Changes in the terms of trade and sectoral reallocation of labor: The case of Guyana, Jamaica, and Trinidad and Tobago*

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Abstract

This paper quantifies the consequences of long-term changes in the terms of trade on the growth rate of real income in Guyana, Jamaica, and Trinidad and Tobago. We find that magnitudes of both the long-term changes in the terms of trade and the responses of income growth rates vary considerably across these three countries. We then develop a model that links a change in the terms of trade to a change in income through the degree of sectoral reallocation of labor. Using this model, we analyze whether specific fiscal and trade policy responses cushion or amplify the impact of terms of trade on income. In a calibrated version of the model, we demonstrate that the degree with which an economy reallocates its labor across sectors is not necessarily a good indicator of its vulnerability to changes in its terms of trade.

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Keywords: terms of trade; gross domestic income; sectoral reallocation of labor; fiscal policy.

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1 Introduction

Recent developments in international commodity markets have underscored the vulnerability of small open economies to terms-of-trade fluctuations. While this vulnerability manifests itself in terms of fluctuations in *aggregate* income, terms-of-trade fluctuations ultimately have differential *sectoral* impacts and therefore unleash potentially significant sector-specific adjustment mechanisms with ramifications for aggregate income. One specific adjustment mechanism that is often emphasized in the academic literature and among policymakers is the reallocation of labor across sectors. However, there is limited conceptual and empirical work on the potential significance of sectoral reallocation of labor to changes in the terms of trade, and how specific economic policies might influence such an adjustment mechanism.[1]

In this paper, we first use an accounting framework due to Kohli (2004) to quantify the vulnerability of Guyana, Jamaica and Trinidad and Tobago to long-term changes in their terms of trade. Using these economies as a specific context, we then develop a model that links a change in the terms of trade to a change in income through the degree of sectoral reallocation of labor. Using this model, we analyze whether specific fiscal and trade policy responses cushion or amplify the impact of terms of trade on income.

The economies we study (plus Barbados) constitute the so-called More Developed Commonwealth Caribbean Countries (Hope, 1987). They are highly suitable for an empirically relevant analysis of vulnerability of income to changes in the terms of trade because they represent different degrees of variability in their terms of trade: from 1990 to 2007, the standard deviation of the terms of trade was 5 percent per year in Jamaica, 8 percent in Trinidad and Tobago, and 14 percent in Guyana.[2]

Guyana, Jamaica, and Trinidad and Tobago are also representative of the different ways in which this vulnerability manifests itself. While these three economies are open to international trade, Guyana stands out in terms of its striking exposure: its exports and imports are equal to or even exceed its GDP (Table 1a). The composition of their trade is also different (Table 1b). In terms of merchandise and service exports, Guyana specializes in food (especially sugar), Jamaica in tourism services (about 45 percent of its *total* exports), bauxite and manufacturing, and Trinidad and Tobago exports energy (liquefied natural gas).[3] In terms of imports, manufactures make up the largest share in all three countries, and fuel (petroleum) is the next significant category. Overall, the external sectors of all three countries are vulnerable to fluctuations in primary commodity prices: Guyana's terms of trade is largely determined by the world price of sugar, and that of Trinidad and Tobago by energy, whereas, among the three economies, Jamaica has the most diversified external sector.

[1] Certainly, sectoral labor reallocation is not the only channel through which changes in the terms of trade may be transmitted to income. Yet, while economists tend to think favorably about policies that facilitate the reallocation of labor across sectors in response to disturbances, the concrete ways in which small open economies reallocate labor has received relatively little attention. In this context, 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."

[2] 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 percent per year. It was 16, 12.5, and 8.5 percent, respectively, in the next three quartiles in their country distribution.

[3] Trinidad and Tobago has natural gas reserves and is the leading exporter of liquefied natural gas to the United States. Part of its fuel imports are liquefied for exporting.

Table 1: Composition of employment, output and international trade

a) Sectoral composition of employment and output

	Employment, %					Output, %			Trade, % of GDP	
	Traded	Nontraded	Agriculture	Industry	Services	Agriculture	Industry	Services	Exports	Imports
			(2002)				(2005–2006)		(1992–2006)	
Guyana	39	61	21	25	54	30	23	47	98.5	115.1
			(1998–2006)				(2005–2006)		(1992–2007)	
Jamaica	28 [54]	73 [46]	20	18	63	6	33	61	47.4	59.6
			(1998–2005)				(2005–2006)		(1993–2005)	
Trinidad and Tobago	21	79	7	29	65	1	60	39	51.4	41.3

b) Industry composition of international trade (% of merchandise exports, imports)

	Agricultural raw materials		Food		Fuel		Manufactures		Ores and metals	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Guyana (1997–2006)	5.26	0.45	59.51	15.08	0.01	22.72	18.37	61.06 [26.65]	14.04	0.47
Jamaica (1997–2007)	0.14	1.43	21.51	15.47	4.18	20.25	66.07	59.89 [23.71]	8.09	0.59
Trinidad and Tobago (1997–2005)	0.09	0.85	6.34	9.56	57.04	24.10	36.24	62.63 [35.65]	0.28	2.51

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, 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 service industry to the traded sector, and the remaining to the nontraded sector. Agriculture includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production; industry comprises mining, manufacturing, construction, electricity, water, and gas. Output is value added. The second entry in square brackets for manufactures imports is machinery and transport equipment. The data are period averages, where applicable and percentage of gross domestic product (GDP) where indicated.
Sources: IADB external accounts database for trade as percent of GDP. UNCTAD for capital goods imports as percent of total merchandise exports. All other data are from the World Bank, *World Development Indicators*.

