>

In principle, there is very little that economic policy can do to influence the elasticity of substitution in production. Nevertheless, economic policy can interact with this elasticity and indirectly influences the vulnerability of an open economy to fluctuations in the terms of trade. The reallocation of labor across sectors in response to terms of trade shocks, in particular, may be affected by the degree of labor mobility, both national and international, as well as by immigration and tax policies (including on international trade). Thus, labor market rigidities, poor social safety nets, and migration policies are important, but relatively under-researched, factors affecting the transmission of these shocks. Among the numerous policy instruments at the disposal of a government, in this paper primarily focuses on specific fiscal policy instruments such as payroll taxes and trade policy through domestic tariffs, as well as aggregate government expenditure. Albeit in a rather crude and rudimentary manner, the model we set up allow also for discussion of fiscal policies affecting remittances, royalty payments, and private capital flows.

The rest of the paper is organized as follows. In section 2, we document the quantitative significance of terms-of-trade shocks for Jamaica, Trinidad and Tobago, and Guyana by using the accounting framework recently proposed by Kohli (2004). In section 3, we describe the small open economy model outlined above and calibrate it to match the decompositions estimated in section 2. In section four, we discuss fiscal policies that could ameliorate the long-run impact of these shocks on income growth.

## 2 Terms-of-trade shocks and income growth

In this section, we quantify the long-run impact of terms-of-trade shocks on income growth in Jamaica, Guyana, and Trinidad and Tobago using the accounting framework developed by Kohli (2004). We first illustrate this framework in subsection 2.1, and then apply it to these three economies in section 2.2.

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<sup>3</sup>In principle, the degree of labor mobility across sectors is also a determinant of the response of relative prices (see, e.g., Dennis and İşcan (2006)). However, there are no impediments to labor mobility across sectors in the basic framework we present here.

<sup>4</sup>Terms-of-trade shocks modify the international relative price of exported and imported goods. Small open economies have little or no influence over these international price changes. As a result of a terms-of-trade shock, domestic prices of exported and imported goods also tend to change, including on the relative price of non-traded goods. That is, relative price changes in international markets pass-through to domestic prices. Exchange rate and monetary policy can affect the speed and the extent of this of this pass-through to domestic relative prices. The analysis in this paper abstracts from this transmission mechanism.

## 2.1 Kohli’s income growth accounting framework

Real GDP growth can underestimate the impact of terms of trade changes on real gross domestic income (henceforth income for brevity), and hence on the real purchasing power of income and the country’s consumption possibilities. This is because of the so called “Trading gains or loss,” which is the difference between the balance on trade in goods and services deflated by the overall GDP deflator and the same balance deflated with separate export and import price indices.<sup>5</sup>

Kohli (2004) shows that this potential divergence can be quantitatively large, adding up to more than 10% of GDP in less than two decades in the 26 countries he analyzed, and provides a theory consistent accounting framework to quantify more accurately the impact of terms of trade changes on income. As this framework is based on a rigorous modeling of the production sector of an open economy, it can also highlight the importance of different structural parameters in determining the overall income vulnerability of a country to these shocks.

Kohli (2004) accounting framework decomposes changes in income growth in three factors: changes in real GDP, changes in the real exchange rate, and changes in the terms-of-trade. As such, this framework allows us to distinguish between changes in output and changes in relative prices. Specifically, let  $D$  denote total nominal domestic demand or absorption—i.e., consumption plus investment plus government expenditures at current, local-currency prices— $D$  is thus an aggregate of domestic traded, domestic nontraded and foreign traded goods. Let  $Z$  denote demand for domestically produced goods—i.e.,  $Z = D + X - M$ , where  $X$  denote nominal export and  $M$  denote nominal imports. In equilibrium, demand must be equal to the nominal value of output (nominal GDP),  $Y$ . Thus:

$$Y_t = p_{D,t} y_{D,t} + p_{X,t} y_{X,t} - p_{M,t} y_{M,t}, \quad (1)$$

where  $p_{i,t}$  are current local currency prices, and  $y_{i,t}$  is the real demand component  $i$ , for each  $i = D, X, M$ . Define now  $q$  as the inverse of the terms of trade (price of import divided by the price of export in domestic currency, and  $h$  as the relative price of export in terms of the absorption deflator (which corresponds to a measure of the real exchange rate in the model in the next section):

$$q_t = \frac{p_{M,t}}{p_{X,t}}, \quad (2)$$

$$h_t = \frac{p_{X,t}}{p_{D,t}}. \quad (3)$$

Next, define income (i.e., real gross domestic income) as the ratio of nominal income ( $Y$ ) to the absorption deflator,  $p_{D,t}$ .

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<sup>5</sup>Recall the following national accounts relations (See IMF, 2007, for more details):

- GDP (Real—i.e., constant price—GDP) + T (Trading gain or loss) = GDI (Real gross domestic income).
- GDI + NFI (Real net factor income from abroad) = NI (Real national income).
- NI + NT (Real net current transfers from abroad) = GNDI (Gross national disposable income).
- $T = \left(\frac{X-M}{P}\right) - \left(\frac{X}{P_x} - \frac{M}{P_m}\right)$ , where X denotes export, M import, P the overall GDP deflator,  $P_x$  the export price index and  $P_m$  an import price index.

It is now useful to normalize income with respect to a base year, and define the *income growth factor* as one plus the growth rate of real domestic income over a specified period. Kohli (2004) shows that income growth can be decomposed in three different factors: a real GDP growth effect, a real exchange rate (or trade-balance) effect, and a terms-of-trade effect. Specifically, the *real GDP effect* is given by

$$\mathcal{G}_{t,t-1} = \frac{Y_t/Y_{t-1}}{P_{t,t-1}}, \quad (4)$$

where  $P_{t,t-1}$  denotes the growth factor in the overall GDP deflator (including imports):

$$\begin{aligned} \ln(P_{t,t-1}) &= \frac{1}{2}(s_{D,t} + s_{D,t-1}) \ln\left(\frac{p_{D,t}}{p_{D,t-1}}\right) \\ &\quad + \frac{1}{2}(s_{X,t} + s_{X,t-1}) \ln\left(\frac{p_{X,t}}{p_{X,t-1}}\right) \\ &\quad - \frac{1}{2}(s_{M,t} + s_{M,t-1}) \ln\left(\frac{p_{M,t}}{p_{M,t-1}}\right) \end{aligned} \quad (5)$$

with  $s_{i,t}$  being the share of component  $i$  in nominal GDP. The *real exchange rate effect* is given by

$$\ln(\mathcal{R}_{t,t-1}) = -\frac{1}{2}(s_{TB,t} + s_{TB,t-1}) \ln\left(\frac{h_t}{h_{t-1}}\right), \quad (6)$$

where  $s_{TB,t} = s_{X,t} - s_{M,t}$ . And finally the *terms-of-trade effect* is given by

$$\ln(\mathcal{T}_{t,t-1}) = -\frac{1}{2}(s_{M,t} + s_{M,t-1}) \ln\left(\frac{q_t}{q_{t-1}}\right). \quad (7)$$

Thus, income growth can be decomposed as the

$$\ln\left(\frac{Y_t/Y_{t-1}}{p_{D,t}/p_{D,t-1}}\right) = \mathcal{G}_{t,t-1} + \mathcal{R}_{t,t-1} + \mathcal{T}_{t,t-1}. \quad (8)$$

The real GDP effect,  $\mathcal{G}_{t,t-1}$ , is the conventional measure of economic growth, which does not take into account changes in purchasing power of domestic residents when the real exchange rate or the terms of trade change significantly. The direct effect of changes in the real exchange rate and the terms of trade is captured by the other two factors. Changes in relative prices, however, also induce households to reallocate their consumption between traded and nontraded goods and domestic producers to substitute between domestic and foreign goods in production. The decomposition above takes these indirect effects into account via the changes in the weights in each component of GDP over time. So the decomposition above does not only take into account the direct effects on income mechanically arising from the change in relative prices, but also the consequences of the substitution effects induced by such relative price changes. It thus highlights the fact that the easiness (or lack thereof) with which countries can enact these substitutions can affect the overall impact of relative price changes on income.<sup>6</sup>

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<sup>6</sup>This is a well known lessons in the policy literature on developing countries. For example, Little et al. (1993, p. 394) argue that, “the policies and general characteristics of an economy—especially its flexibility in responding to shocks—are more important than the size of shocks.”

Interestingly, the decomposition above is relatively simple to implement, requiring only data on nominal share the relevant relative price indices. Of course, this accounting framework cannot explain why share parameters might change over time. In order to address this more fundamental question, in section 3 of the paper, we add assumptions on preferences and technology to a similar accounting framework and focus specifically on the structural sources of flexibility or lack thereof in enacting these substitutions.