There are also significant differences across these three economies in the distribution of employment and output (value added) between the traded and the nontraded sectors (Table 1a). In Trinidad and Tobago, *employment* is highly concentrated in the nontraded sector (about 80 percent). Among the three countries, once the international tourism industry is taken into consideration, Jamaica has the lowest share of nontraded in employment (less than 50 percent). The share of agriculture in employment is substantial in both Guyana and Jamaica (about 20 percent), and is relatively small in Trinidad and Tobago (about 7 percent). The share of industry in employment is largest in Trinidad and Tobago (about 30 percent), in part due to the liquefied natural gas industry. The share of agriculture in *output* is relatively larger in Guyana (30 percent), reflecting the significance of sugar production, and low in both Jamaica and Trinidad and Tobago. The share of services in output is considerably larger in Jamaica (about 60 percent) reflecting the significance of the tourism industry. In Trinidad and Tobago industry occupies the dominant share in output (60 percent). These sectoral shares in employment and output reinforce the external vulnerabilities of the economies documented above.

While the magnitude of the terms-of-trade fluctuations vary across these three countries, it is important to know whether the relative impact of these fluctuations on real incomes also vary across these countries. In Section 2, we use an income growth accounting framework recently developed by Kohli (2004) and quantify the impact of long-term changes in their terms of trade on real gross domestic income (GDI)—an income concept that is more appropriate than GDP for examining changes in economic well-being in open economies. As such, this accounting framework provides a useful starting point to assess the economic significance of "vulnerability" in the context of terms-of-trade fluctuations.[4]

Kohli's (2004) income growth accounting framework shows that the responses of the GDIs vary considerably across these three countries. The terms of trade in Trinidad and Tobago has improved slightly over our sample period (0.3 percent per year from 1992 to 2007), and this accounted for a proportionate growth rate in its GDI (about 0.3 percent per year). Jamaica's terms of trade also improved (0.6 percent per year) over this period, but the contribution of the terms of trade to the growth rate of GDI was relatively small (0.4 percent). Finally, Guyana's terms of trade deteriorated by 4.2 percent per year, and the contribution of the terms of trade to the growth rate of GDI was relatively large in absolute value (about -5 percent).

After documenting these differences in responses of real incomes to changes in their terms of trade, in Section 3, we develop a general equilibrium, small open economy model that relates the magnitude of the change in income induced by a change in the terms of trade to the degree of sectoral reallocation of labor. In the model there are two domestic production sectors (traded and nontraded sectors) and three goods: a domestically produced traded good that can either be exported or consumed at home, a nontraded good that can only be consumed at home, and an imported good, which is an intermediate input in the production of both traded and nontraded goods. The focus of this paper is on the consequences of long-term movements in the terms of trade for real income, when we can safely take the view that relative price adjustments have been completed. As such, the reallocation of labor across sectors represents an adjustment in the real side of the economy, which is appropriate for a long-term analysis.

[4]We study the impact of long-run changes in the terms of trade. See Prebisch (1950) and Singer (1950) for the economic consequences of long-term permanent changes in the terms of trade in developing countries. In the data, terms-of-trade shocks are highly persistent (e.g., Powell, 1991), and that is sufficient for our purposes. Mendoza (1995), and Dennis and İşcan (2006) study the short-term consequences of terms-of-trade fluctuations. Mendoza (1997), on the other hand, studies the link between terms-of-trade uncertainty and long-run economic growth.

In this framework, the key determinant of the long-term impact on income of movements in the terms of trade is the elasticity of substitution in production between labor and the imported intermediate goods (in both the nontraded and traded good sectors). This elasticity determines the magnitude of relative price changes, which in turn determine the income and substitution effects. Overall, the reallocation of labor across sectors and these income and substitution effects are highly interrelated. We illustrate the quantitative implications of the model by calibrating it to the economy of Trinidad and Tobago, the country on which we have the best data. The case of Trinidad and Tobago is also interesting because of its energy-exports based industrialization policy, and the implications of this policy for resource allocation (Mottley, 2008).

In the model, economic policy has no influence on the elasticity of substitution in production. Nevertheless, by influencing the degree of sectoral reallocation of labor, economic policies can affect the magnitude of the response of income to changes in the terms of trade. In Section 4, we consider two fiscal policy instruments (payroll taxes and government consumption expenditures), and one trade policy instrument (import tariff rate), and examine how changes in these policies affect the response of real domestic income to a change in the terms of trade through labor reallocation. Albeit in a rather rudimentary manner, the model also allows for a consideration of economic policies related to remittances—a large component of the current account of Jamaica—royalty payments, and private capital flows, and we outline how these policies might affect the magnitude of changes in income. Using these policy experiments, we demonstrate that the degree with which an economy reallocates its labor across sectors (or "flexibility") is not necessarily a good indicator of its vulnerability to changes in its terms of trade.

In Section 5, we provide a summary of our results, and conclude.

2 Changes in the terms of trade and income

To quantify the long-run impact of changes in the terms of trade on income growth, we use the accounting framework developed by Kohli (2004). (See Diewert and Morrison (1986) for a similar treatment.) In Section 2.1, we outline Kohli's framework, and in Section 2.2, we apply this framework to Guyana, Jamaica, and Trinidad and Tobago.

2.1 Kohli's income growth accounting framework

We examine the implications of changes in the terms of trade on the changes in real gross domestic income (GDI), which is a more appropriate measure of changes in consumption possibilities compared to real gross domestic product (GDP). In practice, real GDI typically differ from changes in real GDP, because the balance on trade in goods and services deflated by the overall GDP deflator is typically different from the same balance deflated by separate export and import price indices.[5] Changes in gross domestic income in

[5]The difference is called the "trading gain or loss," $T = \left(\frac{X-M}{P}\right) - \left(\frac{X}{P_x} - \frac{M}{P_m}\right)$, where X is exports, M is imports, P is the GDP deflator, P_x is the export price index, and P_m is the import price index. From the national accounts relations, we have:

GDP (constant price GDP) + T (trading gain or loss) = GDI (constant price GDI).

A more comprehensive measure of consumption possibilities would be gross *national* income, which includes net income receipts from abroad, and unilateral transfers. The analysis here uses the balance on trade from the balance of payments accounts, rather than the entire current account. The former is sufficient to identify the direct impact of changes in the terms of trade

constant prices (henceforth income for brevity) incorporate such relative price changes, and are therefore more informative about the changes in the purchasing power of domestic income. More generally, Kohli (2004) develops a theory consistent accounting framework, which decomposes changes in income growth into three factors: changes in real GDP, changes in the trade balance, and changes in the terms of trade. As such, this framework carefully distinguishes between changes in real output and changes in relative prices.[6]

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 denotes nominal exports and M denotes nominal imports. In equilibrium, demand must be equal to the nominal value of output (nominal GDP), Y. Thus:

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

where $p_{i,t}$ are prices in local currency, and $y_{i,t}$ is the real demand component i, for each $i = D, X, M$. Based on this expression, we define real gross domestic income as the ratio of nominal income Y to the absorption deflator, $p_{D,t}$, and distinguish it from the real GDP, which is the ratio of nominal income to the GDP deflator.

Also, let q be the price of imports divided by the price of exports (in domestic currency), and h be the relative price of exports in terms of the absorption deflator:

$$q_t = \frac{p_{M,t}}{p_{X,t}}, \tag{2}$$

$$h_t = \frac{p_{X,t}}{p_{D,t}}. \tag{3}$$

In our context, q is the inverse of the terms of trade, and h corresponds to the price of domestically-produced traded goods relative to the price of domestic expenditures.

Finally, normalize real 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 real income growth can be decomposed into three distinct effects: a real GDP growth effect, a trade-balance effect, and a terms-of-trade effect. Specifically, the *real GDP growth effect* is

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

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

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

with $s_{i,t}$ being the share of component i in nominal GDP. The real GDP effect, $\mathcal{G}_{t,t-1}$, is the conventional measure of economic growth, but it does not take into account the changes in purchasing power of domestic

on domestic resource reallocation.

[6] Kohli (2004) shows that the potential divergence between real GDP and GDI can be quantitatively large, adding up to more than 10 percent of GDP in less than two decades in several of the 26 countries he analyzes. Using Kohli's (2004) accounting framework, Macdonald (2007) shows that differential changes in the terms of trade yield a significant wedge between income growth rates in Canada and the United States during the period 2000–2006.

residents when either the external terms of trade, or the price of traded goods relative to the price of domestic expenditures change significantly. The direct effects of such changes are captured by the remaining two effects.

The *trade-balance effect* is

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

where $s_{TB,t} = s_{X,t} - s_{M,t}$. As discussed by Kohli (2004, p. 95), this effect arises primarily because balance on trade in the balance of payments is typically different from zero. So, with an initial trade deficit, even a small but equi-proportionate change in the prices of imports and exports, which leaves the terms of trade intact but changes the price of domestically-produced traded goods relative to the price of domestic expenditures, would have a negative real effect. With an initial trade surplus, the real effect would be positive. The trade balance effect captures such effects.