## 2.2 Accounting for income growth in Guyana, Jamaica, and Trinidad and Tobago

Table 2 shows the decomposition discussed in the previous section for Guyana, Jamaica, and Trinidad and Tobago for the period 1993–2007.<sup>7</sup> Specifically, the table reports period average growth rate of real gross domestic income (GDI) and its three components: the gross domestic product (GDP) effect, the terms-of-trade effect, and the real exchange rate (or trade balance) effect. For comparison, the last column of the table also reports the average growth rate and the standard deviation of the terms of trade (also plotted for each year and each country in Figure 1). As the theoretical analysis and the policy discussion in the paper focus on the medium-to-long-term, Table 1 reports only average effects together with their variability over time. In Figure 2, however, plots the growth rate of GDI for each year in all three countries, while in Figure 3 plots the decomposition for each year and for each country.

As we can see from Table 1 there are large differences across countries and over time (as indicated by large standard deviations) in the importance of terms of trade changes for income growth, which is our summary measure of vulnerability to these shocks, as well as differences in the channels through which relative price changes are bringing about such vulnerability.

The case of Guyana is striking. Despite having grown at the average rate of 3 percent per year in conventional GDP term, Guyana had a negative average income growth during the same period, albeit estimated imprecisely as highlighted by the very large standard deviation of income growth. The main driver of the result is the negative terms of trade effect, which is even slightly larger than the average terms of trade decline and is estimated precisely. In fact, between 1992 and 2007, Guyana’s terms of trade declined on average by 4.2% per year, while the terms of trade effect averaged -4.7% per year over the same period. This is suggestive of a country with little or no ability to substitute away from imported goods, as their price increased over time relative to the price of exports (see also Figure ??), even in the long-run.<sup>8</sup> The real exchange rate effect was also negative on average during this period, but it is not estimated precisely. The results therefore also suggest that exchange rate policy may have been ineffective in contrasting the averse external environment.

Although less striking, Jamaica, is also an interesting case in that it has had average income increase (0.85%) smaller than the average increase in GDP (1.3%), despite a small average terms of trade increase (0.6% per year), only partially reflected in the terms of trade effect (0.43%). In

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<sup>7</sup>See the appendix on the data sources and the construction of the variables needed to implement it. Note that, for 2006 and 2007, in several instances, there were missing observations that were filled extrapolating recent trends.

<sup>8</sup>Recall from equation 7 that the terms-of-trade effect depends on both relative price changes and changes in the share of import in GDP. For instance, a terms-of-trade effect that is smaller than the percentage change in the terms of trade is indicative of the ability of an economy to substitute away from imported goods.

this case, it is the exchange rate factor that accounts for the income growth below the average GDP growth, which was -0.84% on average and is estimated precisely. Interestingly, in the case of Jamaica, the volatility of the terms-of-trade effect is less than the volatility of the terms of trade, suggesting the presence of substitution mechanisms at work that may mitigate the consequences of the terms-of-trade shocks.

Trinidad and Tobago exhibits strong average growth in both real GDI and GDP, with much smaller contributions from the exchange rate and the terms-of-trade effects. Trinidad and Tobago's terms of trade increased mildly on average over the period considered (0.3% per year), but their volatility was one order of magnitude larger (i.e., 6% per year), driven by the large swings in the price of crude oil. The terms-of-trade effect has the same average magnitude (0.33%) but a much smaller standard deviation, perhaps suggesting the presence of smoothing mechanisms that mitigate the consequences of the terms-of-trade shocks.

Overall, these results rank the three countries we considered in terms of income vulnerabilities to terms-of-trade shocks. Guyana appears the most vulnerable case, Jamaica the least vulnerable one, and Trinidad and Tobago is somewhat in the middle. In all cases except, however, the difference between income and output growth is non-negligible.

We now proceed to study one specific mechanism through which these important differences in income and output growth may arise in the medium-to-long term in response to persistent changes in the terms of trade. With the aid of a relatively simple, static, small open economy model, we will therefore now attempt at explaining some of the results above in terms of substitution effects in domestic production possibilities. In the last section of the paper, we will then discuss the role that policy may have in affecting such substitutions.

### 3 Terms-of-trade shocks and sector labor reallocation

The terms-of-trade shocks directly or indirectly affect the relative prices of traded and non-traded goods, and hence lead to reallocation of resources and expenditure patterns across sectors. As we discussed in the previous section, these sector reallocations can ultimately cushion or exacerbate the impact of terms-of-trade shocks on income. In this section, we set up a tractable static model of labor reallocations in response to terms of trade shocks to illustrate and quantify this mechanism rigorously.<sup>9</sup>

#### 3.1 A small open economy model of sector labor reallocation

To analyze sector factor reallocation following a terms of trade shock, we use a modified version of the small open economy model of Dennis and İřcan (2005). The model has two production sectors: a sector producing domestic traded goods that can either be consumed domestically or exported and a sector producing nontraded goods that cannot be exported. In the model,

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<sup>9</sup>The model has no physical capital, financial assets, or other inter-temporal substitution mechanism. Gavin (1990) and Mendoza (1995) focus on inter-temporal considerations. In addition, the model has no trend reallocation of labor across sectors. For instance, as incomes rise, the share of labor in agriculture (a sector typically producing traded goods) tends to decrease, and the share of services tends to increase. Our analysis is not intended to capture these long-term changes. Extending the current environment to an intertemporal setting, or to consider trend-reallocation mechanism in this model, is feasible, but is beyond the scope of this paper.

there is also an imported good, which is an intermediate input produced abroad and supplied in infinitely elastic manner by the rest of the world economy.<sup>10</sup> Domestic traded and nontraded goods are produced using labor and the imported good, whose international market price is taken as given and normalized to one (i.e., it is the numeraire in the model). The c.i.f. unit price of this good faced by the domestic producers is  $1 + \tau_M$ , because, as we shall see, the government imposes an external tariff,  $\tau_M$ .

**Production** Firms in the domestic traded and nontraded goods sectors use labor and imported intermediate inputs. Specifically, the traded good production is

$$Y_T = A_T L_T^\beta M_T^{1-\beta}, \quad \beta \in (0, 1). \quad (9)$$

The nontraded good production is

$$Y_N = A_N [\omega L_N^\mu + (1 - \omega) M_N^\mu]^{\frac{1}{\mu}}, \quad \alpha \in (0, 1). \quad (10)$$

Here,  $A_i > 0$ , for  $i = N, T$  is a total factor productivity index,  $L_i$  is labor input;  $M_i$  is the imported intermediate input,  $1/(1 - \mu)$  is the elasticity of substitution between labor services and imported intermediate good,  $\omega \in (0, 1)$  is the share of labor in the nontraded sector, and  $\beta$  is the share of labor in the traded sector.<sup>11</sup>

Labor is perfectly mobile across sectors. So, there is a unique wage rate in the economy. However, there are sector-specific payroll taxes,  $\tau_N$  and  $\tau_T$  so that the value marginal products are equalized across sectors only up to a tax wedge:

$$W(1 + \tau_N) = P_N \omega A_N L_N^{\mu-1} [\omega L_N^\mu + (1 - \omega) M_N^\mu]^{\frac{1-\mu}{\mu}} \quad (11)$$

$$W(1 + \tau_T) = P_T \beta A_T L_T^{\beta-1} M_T^{1-\beta}. \quad (12)$$

Domestic producers operate in competitive industries. Given a constant returns to scale technology in each industry, firms earn zero profits. Thus, the domestic traded good price is

$$P_T = A_T^{-1} \beta^\beta (1 - \beta)^{\beta-1} [W(1 + \tau_T)]^\beta (1 + \tau_M)^{1-\beta},$$

while the price of nontraded good is:

$$P_N = A_N^{-1} \left[ \omega^{\frac{1}{1-\mu}} [W(1 + \tau_N)]^{\frac{\mu}{\mu-1}} + (1 - \omega)^{\frac{1}{1-\mu}} (1 + \tau_M)^{\frac{\mu}{\mu-1}} \right]^{\frac{\mu-1}{\mu}};$$

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<sup>10</sup>Note that there is no production of natural resources in the model. However, the model allows for an exogenous stream of income from abroad representing remittances, royalties on the production and export of natural resources, official aid inflows, or exogenous movements in private capital flows, that can affect the terms of trade and the real exchange rate. Therefore, as we shall discuss below, some features of the Dutch disease phenomenon, such as for instance the appreciation of the real exchange rate in response to an increase in the price of natural resource produced and exported, could be captured, albeit in a rudimentary manner, by our model.

<sup>11</sup>Although we do not have direct evidence for the countries we consider, our choices of a Cobb-Douglas production function in the traded sector and CES function in the nontraded sector reflects the prior that a unitary elasticity of substitution between labor and intermediate inputs (i.e., the Cobb-Douglas case) is unlikely to hold in the nontraded sector of these small open economies.

and the consumption-based aggregate price index for the composite consumption good is:<sup>12</sup>

$$P = P_T^\eta P_N^{1-\eta} / \eta^\eta (1-\eta)^{1-\eta}.$$

**Demand** There is a representative household in the economy whose preferences are represented by a (logarithmic) utility function over a composite consumption good,  $C$ . The household faces a wage rate,  $W$ , inelastically supplies work effort,  $L$ , and receives exogenous foreign income inflows,  $F$ , denominated in units of the imported good. We think of these inflows as a combination of unilateral transfers and remittances. However, the setup is very flexible and  $F$  could also represent royalties from a natural resource sector or private capital inflows. Capital inflows contribute to after-tax personal income,  $Y$ .

Specifically, the household's objective is to maximize

$$\log C, \tag{13}$$

subject to

$$C = C_T^\eta C_N^{1-\eta}, \tag{14}$$

$$P_N C_N + P_T C_T = WL + F \equiv Y, \tag{15}$$

where  $C_T$  is the consumption of traded good with price  $P_T$ ,  $C_N$  and  $P_N$  are, respectively, the consumption and unit price of the composite nontraded good, and  $\eta \in (0, 1)$  is a preference parameter that measures the share traded goods in the consumption basket.<sup>13</sup>

The household's utility maximization problem gives the following familiar first-order conditions with constant expenditure share:<sup>14</sup>

$$C_N = \frac{(1-\eta)Y}{P_N}, \tag{16}$$

$$C_T = \frac{\eta Y}{P_T}. \tag{17}$$

**Exports** Following Dennis and İřcan (2005) and Kehoe and Ruhl (2007), we close the model by specifying a downward sloping demand curve for exports in the international market:

$$X = A_X P_T^{\frac{-1}{\theta}}, \tag{18}$$

where  $A_X$  is a demand shifter, and  $\theta > 0$  is the inverse of the foreign price elasticity of demand for exports (thus, in relation to section 2.1, we have  $P_X = P_T$ ).

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<sup>12</sup>Note that, in relation to the notation used to illustrate the income decomposition in the previous section, we thus have that  $q = 1/P_T$ , and  $h = P_T/P = (\eta^\eta (1-\eta)^{1-\eta}) (P_T/P_N)^{1-\eta}$ , which is a function of the relative price of non-tradable goods, and hence a key component of the real exchange rate.

<sup>13</sup>In this specification, government services do not generate any utility flow for the households. Alternatively, we could think of government services to be separable from market consumption in the instantaneous utility function.

<sup>14</sup>We assumed unitary elasticity of substitution in consumption for simplicity and to isolate sector labor reallocation effects, but it would be very simple to extend it to consider expenditure pattern reallocations as an additional factor affecting the analysis.

**Government** We consider a very stylized government budget constraint. Government revenues consist of payroll taxes levied on the traded and nontraded sector employees. Government expenditures consist of direct expenditures on nontraded goods. Specifically, the government budget constraint is

$$\tau_T W L_T + \tau_N W L_N = P_N G_N, \quad (19)$$

where for  $i = N, T$ ,  $\tau_i$  is the payroll-tax rate in sector  $i$ ,  $W$  is the wage rate,  $L_i$  is employment in sector  $i$ , and  $G_N$  is the government consumption of nontraded goods.

The government can influence the allocation of labor across sectors in several ways. First, we allow for differentiated payroll tax rates across traded and nontraded sectors. Such a differential treatment affects the cost of labor in different sectors, and, as such, directly influences the sectoral allocation of labor. Second, the government directly purchases nontraded goods.<sup>15</sup> Thus the demand for nontraded goods by the government sector also affects the sectoral allocation of labor. Third, we allow for an external tariff on the imported intermediate good. Thus, government policy may have an influence on the c.i.f. unit price of imported intermediate inputs via  $\tau_M$ .<sup>16</sup> Finally, the government can affect the sector allocation of labor by interfering, or regulating, the flows of net income from abroad,  $F$ . For instance, the government could impose control on private capital inflows, or could alter migration policies affecting remittances, or could change its royalties agreement on the production and export of natural resources.

To close the government budget, following Kehoe and Ruhl (2007), we assume that, given the payroll tax rates, the government demands  $G_N$  in a price elastic way, with its demand specified as:

$$G_N = A_G P_N^{\frac{-1}{\nu}}, \quad (20)$$

where  $A_G$  is an exogenous demand shifter, and  $\nu > 0$  is the inverse of its price elasticity. To be realistic, however, in the calibration of the model, we shall assume a very low price elasticity.

**Equilibrium** Equilibrium allocations in the model must satisfy the following four market clearing conditions:

$$Y_N = C_N + G_N, \quad (21)$$

$$Y_T = C_T + G_T + X, \quad (22)$$

$$P_T X + F = M, \quad (23)$$

$$L = L_N + L_T. \quad (24)$$

Equation 21 states that, in equilibrium, domestic production of the nontraded good is equal to its consumption. Equation 22 states that domestic production of the traded good equals its final domestic (households plus government) consumption and foreign ( $X$ ) consumption. Equation 23 is the current account balance, whereby the (f.a.s.) value of exports plus net transfers from

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<sup>15</sup>It is straightforward to allow for government consumption of traded goods as well. However, this would complicate the analysis without adding useful insights. In addition, in practice, government expenditures are overwhelmingly concentrated in the nontraded goods sector (i.e., the wage and pension bill, health and education, are often the largest expenditure categories).

<sup>16</sup>For simplicity, tariff revenues are not part of the government budget constraint, although it is straightforward to include them in the revenue side of government finances. Tariff revenues, in the model, may be thought of as financing direct imports by the government sector.

abroad ( $F$ ) is equal to the value of imports, when  $P_M$  is the (c.i.f.) price of imports. Finally, equation 24 states that labor hours in the nontraded and traded goods producing sectors must add up to the total labor supply.

**Solution** Personal disposable income is

$$Y = WL + F. \quad (25)$$

Using the market-clearing condition 21 and demand for nontraded good by the government sector 20 in equation 11 gives an expression for nontraded employment

$$L_N = \left[ \frac{\omega}{W(1 + \tau_N)} \right]^{\frac{1}{1-\mu}} (A_N P_N)^{\frac{\mu}{1-\mu}} \left[ (1 - \eta)Y + A_G P_N^{\frac{\nu-1}{\nu}} \right]. \quad (26)$$

Similarly, using the market-clearing condition 22 in equation 12 gives an expression for traded employment

$$L_T = \frac{\beta}{W(1 + \tau_T)} \left( \eta Y + A_X P_T^{\frac{\theta-1}{\theta}} \right). \quad (27)$$

Combining equations 25, 26 and 27 with the government budget constraint 19 and the labor market clearing condition 24 gives

$$\begin{aligned} L + \frac{A_G P_N^{\frac{\nu-1}{\nu}}}{W} &= \left( \frac{\omega}{W} \right)^{\frac{1}{1-\mu}} \left( \frac{A_N P_N}{1 + \tau_N} \right)^{\frac{\mu}{1-\mu}} \left[ (1 - \eta)(WL + F) + A_G P_N^{\frac{\nu-1}{\nu}} \right] \\ &+ \frac{\beta}{W} \left[ \eta(WL + F) + A_X P_T^{\frac{\theta-1}{\theta}} \right]. \end{aligned} \quad (28)$$

The model has nine parameters ( $\beta, \omega, \mu, \eta, \theta, \nu, \tau_N, \tau_T, \tau_M$ ), seven exogenous variables ( $F, L, A_N, A_T, A_G, A_X$  and  $P_M$  (normalized to 1)), three endogenous variables ( $W, P_N, P_T$ ) and three independent equations: 12, 11, and 28. We solve this system of three equations in three unknowns numerically using a nonlinear equation solver in GAUSS (codes available on request from the authors).

### 3.2 Calibration

Before proceeding to analyze the model properties and discuss the impact of alternative policies by means of simulations, we need to assign values to its exogenous variables and parameters. For the purpose of illustrating the model properties, and to discuss alternative policies, we report and discuss below a calibration benchmarked to the case of Trinidad and Tobago.<sup>17</sup>

The calibration is benchmarked to the terms of trade contribution of the income growth decompositions illustrated in section 2.2, and we proceed in two steps. In the first step, we select elasticities, production and consumption shares, and other parameters and variables which are quantifiable based on available evidence (e.g., see Table 1). In the second step, we set the

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<sup>17</sup>Calibrations and analyses for the other two cases are not reported, but are available on request from the authors.

elasticity of foreign demand for domestic tradable goods,  $\theta$ , and the elasticity of substitution in production between labor and intermediate imported goods,  $\mu$ , to match the terms-of-trade effect we estimated in the decomposition in Table 2. So, in the second step, we target a terms of trade effect of approximately the same magnitude as a terms of trade change.<sup>18</sup> As in the model there is no growth and exchange rate policy, we do not attempt to benchmark also to the GDP and the exchange rate effects.