Finally, the *terms-of-trade effect* is

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

Thus, income growth can be decomposed as (see Kohli (2004) for a detailed derivation):

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

Note that, in principle, changes in relative prices 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 through changes in the shares of each component of GDP over time. As such, it highlights the fact that the flexibility (or lack thereof) with which countries can undertake these substitutions affect the overall impact of relative price changes on real income.[7]

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

Table 2 shows the results of Kohli's income growth accounting for Guyana, Jamaica, and Trinidad and Tobago covering the period 1993–2007.[8] 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 trade-balance effect. The last column of the table also reports the average growth rate and the standard deviation of the terms of trade.

[7] Of course, this accounting framework is not intended to explain precisely how shares might change over time. Section 3 addresses this more fundamental question using a stylized model with explicit production and preferences. The accounting framework does not address the possible causal links running from the terms of trade and international trade to GDP growth, as well. However, given the similarities in terms of their income per capita, and given that their international trade patters are driven largely by their natural endowments, we think that comparing the terms-of-trade effects across these countries is informative.

[8] While the decomposition is relatively straightforward to implement, it nevertheless requires data on individual components of aggregate demand, some of which are not immediately available. Specifically, for 2006 and 2007, in several instances, there were missing observations that were extrapolated from recent trends. See Appendix A for details on the data sources and the construction of the variables.

Table 2: Decomposition of the growth rate of gross domestic income for Guyana, Jamaica, and Trinidad and Tobago, 1993–2007 (percent)

	Real	Income growth decomposition			
	domestic income	Real GDP	Trade balance	Terms of trade	$\Delta \ln (p_X/p_M)$
Guyana	−3.17	3.09	−1.53	−4.66	−4.20
	(7.99)	(3.91)	(2.23)	(5.96)	(5.19)
Jamaica	0.85	1.26	−0.84	0.43	0.60
	(3.72)	(1.27)	(0.60)	(2.60)	(4.32)
Trinidad					
and Tobago	6.58	7.08	−0.78	0.33	0.33
	(4.84)	(3.81)	(2.11)	(2.79)	(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 (8). All variables are average growth rates over the period (in percent). Numbers in parentheses are standard deviations.

We think of the changes in real income induced solely by changes in the terms of trade as a summary measure of *vulnerability* to changes in the terms of trade. The period averages that we report in Table 2 provide striking differences across these three countries in their vulnerabilities to long-term changes in the terms of trade. We also find that there are economically significant differences in the channels through which relative price changes influence the degree of vulnerability across these countries.

Consider the striking case of Guyana, primarily an exporter of food (sugar). Despite having grown at the average rate of 3 percent per year in conventional GDP terms, Guyana had a negative average income growth during the same period—albeit a highly variable one as indicated 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 decline in its terms of trade. In fact, from 1992 to 2007, Guyana's terms of trade declined by 4.2 percent per year, while the terms-of-trade effect averaged −4.7 percent over the same period. This is suggestive of a country with, even in the long run, little or no ability to substitute away from imported goods, whose prices have increased over time relative to the price of exports (see Figure 1).[9] The trade-balance effect also was on average negative during this period, with a large standard deviation.

Jamaica's income, on the other hand, has increased (0.85 percent per year) from 1992 to 2007. However, this increase was smaller than the average increase in its GDP (1.3 percent). In fact, Jamaica had a small increase in its terms of trade (0.6 percent per year), which contributed to a positive, albeit smaller, terms-of-trade effect (0.43 percent). In the case of Jamaica, it was the trade-balance effect that was a drag on income growth and that accounted for the income growth below the average GDP growth (−0.84 percent per year). 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

[9]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.

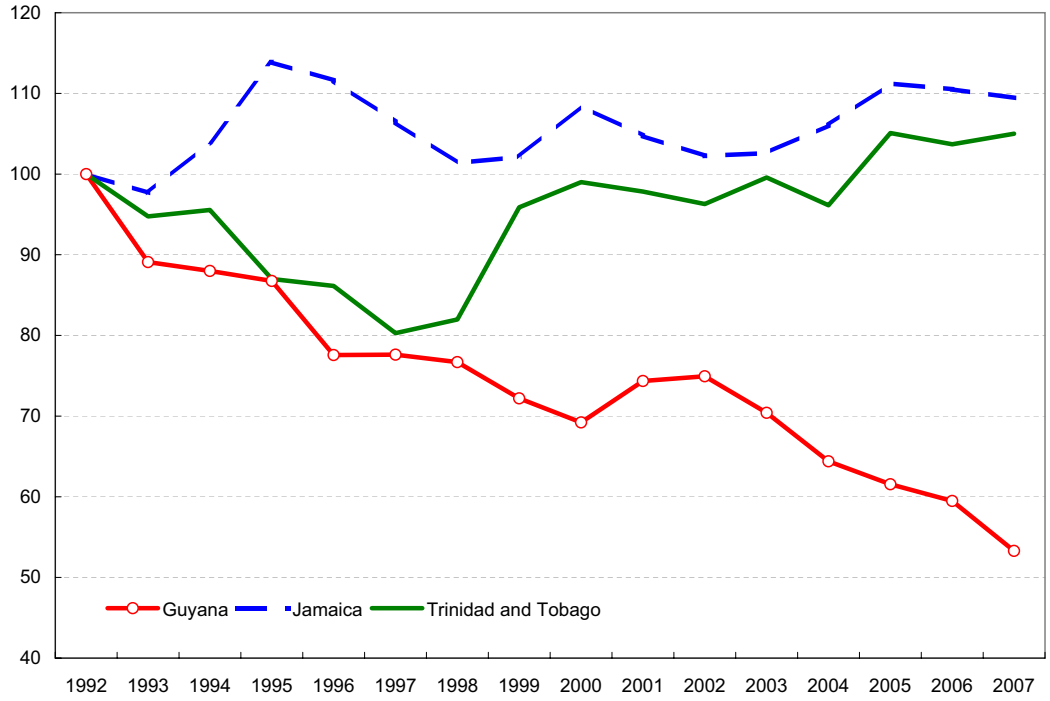

Figure 1: The terms of trade of Guyana, Jamaica, and Trinidad and Tobago, 1992=100

Note: The terms of trade is export price index divided by the import price index.
Source: IADB data base.

consequences of the long-term changes in its terms of trade.

Trinidad and Tobago, on the other hand, exhibited strong average growth in both real GDI and GDP from 1992 to 2007, with much smaller contributions from the trade-balance and the terms-of-trade effects. Trinidad and Tobago's terms of trade increased mildly on average over this period (0.3 percent per year), but the volatility of its terms of trade was one order of magnitude larger (i.e., 6 percent per year), driven by the large swings in energy prices. The terms-of-trade effect has the same average magnitude (0.33 percent), but a much smaller standard deviation—perhaps suggesting the presence of substitution mechanisms that cushion the impact of the changes in the terms of trade.

While we stress that the degree of vulnerability is likely to be different in the short run, we also report annual data on terms of trade and income growth decomposition for completeness. In particular, Table 2 presents the variability over time of each component of the income growth decomposition, Figure 1 presents for each country the annual variations in their terms of trade, Figure 2 plots the annual growth rate of real GDI for each country, and Figure 3 plots the annual decompositions. Since our analysis in Section 3 relates to the long-run adjustment mechanisms, here we do not further discuss the annual data.

Overall, our findings based on Kohli's growth accounting framework and long-term data highlight economically significant differences across these three countries in their vulnerabilities to changes in the terms of trade. However, this accounting framework cannot provide insights into the possible mechanisms that

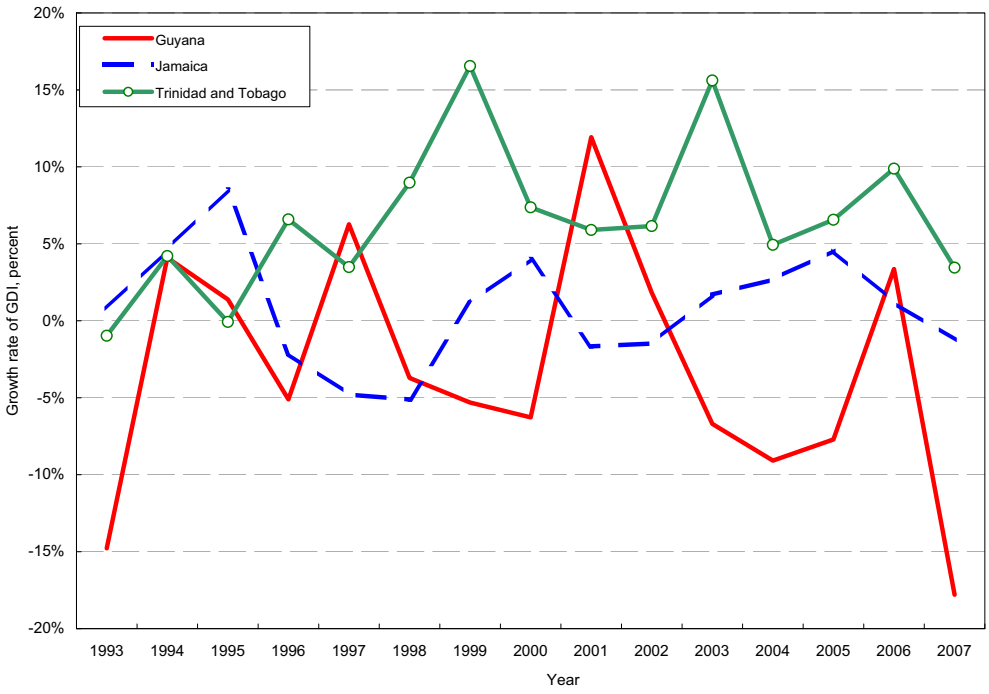

Figure 2: Growth rate of gross domestic income, 1993–2007

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.
Source: IADB data base.

may ultimately account for these differences. In the next section, we proceed to examine the degree of labour reallocation across sectors as one specific mechanism through which long-run differences in the response of income to changes in the terms of trade may arise.