Table 3 reports the values chosen of all parameter and exogenous variables. Consistent with the evidence reported in Table 1, the parameters  $\omega$ ,  $\eta$ , and  $\beta$  are set to .4, .5 and .6 respectively.  $A_N$  and  $A_T$  are chosen to proxy the employment shares in traded and nontraded sectors. The inverse of the government price elasticity,  $\nu$ , is set to 9, implying a very low price elasticity. The values of  $A_G$ , and the payroll tax rates are set so that the model roughly matches the 10 percent  $G/Y$  ratio in the data. In the benchmark calibration,  $\tau_N = \tau_T$ . The tariff rate,  $\tau_M$ , is set to 8.6 percent consistent with data on the average tariff rate for 2006. The value of  $F$  is chosen so that the model matches the  $F/Y$  ratio in the data.

The remaining two free parameters,  $\theta$  and  $\mu$ , are set, in the second stage, to match the unit ratio of the terms of trade change to the terms of trade effect in the data.<sup>19</sup> The value of  $\mu$  necessary to benchmark the model to this ratio is very low, 0.1, and is suggestive of very limited substitutability in production between labor and intermediate imported inputs in the non-traded sector. Interestingly, the value of the inverse of the foreign price elasticity of demand is set to 0.45, which is close to values typically found in the empirical literature (See IMF, 2007, for instance).

### 3.3 Adjustment to a terms of trade shock

We are now ready to illustrate the labor reallocation channel of adjustment to a terms of trade shock in our model. We consider an exogenous change in the foreign demand shifter,  $A_X$ , and hence an autonomous increase in the foreign demand for domestically produced traded goods that leads to an increase in the export price, and hence to a favorable terms of trade change.<sup>20</sup> Given the static nature of the model, we interpret this disturbance as a permanent shock, and in practice the analysis should be seen as a comparative static exercise applying to the medium-to-long term process of adjustment to such shock.<sup>21</sup>

Figure 4 plots, as a function of the foreign demand shifter, the inverse of the terms of trade (i.e., an increase is an improvement in the terms of trade; Panel A), the inverse of the relative price of non-tradable goods (an increase leads to a depreciation of the real exchange rate; Panel

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<sup>18</sup>So, in the case of Jamaica, the calibration would be benchmarked to a ratio between term of trade change and terms of trade effect of 0.6/0.43; in the case of Guyana, to a ratio of 4.2/4.6.

<sup>19</sup>More specifically, a 1 percent improvement in the terms of trade leads to a 0.98 percent increase in domestic income in the model, which is broadly consistent with the results reported for Trinidad and Tobago in Table 3 based on Kohli's decomposition.

<sup>20</sup>As the model non-linearity is small, neither the sign nor the size of the shock matters for the discussion of the results.

<sup>21</sup>See Prebisch (1950) and Singer (1950) for the economic consequences of long-term permanent changes in the terms of trade of developing countries. Although most terms-of-trade shocks in the data are highly persistent (and unit root tests typically reject stationarity), most commodity price shocks are more likely to be temporary ultimately (see Powell, 1993 on this).

B), and the employment share of the tradable sector in total employment (Panel C), and the natural logarithm of GDI (Panel D).

As foreign demand for domestic traded good increases, firms in the traded sector increase production and factor demand (i.e., labor and imported intermediate inputs) to meet the higher demand. Higher demand for labor in the traded goods sector, all else equal, puts upward pressure on the economy-wide wage rate and hence on GDI. A higher economy-wide wage rate affects relative prices in two ways. First, it increases the marginal cost of production in both the domestic traded and nontraded sectors. As a result, the prices of both traded and nontraded goods increase. Given that import prices are fixed in international markets, the terms of trade  $P_T/P_M$  improves. Second, the relative price of traded to nontraded goods  $P_T/P_N$  also increases (i.e., the exchange rate depreciates). Given production functions' functional form and the value of the calibrated parameters, the nontraded output price increases less than the traded output price (Panel B). This is because the share of labor in production in the nontraded sector is calibrated to a lower value than in the traded sector.<sup>22</sup> The balanced foreign trade constraint (equation 23) reinforces this mechanism. As the shock opens up a trade surplus, a smaller increase of non-traded good prices helps to close this gap by allowing for a relatively higher demand for intermediate inputs.

The wage increase has both income and substitution effects. Consider first the income effects. As the wage rate and GDI rise, demand for non-traded goods will also rise. So, increased foreign demand for domestic traded goods tends to increase labor demand also in the non-traded sector. Next, consider the substitution effect. As the wage rate increase economy-wide, labor becomes more expensive relative to intermediate inputs whose price is unchanged. Thus, firms in both the traded and the nontraded sectors will tend to substitute away from the more expensive labor toward cheaper intermediate inputs, which can be easily financed with the higher export revenues. So, the wage increase has to opposite effects: it tends to increase demand for labor in both sectors via the income effect and to decreases demand for labor in both sectors via the substitution effect.

To accommodate the increase in foreign demand of domestic goods, with balanced trade, exogenous labor supply, and structural differences across sectors, the sector distribution of employment must change. In equilibrium, all workers are employed. Since individual labor effort is exogenous and firms in both sectors attempt to adjust in the same direction to income and relative price effects, the economy must reallocate resources across sectors to accommodate the structural differences between them. Specifically, under the calibration assumptions made, the employment share of the traded sector must fall and the employment share of non-traded sector must rise to accommodate the shock. This is because, (i) assuming no change in relative prices, income effects alone are identical across sectors (given that the shares of consumption expenditure on different goods are constant, the change in derived demand for labor is the same in both sectors), and (ii) the substitution effects are different. In fact, the nontraded sector has a lower elasticity of substitution between labor and imported intermediate input, so it is less flexible in using relatively cheaper intermediate inputs in response to the increasing price of labor. As a result, in equilibrium, the share of labor in total employment in the traded sector falls despite

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<sup>22</sup>Note from equation 13 and 14 that  $P_T$  and  $P_N$  are weighted averages of the wage rate and the price of intermediate input, which is equal one, with weights roughly given by  $\beta$  and  $\omega$ . Recall from Table 3 also that  $\beta$  is assumed to be larger than  $\omega$  in our calibration.

the improvement in the terms of trade (Panel C).

Note also that the employment response to changes in foreign demand is slightly non-linear (Panel A and C). This nonlinearity implies that the labor reallocation depends not only on the change in foreign demand, but also on its level—a point that is important in the policy discussion in the next section. When foreign demand for domestic traded goods is low,  $P_T/P_M$  and  $P_T/P_N$  are relatively low (Panel A and B)), the economy has a lower level of income and finds it easier to shift labor from the traded to the nontraded sector. As the foreign demand for domestic traded goods increases, the responsiveness of sector allocation of labor to the terms of trade shock decreases making it more difficult to adjust to it.

The net impact of these different effects is an increase in GDI (Panel D). While substitution away from more expensive labor toward relatively cheaper imported intermediate inputs in both the traded and nontraded sectors does contain the wage and hence income increase, it is not sufficient to prevent it altogether. In other words, the improvement in the terms of trade triggered by the increase in foreign demand affects GDI because the income effect of the shocks exceeds the substitution effect triggered by the ensuing relative price changes.

There are also income and substitution effects in consumption in response to the shock. Higher income increases the demand for both traded and nontraded goods. At the same time, consumption tends to switch toward the nontraded good in response to the increase in the relative price of traded goods (Panel B). However, the unitary elasticity of substitution in consumption between traded and nontraded goods implies that households keep the ratio of traded to nontraded expenditures constant. As a result, the change in the relative quantities demanded is always proportional to the change in the relative price of the traded and nontraded goods. So, under the calibration assumption made, in terms of domestic demand, the relative price effects do not lead to gross substitution and complementarity effects, which would otherwise be present in a more general CES specification of the consumption basket.

In sum, in the model, substitutability in production in the nontraded sector between labor and intermediate inputs (or lack thereof) is the key structural feature in the economy that provides insulation of the wage rate and hence domestic income from the changes in foreign demand and the terms of terms. We are now going to discuss the channels through which government policies may affect this adjustment process through other compensating mechanisms, taking substitutability in production as given.

## 4 Policies to mitigate the income impact of terms of trade shocks

In this section, we discuss how different government policies can alter the impact of terms-of-trade shocks on income, which is our measure of vulnerability to these shocks. Relative to the baseline model, the policy scenarios that we discuss include a sector-specific change in payroll taxes, a change in the government demand shifter ( $A_G$ ) that alters total domestic demand for on non-traded goods, a change in the external tariff rate on imported intermediate goods, and an increase in foreign income inflows. For each of these scenarios, we discuss the channels through which such a policy change influences the response of income to a positive terms-of-trade disturbance.<sup>23</sup>

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<sup>23</sup>Note that our objective, here, is not to compute “optimal” policy responses to the shock.

We report results for both the level and the change of the same variables discussed in the previous section: the terms of trade, the real exchange rate, the employment share in the tradable sector, and GDI. Figure 5 presents the relationship between the levels of the foreign demand shifter  $A_X$  and the four variables we focus on. Table 4 reports changes for the same variables and, to facilitate the comparison with Kohli’s (2004) decomposition in Table 2, also the ratio of the resulting income change and the terms of trade change.