3 Changes in the terms of trade and labor reallocation

We now present a tractable multi-sector model with the explicit goal of linking changes in the terms of trade to the sectoral reallocation of labor. In the model, there are demand- and supply-side channels, which lead to reallocation of labor across sectors in response to a change in the terms of trade. These reallocations can ultimately cushion the impact of changes in the terms of trade on income, and using parameterized versions of the model, we illustrate how allocation of labor responds to changes in the terms of trade.[10] In Section 4, we use this setup to examine the potential role of economic policies in affecting the degree of labor reallocation.

[10]To isolate the long-term substitution possibilities through labor reallocation alone, the model abstains from physical capital, financial assets, or other intertemporal substitution mechanism. Gavin (1990) and Mendoza (1995) focus on intertemporal considerations.

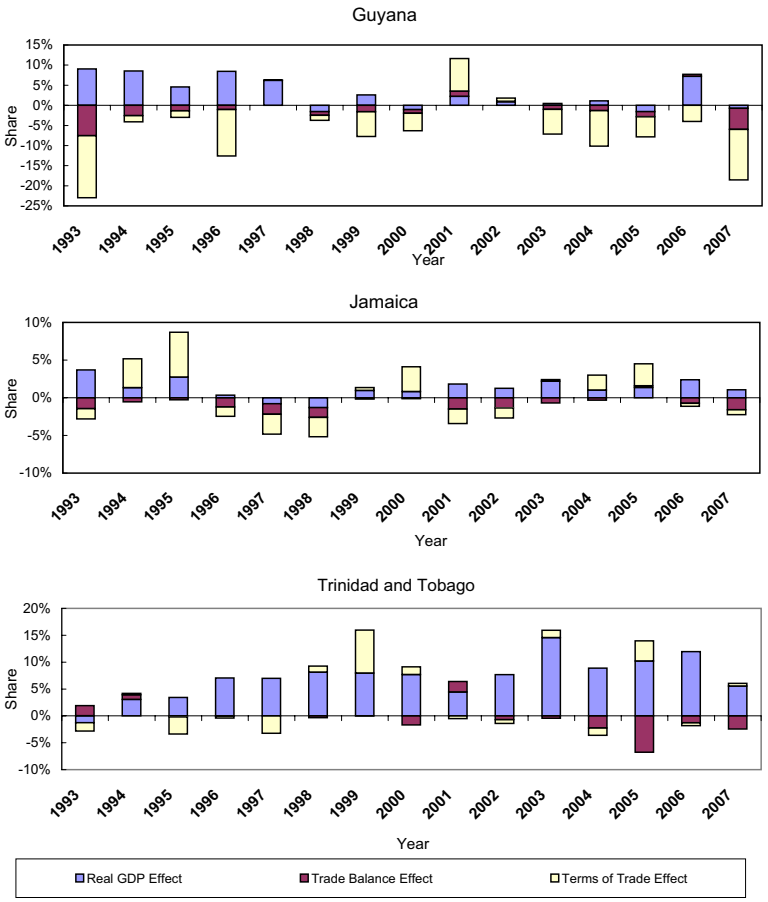

Figure 3: Decomposition of the growth rate of gross domestic income, 1993–2007

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.
Source: Authors' calculations based on IADB data base.

3.1 A small open economy model

We model an economy with two production sectors: a sector producing a domestic traded good that can either be consumed domestically or exported, and a sector producing a nontraded good that cannot be exported. In the model, there is also an imported intermediate good with an infinitely elastic supply. The international market price of the imported intermediate good is given and normalized to one. The domestic (c.i.f.) unit price of this good is $1 + \tau_M$, where τ_M is the tariff rate.

Demand: There is a representative household in the economy whose preferences are represented by a (logarithmic) utility function over a composite consumption good made up of traded C_{T} and nontraded consumption goods C_{N}. We do not model the demand for government services. The elasticity of substitution in consumption is unitary, so the model focuses on the supply-side driven labor reallocation.[11] The household supplies work effort L, and receives exogenous foreign income inflows F, which is denominated in units of the imported good. We think of these inflows as a combination of unilateral transfers, remittances and net income payments or receipts on outstanding foreign assets, which we do not model, but which are prominent

[11] So, a change in the relative price does not lead to gross substitution and complementarity in domestic private consumption demand. We have no direct evidence on the Caribbean economies we study that suggests otherwise.

in the Caribbean region. However, the setup is flexible and F could also represent royalties from a natural resource sector. Capital inflows contribute to after-tax personal income Y.

Specifically, the household's objective is to maximize

$$\log C_{\mathrm{T}}^{\eta} C_{\mathrm{N}}^{1-\eta}, \qquad \eta \in (0,1), \tag{9}$$

subject to

$$P_{\mathrm{N}} C_{\mathrm{N}} + P_{\mathrm{T}} C_{\mathrm{T}} = WL + F \equiv Y, \tag{10}$$

where P_{T} and P_{N} are prices of traded and nontraded consumption goods, respectively, and η is a preference parameter that measures the share of traded goods in the consumption basket.