All scenarios are driven by the same percent change in the foreign demand shifter that generates a 10 percent increase in the terms of trade in the baseline model. For this given value of the foreign demand shifter, different policy scenarios result in economies with different *levels* of relative prices and income. In addition, as we noted earlier, the response of income to changes in the foreign demand shifter is slightly non-linear. Therefore, the comparison across different scenarios is conditional on the initial level of the foreign demand shifter, marked by a vertical line in Figure 5.

As we shall see, the analysis ranks scenarios differently in terms of income impact of the same increase in the foreign demand for domestic goods. In particular, a reduction in the traded payroll tax or the import tariff on imported intermediate goods tend to increase the income impact of the shock, whereas a reduction in government spending and an increase in foreign income inflows tend to decrease it.

**A reduction in payroll tax rate in the traded sector** In this scenario, we reduce the payroll tax rate in the traded sector from 0.2 to 0.1. All other model parameters are unchanged, including the payroll tax rate in the nontraded sector. With a lower payroll tax rate, labor in the traded sector is cheaper than in the baseline model. Hence, the relative price of the traded good and the terms of trade are lower than in the baseline (Figure 5, Panel A). Lower payroll taxes in the traded sector also creates a budget gap compared to the baseline. This gap can be closed in two ways—by reducing government expenditure, which is concentrated on nontraded good and by collecting more taxes from the traded sector. For the government expenditure to fall, the relative price of non-traded goods must increase significantly.<sup>24</sup> A higher price of nontraded goods relative to the baseline adds to the demand for traded goods. As a result, in this economy, the real exchange rate is more appreciated (Panel B), and employment in the traded sector is much higher (Panel C). However, total labor demand is less than in the baseline model with a lower payroll tax rate, so that the wage rate and hence GDI is also lower (Panel D).

In terms of changes, income increases more than the terms of trade change in the economy with a lower traded payroll tax rate compared to the baseline model (Table 4 Column 5).<sup>25</sup> The main reason is the response to the shock of the employment shares in the traded sector, which falls more than in the baseline model (Table 4 Column 3), but not enough more to induce a smaller wage (and hence income) increase than the terms of trade change.

**A reduction of the tariff rate on imported goods** In this scenario, we eliminate the 8.6 percent tariff on imported intermediate goods. In terms of levels, relative to the baseline model,

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<sup>24</sup>Recall that the government demand of non-traded goods is price sensitive, but relatively inelastic.

<sup>25</sup>Note also that, in the economy with lower payroll tax rate, the terms of trade increases slightly more than in the baseline in response to the shock. This small difference is due to the model non-linearity. By focusing on the ratio of the income change to the terms of trade change we abstract from this second-order effect.

the elimination of the tariff results in weaker terms of trade (Figure 4, Panel A), a slightly more depreciated internal exchange rate (Panel B), the same share of employment in the traded sector, and a slightly higher level of income. The elimination of the tariff reduces the price of imported intermediate goods. Cheaper intermediate imports induce firms in both sectors to substitute away from labor. So, all else equal, employment and wages tend to fall. With factors of production becoming cheaper, both the price of traded and non-traded goods tends to fall. However, because of the asymmetries in the production function of the two sectors, the price of non-tradable falls more than the price of traded goods, and the internal component of the real exchange rate depreciates. Demand for both goods increases with lower prices and, all else equal, this tends to offset the wage decline triggered by the substitution effects. As a result of these opposing forces in the labor market, wage and GDI increase slightly in equilibrium. Demand also switches toward non-traded goods, which are relatively cheaper compared to the baseline. The nontraded sector, however, has a lower share of labor in production. So, in equilibrium, there is no change in the employment share of the traded sector.

In terms of changes (Table 4), relative to the baseline model, the main difference in the response to the shock is a slightly higher wage and income increase. This is because, with cheaper intermediate inputs and lower good prices, demand for both traded and non-traded goods is higher than in the baseline for each level of foreign demand, and this puts more pressure on the wage rate than in the baseline model in response to the shock. In other words, under a low tariff scenario, the proportionate increase in  $P_T/P_N$  is identical to that in the baseline model. So, given the ratio of the pricing equations (13) and (14), we have different responses of wages in the baseline model and the model with a lower tax rate to changes in  $A_X$ . In particular, since in the calibration the share of labor in production in the nontraded sector is lower than that of the traded sector (i.e.,  $\beta > \omega$ ), and since the production function for the nontraded good has a elasticity of substitution in production that is less than one, a larger increase in the wage rate  $W$  would be required to obtain the same proportionate increase in  $P_T/P_N$  when the value of  $\tau_M$  is lower (compared to the baseline).

So, like the case of lower payroll tax rate in the traded sector, a reduction of the tariff rate on intermediate imports does not help to contain the income effects of a terms of trade change associated with a increase in foreign demand of domestic traded goods under the calibration assumptions made.

**A decrease in government expenditure** In this scenario, we reduce the amount of resources absorbed by the government sector, from about 11 percent of the GDP in the baseline model to slightly less than 8 percent of GDP, by reducing the demand shifter  $A_G$  from .35 to 0.25.

In terms of levels, relative to the baseline model, a reduction in government spending, which is concentrated on non-traded goods, releases resources for more private consumption of non-traded goods. All else equal, weaker total demand of non-traded goods lowers their price. As the private sector demand shifts from more expensive traded to cheaper non-traded goods, the price of traded goods must also fall. Lower price of traded and non-traded goods, however, have income effects via the household budget constraint. These income effects are very strong given the much higher elasticity of demand in the private sector, and they work toward increasing demand of

both kind of goods.<sup>26</sup> To meet a higher demand of both goods, the production increase has to be skewed toward the traded sector. This is because international trade must be balanced period-by-period in the model, and producing and exporting more tradable goods is the only way to accommodate the increase in intermediate import goods needed to support more production of booth goods. The net difference compared to the baseline model are weaker terms of trade, a more appreciated internal component of the exchange rate, a higher share of employment in the traded sector, and higher income. This is because the price of traded goods, in equilibrium, falls more than the price of non-traded goods, thereby helping to meet the balanced international trade constraint with higher exports. As a result, the share of employment in the traded sector is also higher. The wage rate is higher because, in equilibrium, the higher private sector demand of both traded and non-traded goods that accommodates the government demand, in the presence of large differences in price elasticities, put more pressure on the domestic labor market than in the baseline model.

In terms of changes in response to the increase in foreign demand for domestic goods, compared to those in the baseline model, a model with a lower government expenditure results in a smaller terms of trade increase, a smaller real exchange rate depreciation and traded sector labor share decline, as well as a smaller income increase, both in absolute terms and relative to the terms of trade change. Since government consumption absorbs a smaller share of domestic resources, total demand in the nontraded sector is weaker. And since the economy is relatively richer for every level of foreign demand, in response to an increase in foreign demand, relative prices—both the terms of trade and the real exchange rate—respond by less. As a result, the proportionate change in wages and real domestic income is smaller than that in the baseline model. So reducing government expenditure in the model is a way to contain the income effect of the terms of trade increases.

**Increase in financial inflows** In this scenario, we reduce net foreign income from abroad from about -8.5 percent of GDP to about -5.5 percent of GDP by increasing  $F$  from  $-.25$  to  $-.15$ . We can interpret this scenario as one in which emigration policies become more liberal (more transfers from abroad and smaller labor force at home) and put upward pressure on wages.

In terms of levels, an increase in income from abroad increases demand of both traded and non traded goods. Higher demand can be met with higher production and factor demands in both sectors. This tends to put upward pressure on the wage rate and GDI compared to the baseline model (Figure 5, Panel D). A higher wage rate induces firms to substitute more expensive labor with cheaper intermediate inputs that can be financed partly with higher income from abroad and partly by skewing the production increase toward the traded sector. To accommodate the switch in the composition of output toward tradable goods, the terms of trade are weaker compared to the baseline model and the internal component of the real exchange rate appreciates (Panel A and B), while the traded sector share of employment is higher than in the baseline model (Panel C).

In terms of changes in response to a foreign demand increase, the terms of trade increase less, the exchange rate appreciate less, and income increases significantly less than in the baseline

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<sup>26</sup>The relative price of non-traded goods has to falls markedly to accommodate the fall in government demand with a low price elasticity, but the quantities demanded by the private sector will respond elastically to price changes. As a result quantity demanded by the private sector increases significantly in response to the shock.

model—as well as markedly less than the terms of trade. The response of employment to an increase in the demand for domestic traded good is as strong as in the baseline. Higher income from abroad dampens variations in relative prices because it alleviates the pressure on relative prices imposed by the balanced international trade constraint. Since relative price responses are more muted compared to the baseline model, and the labor reallocation from the non-traded to the traded sector is similar to the one in the baseline model, the shock ends up generating a smaller wage and GDI increase. So, policies that increase foreign income inflows may help contain the domestic income effect of increased foreign demand for domestic goods.

## 5 Conclusions

In this paper we quantified the long-run impact of terms-of-trade changes on real gross domestic income growth in Jamaica, Guyana, and Trinidad and Tobago. We found that terms of trade shocks have a large incidence on income growth only in the case of Guyana and, to a lesser extent, Trinidad and Tobago. Somewhat surprisingly, in the case of Jamaica, its diversified export base (which includes tourism revenues), seems to provide a good cushion to absorb such shocks.

We then related these effects to the reallocation of labor across production sectors in response to terms of trade shocks with the aid of a relatively simple, general equilibrium, open economy model, calibrated to the case of Trinidad and Tobago. The analysis highlighted the importance in the adjustment mechanism of substitution in production between labor and imported intermediate inputs, as well as the complexity of the general equilibrium effects triggered by the presence of financial constraints on the government and the economy as a whole (in the form of fiscal and international trade accounts balanced period by period).

The paper finally discussed alternative fiscal policy responses to these shocks that may mitigate or exacerbate their incidence on income growth via the sector labor reallocation channel. The main finding of this part of the analysis was that a reduction of payroll taxes in the tradable sector, or a reduction of tariff rates on imported intermediate goods, exacerbates the incidence of terms of trade shocks on income growth. A reduction in government expenditure, or an increase in foreign income from abroad, instead, mitigates the impact on income growth of these shocks.

## Data Appendix

Data for Kohli's (2004) decomposition come from the Inter-American Development Bank (IADB) database.

- GDP, current prices, in millions of domestic currency (from National Accounts)
- GDP, constant prices, in millions of domestic currency (from National Accounts)
- Total Exports: % of GDP (from External Accounts)
- Total Imports: % of GDP (from External Accounts)
- Domestic Absorption: % of GDP (National Accounts)
- Export Prices: Index (from "Prices and Wages" database)
- Import Prices: Index (from "Prices and Wages" database).

Data for the calibration of Trinidad and Tobago are based on the following methodology and data sources.

- $G/Y$ : Government spending and nominal GDP are from IMF, International Financial Statistics.
- $F/Y$ : Financial inflows as a percent of GDEP flows are from IADB, External Accounts database.
- $\tau_M$ : Tariff rates are from IADB database on tariffs.
- $\omega$ : Share of labour in non-traded sector. We provided a benchmark value for this parameter by using the estimates of persons employed in the non-traded sector (in thousands) and value of imports of goods (imports in millions of USD). The data source underlying the employment shares is ILO (2009), Laborsta Database.
- $\mu$ : Elasticity of substitution between labour and imports in the nontraded CES production function. We provided a benchmark estimate for this parameter by comparing the change in (log) employment in nontraded with the change in (log) imports.
- $\eta$ : Expenditure share of traded good. We provided a benchmark estimate for this parameter by using export, import, and domestic production data for all available sectors. Specifically, we calculated the exports and imports for each sector. We deducted exports from and added the imports to the value of domestic production to obtain domestic consumption, and expressed the final figure as a percent of GDP. The data source underlying sectoral exports and imports is WTO (2007), Trade Profiles, and sectoral output is World Bank (2009), World Development Indicators.

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Table 1: Sectoral composition of employment and output in Guyana, Jamaica, and Trinidad and Tobago

	Employment		Output			Trade, % of GDP	
	Traded	Nontraded	Agriculture	Industry	Services	Exports	Imports
		(2002)		(2005–2006)		(1992–2006)	
Guyana	0.39	0.61	0.30	0.23	0.47	98.5	115.1
		(1998–2006)		(2005–2006)		(1992–2007)	
Jamaica	0.50 [0.54]	0.50 [0.46]	0.06	0.33	0.61	47.4	59.6
		(1998–2005)		(2005–2006)		(1993–2005)	
Trinidad and Tobago	0.21	0.79	0.01	0.60	0.39	51.4	41.3

Notes: Traded sectors are agriculture, mining, and manufacturing, and nontraded sectors are electricity, construction, wholesale, transport, finance, community and other services. Wholesale sector includes hospitality industry. For Jamaica, this sector is treated as traded in the first employment share entry. In the second entry in square brackets, we used the share of service exports, which largely fall on the hospitality industry, to allocate that fraction of the wholesale industry to the traded sector, and the remaining to the nontraded sector. The data are period averages, where applicable and in percent where indicated.

Sources: IADB database (2009) for data on trade shares. World Bank, 2009. World Development Indicators online edition, for data on employment and output shares.

Table 2: Gross domestic income decomposition for Guyana, Jamaica, and Trinidad and Tobago, 1993–2007

	Real domestic income	Real GDP	Trade balance	Terms of trade	$\Delta \ln(p_X/p_M)$
Guyana	−3.17 (7.99)	3.09 (3.91)	−1.53 (2.23)	−4.66 (5.96)	−4.20 (5.19)
Jamaica	0.85 (3.72)	1.26 (1.27)	−0.84 (0.60)	0.43 (2.60)	0.60 (4.32)
Trinidad and Tobago	6.58 (4.84)	7.08 (3.81)	−0.78 (2.11)	0.33 (2.79)	0.33 (6.19)

Notes: This table reports the average percentage change in the terms of trade  $\Delta \ln(p_X/p_M)$ , and the decomposition of the growth rate in real gross domestic income into its three components: the growth rate of gross domestic product (GDP), the terms-of-trade effect, and the trade-balance effect. See equation (??). All variables are average growth rates over the period (in percent). Numbers in parentheses are standard deviations.

Table 3: Parameter values for calibration: Trinidad and Tobago

Mnemonic	Description	Value	Source
$F/Y$	financial capital inflows, % of GDP	-8.70 (3.84)	IADB
$\tau_M$	average tariff rate on imported intermediate inputs	0.086	IADB
$G/Y$	government expenditures to GDP ratio	0.11	IMF
$\omega$	bias towards intermediate traded good in the $N$ -sector	0.42	Authors
$\eta$	expenditure share of $T$ -good	0.50	Authors
$\beta$	elasticity of output with respect to labor in the $T$ -sector	0.6	Authors
$\mu$	elasticity of substitution between labor and $M$ -good in the $N$ -sector	0.1	Authors
$\theta$	inverse of the foreign price elasticity for domestic exports	4.5	Authors
$\nu$	inverse of the government price elasticity for nontraded goods	9.0	Authors
$\tau_N$	tax rate on $N$ -sector labor income	0.2	Authors
$\tau_T$	tax rate on $T$ -sector labor income	0.2	Authors
$A_G$	government demand shifter	0.35	free
$F$	foreign capital inflows	-0.25	free
$A_X$	foreign demand shifter	1.75	free
$A_N$	TFP in the $N$ -sector	2	free
$A_T$	TFP in the $T$ -sector	1	free

Notes: Financial capital inflows  $F/Y$  are averages for the periods 1992–2006 for Guyana, 1996–2006 for Jamaica, and 1996–2005 for Trinidad and Tobago, with standard deviations in parentheses. Average tariff rates  $\tau_M$  are for 2006. The ratio of government expenditures to GDP is the average of 2005–2007 for Guyana and Jamaica, and 2005–2006 for Trinidad and Tobago. The parameters  $\omega$  and  $\eta$  are based on (incomplete) data and rough estimates by the authors. Other parameters, where authors are listed as the main source, are based on best-guess estimates. “Free” corresponds to a free parameter, which we use to match a particular calibration target: the values of  $A_G$  is chosen so that the calibrated model matches the  $G/Y$  ratio, the value of  $F$  and  $A_X$  are chosen so that the calibrated model matches the  $F/Y$  ratio, the values of  $\theta$ ,  $\mu$ , and especially  $A_N$  and  $A_T$  are chosen to proxy the employment shares in traded and nontraded sectors.

Sources: IADB database (2009). IMF (2009), International Financial Statistics, for government expenditures in domestic currency units and GDP in domestic currency units.

Table 4. Alternative values for the government policy instruments (Percent changes) 1/

	[1]	[2]	[3]	[4]	[5]
	Terms of trade	Real Exch. Rate	Traded share of employment 2/	Income	Ratio
Baseline	10.0	3.8	-0.009	9.8	0.98
TauT=0.10	10.2	3.8	-0.012	10.2	1.00
TauM=0.00	10.0	3.8	-0.009	10.0	1.00
AG=0.25	9.4	3.5	-0.007	8.7	0.93
F=-.15	9.5	3.5	-0.009	9.1	0.95

1/ See Table 3 the baseline parameter values.

2/ Absolute changes, in percentage points.