The household's utility maximizing consumption decisions are characterized by the following first-order conditions:

$$C_{\mathrm{N}} = \frac{(1-\eta)Y}{P_{\mathrm{N}}}, \tag{11}$$

$$C_{\mathrm{T}} = \frac{\eta Y}{P_{\mathrm{T}}}. \tag{12}$$

Exports: As in Dennis and İşcan (2005) and Kehoe and Ruhl (2007), domestic exports face a downward sloping demand curve in the international market:

$$X = A_{\mathrm{X}} P_{\mathrm{T}}^{-\frac{1}{\theta}}, \qquad \theta > 0, \tag{13}$$

where A_{X} is a demand shifter, and θ is the inverse of the foreign price elasticity of demand for exports (thus, in relation to Section 2.1, we have $P_X = P_T$). In the quantitative analysis below, variations in A_{X} will be essential for generating changes in the terms of trade. However, the specification of exports above should not be interpreted literally as endowing the small open economy with market power. For one thing, by varying the elasticity of demand, it is possible to make this market power negligible. Rather, in the specific case of Trinidad and Tobago, a change in A_{X} should be thought of as a worldwide demand shock for energy. Given that world energy supply is relatively inelastic, such a worldwide demand shock leads to a change in the world price of energy. So, our interpretation would be that an endogenous change in the terms of trade of Trinidad and Tobago corresponds to a change in world price of energy.

Government: We consider a stylized government budget constraint. Given the increasing significance of direct taxes in the three Caribbean economies over time (e.g., Hope, 1987, chp. 2), we focus on income taxes. Specifically, government revenues consist of payroll taxes levied on the traded and nontraded sector wage earnings. Government expenditures consist of direct expenditures on nontraded goods. Specifically, the government budget constraint is

$$\tau_{\mathrm{T}} W L_{\mathrm{T}} + \tau_{\mathrm{N}} W L_{\mathrm{N}} = P_{\mathrm{N}} G_{\mathrm{N}}, \tag{14}$$

where for each $i = N, T$, τ_i is the payroll-tax rate in sector i, and G_{N} is the consumption of nontraded goods by the government sector.

The government influences 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 demand for nontraded goods by the government sector affects the sectoral allocation of labor.[12] 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 through τ_{M}.[13] Finally, the government can affect the allocation of labor by regulating the flow of net income from abroad F, say by imposing taxes on private capital inflows, remittances, or natural resources.

To close the government budget, we follow Kehoe and Ruhl (2007). Given payroll tax rates, the government demand G_{N} is price elastic:

$$G_{\mathrm{N}} = A_{\mathrm{G}} P_{\mathrm{N}}^{\frac{-1}{\nu}}, \qquad \nu > 0, \tag{15}$$

where A_{G} is an exogenous demand shifter, and ν is the inverse of its price elasticity. In the case of the Caribbean region, we expect this elasticity to be low.

Production: The production of domestic traded and nontraded goods require labor and imported intermediate inputs.[14] Specifically, the traded good production is

$$Y_{\mathrm{T}} = A_{\mathrm{T}} L_{\mathrm{T}}^{\beta} M_{\mathrm{T}}^{1-\beta}, \qquad \beta \in (0,1), \tag{16}$$

while the nontraded good production is

$$Y_{\mathrm{N}} = A_{\mathrm{N}} \left(\omega L_{\mathrm{N}}^{\mu} + (1-\omega) M_{\mathrm{N}}^{\mu}\right)^{\frac{1}{\mu}}, \qquad \mu \in (0,1), \quad \omega \in (0,1). \tag{17}$$

Here, for each $i = N, T$, $A_i > 0$ is a total factor productivity index in sector i, L_i is labor input, M_i is the imported intermediate input, $1/(1-\mu)$ is the elasticity of substitution between labor and imported intermediate good, ω is the weight of labor in the nontraded sector production, and β is the elasticity of output with respect to labor in the traded sector.[15]

Labor is mobile across sectors.[16] So, there is a unique wage rate W in the economy. However, there are sector-specific payroll taxes, τ_{N} and τ_{T} so that the value marginal products are equalized across sectors only up to a tax wedge:

$$W(1+\tau_{\mathrm{N}}) = P_{\mathrm{N}} \omega A_{\mathrm{N}} L_{\mathrm{N}}^{\mu-1} \left[\omega L_{\mathrm{N}}^{\mu} + (1-\omega) M_{\mathrm{N}}^{\mu}\right]^{\frac{1-\mu}{\mu}} \tag{18}$$

$$W(1+\tau_{\mathrm{T}}) = P_{\mathrm{T}} \beta A_{\mathrm{T}} L_{\mathrm{T}}^{\beta-1} M_{\mathrm{T}}^{1-\beta}. \tag{19}$$

[12] It is possible 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.

[13] 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. In the model, Tariff revenues may be thought of as financing direct imports by the government sector.

[14] There is no explicit production of natural resources in the model. However, the model allows for an exogenous stream of income from abroad possibly representing royalties on the production and export of natural resources. Therefore, either through the export sector or through income from abroad, the model can capture key features of the Dutch disease phenomenon, such as the appreciation of the real exchange rate in response to an increase in the export price of natural resource. However, in the case of Trinidad and Tobago, since F is negative (due to interest payments on outstanding debt), we do not emphasize the latter channel.