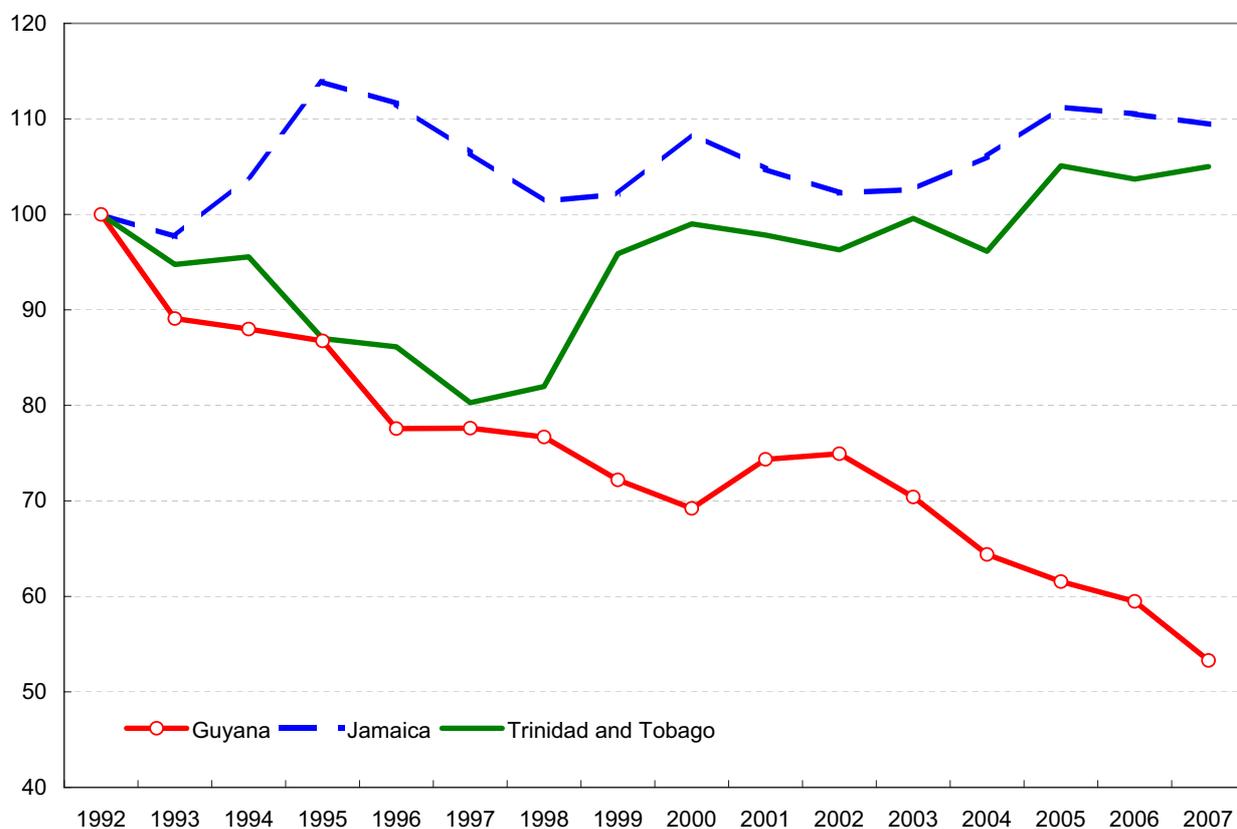


Figure 1: The terms of trade of Guyana, Jamaica, and Trinidad and Tobago, 1992=100

Source: IADB data base, 2009.

Note: The terms of trade is export price index divided by the import price index.

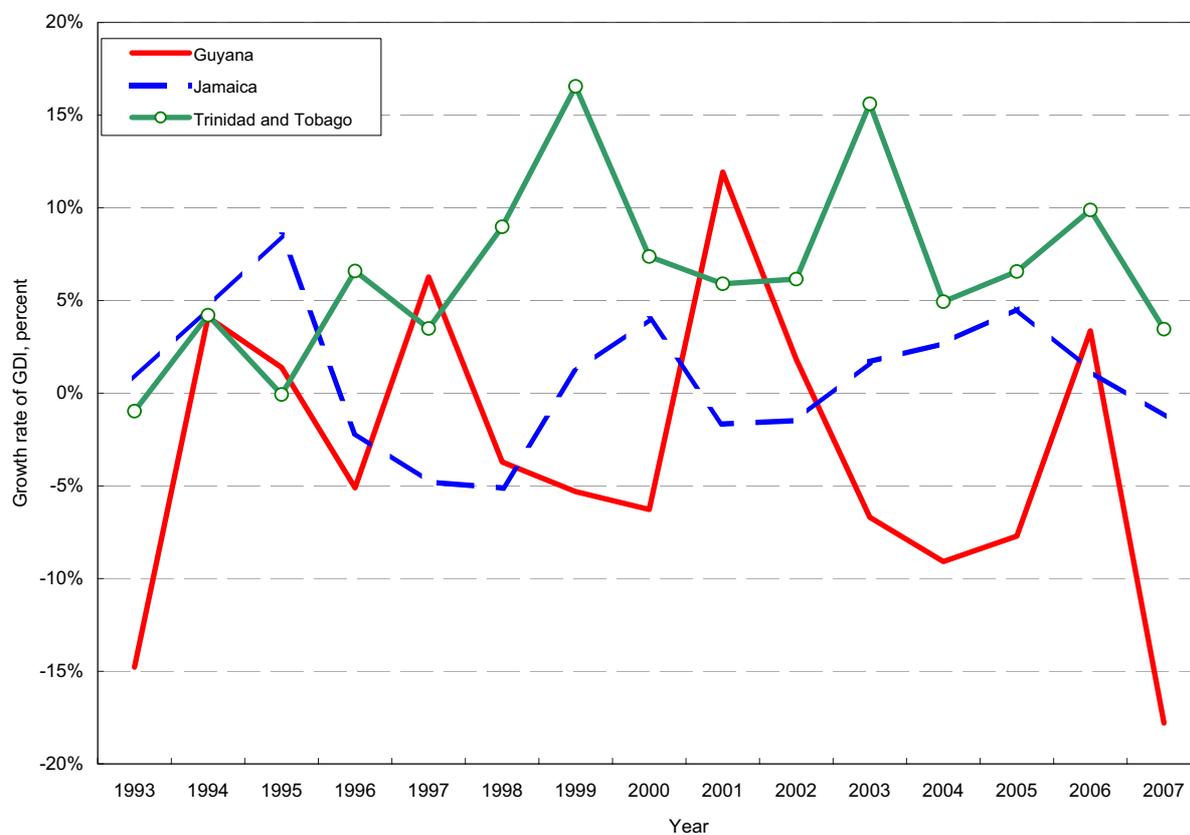


Figure 2: Growth rate of gross domestic income, 1993–2007

Source: IADB data base, 2009.

Note: The growth rate of gross domestic income is based on method proposed by Kohli (2004), and captures the contributions of changes in the trade balance, and the terms of trade to changes in domestic income.

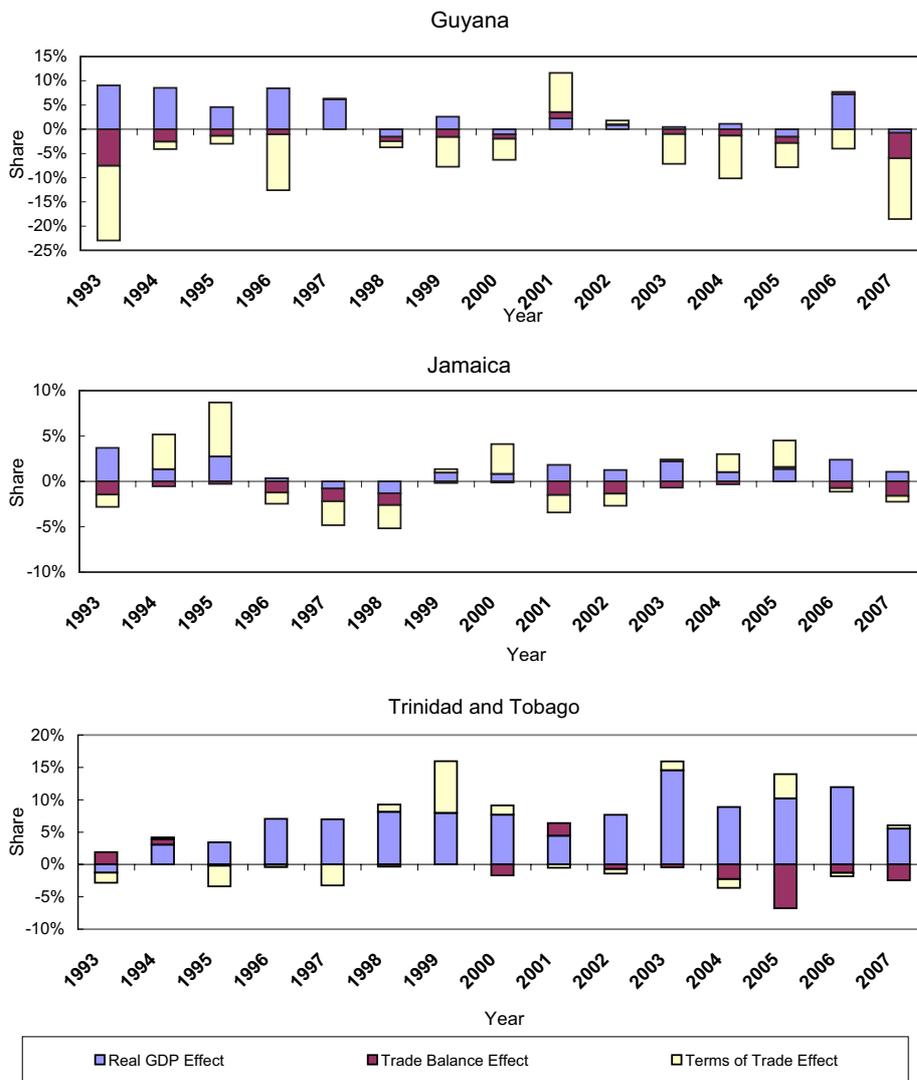


Figure 3: Decomposition of the growth rate of gross domestic income, 1993–2007

Source: IADB data base, 2009.

Note: The growth rate of gross domestic income is based on method proposed by Kohli (2004), and captures the contributions of changes in GDP, the trade balance, and the terms of trade to changes in domestic income.

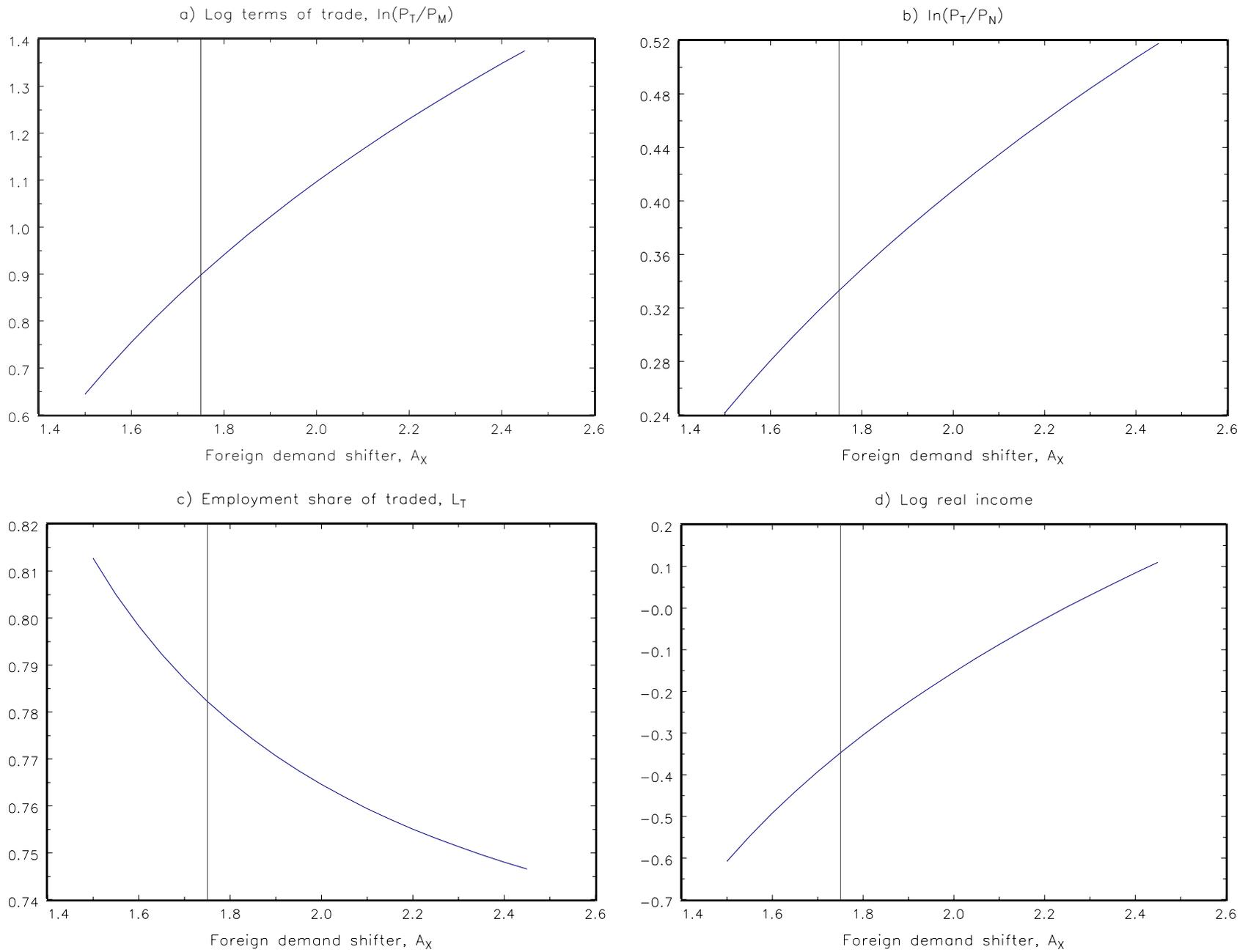


Figure 4: Simulation results for the baseline model

Notes: See Table 3 for the baseline parameter values. The vertical line indicates the benchmarked value of  $A_G$ .

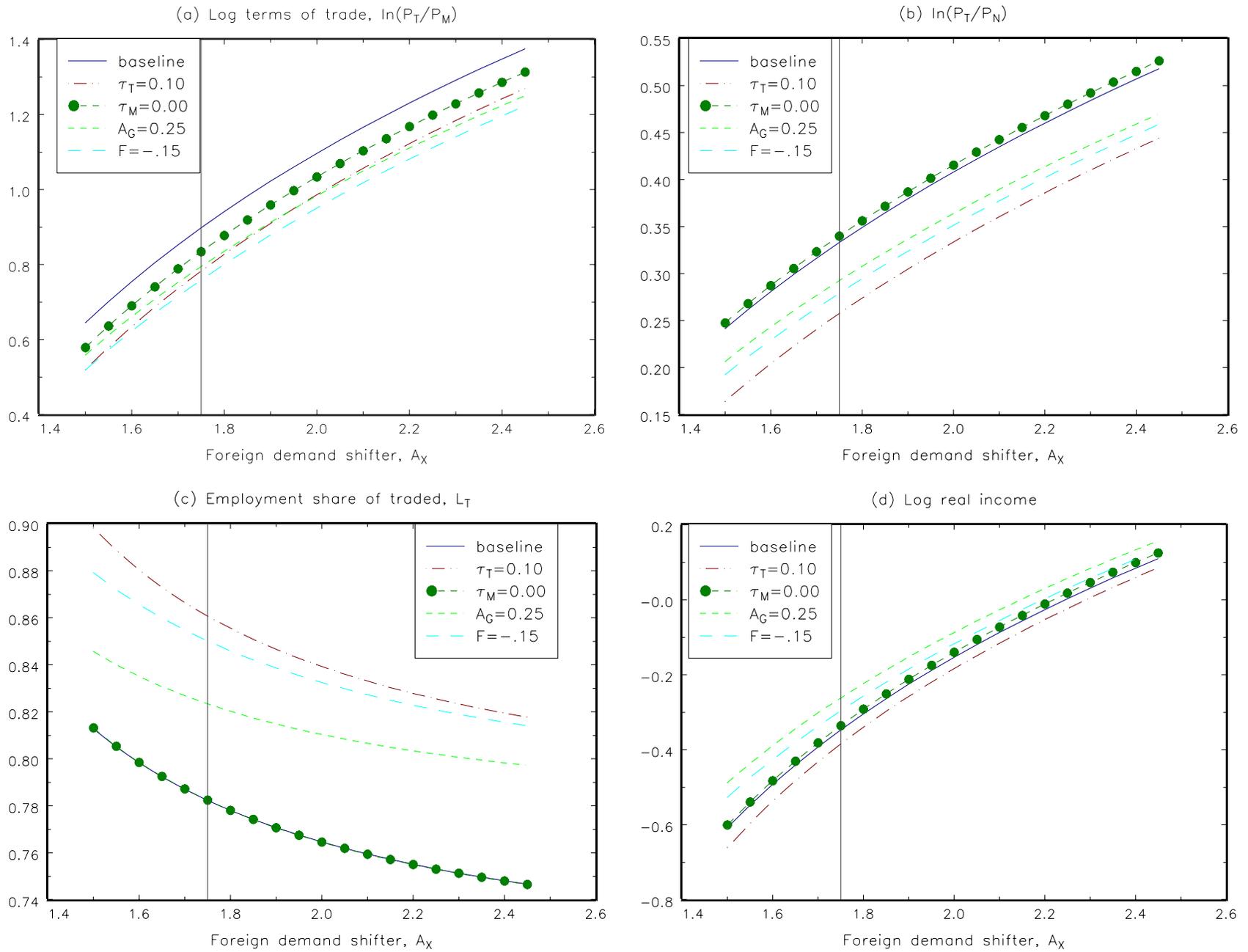


Figure 5: Simulation results for different policy scenarios

Notes: See Table 3 for the baseline parameter values. The vertical line indicates the benchmarked value of  $A_G$  in the baseline model.