[15] We do not have direct empirical evidence on sectoral production function for the economies we consider. However, we conjecture that a unitary elasticity of substitution between labor and intermediate inputs (i.e., the Cobb-Douglas case) is less likely to be appropriate for the nontraded sector.

[16] Given the long-run analysis we undertake in this paper, this is plausible. For a model of short-run intersectoral labor mobility, see Dennis and İşcan (2006).

Domestic producers operate in competitive industries and take prices as given. Since the technology in each industry exhibits constant returns to scale, the price of the domestic traded good is

$$P_{\mathrm{T}} = A_{\mathrm{T}}^{-1}\beta^{\beta}(1-\beta)^{\beta-1}\left[W(1+\tau_{\mathrm{T}})\right]^{\beta}(1+\tau_{\mathrm{M}})^{1-\beta}, \tag{20}$$

while the price of nontraded good is

$$P_{\mathrm{N}} = A_{\mathrm{N}}^{-1}\left(\omega^{\frac{1}{1-\mu}}\left(W(1+\tau_{\mathrm{N}})\right)^{\frac{\mu}{\mu-1}} + (1-\omega)^{\frac{1}{1-\mu}}(1+\tau_{\mathrm{M}})^{\frac{\mu}{\mu-1}}\right)^{\frac{\mu-1}{\mu}}, \tag{21}$$

and the consumption-based aggregate price index is:[17]

$$P = P_{\mathrm{T}}^{\eta}P_{\mathrm{N}}^{1-\eta}/\eta^{\eta}(1-\eta)^{1-\eta}.$$

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

$$Y_{\mathrm{N}} = C_{\mathrm{N}} + G_{\mathrm{N}}, \tag{22}$$

$$Y_{\mathrm{T}} = C_{\mathrm{T}} + X, \tag{23}$$

$$P_{\mathrm{T}}X + F = M, \tag{24}$$

$$L = L_{\mathrm{N}} + L_{\mathrm{T}}, \tag{25}$$

and the government budget constraint in equation (14). Equation (22) states that, in equilibrium, domestic production of the nontraded good is equal to its consumption. Equation (23) states that domestic production of the traded good equals its final domestic and foreign consumption. Equation (24) is the current account balance, whereby the (f.a.s.) value of exports plus net transfers from abroad is equal to the (c.i.f.) value of imports. Equation (25) states that labor hours in the nontraded and traded goods producing sectors must add up to the total labor supply.

3.2 Calibration and the benchmark model

We illustrate the implications of the model for sectoral reallocation of labor in the face of changes in terms of trade by solving the model numerically. To determine the model parameters, we use data from Trinidad and Tobago, the country with the best available data. The parametrization of the model involves several steps. In the first step, we select several production and consumption shares and parameters, which are roughly quantifiable based on the available data ("calibration"). We treat these calibrated parameters as invariant to policy changes. In the second step, we assign values to the remaining parameters so that our numerical solution matches several features of the economy of Trinidad and Tobago circa 2006 ("benchmark"). For instance, while we calibrate the bias toward labor services in the nontraded sector ω using average labor share data between 2005 and 2007, our benchmark value for the tariff rate matches the actual average tariff rate in 2006, and later we will allow it to vary. Table 3 reports the parameter values, and we discuss these choices next (see also Appendix A).

[17] In relation to the notation used to illustrate the income decomposition in the previous section, we have $q = 1/P_T$, and $h = P_T/P = \left(\eta^{\eta}(1-\eta)^{1-\eta}\right)(P_T/P_N)^{1-\eta}$, which is a function of the relative price of non-tradable goods, and hence a key component of the real exchange rate. Also, we take foreign prices —both prices of domestic imports and foreign nontraded goods—as given. So, here, an increase in P corresponds to a real exchange rate appreciation.

Table 3: Parameter values for numerical solution: Trinidad and Tobago

Mnemonic	Description	Value	Source
F/Y	financial capital inflows to GDP ratio, %	-8.70 (3.84)	IADB
G/Y	government expenditures to GDP ratio, %	11	IMF
τ_{M}	average tariff rate on imported intermediate inputs	0.086	IADB
ω	bias towards labor input in the N-sector	0.6	authors
η	expenditure share of T-good	0.1	authors
β	elasticity of output with respect to labor in the T-sector	0.4	authors
μ	the inverse of one minus the elasticity of substitution between labor and M-good in the N-sector	0.1	benchmark
θ	inverse of the foreign price elasticity for domestic exports	4.5	authors
ν	inverse of the government price elasticity for nontraded goods	9.0	authors
τ_{N}	tax rate on N-sector labor income	0.2	authors
τ_{T}	tax rate on T-sector labor income	0.2	authors
A_{G}	government demand shifter	0.25	benchmark
A_{X}	foreign demand shifter	2.5	benchmark
A_{N}	TFP in the N-sector	0.5	normalization
A_{T}	TFP in the T-sector	1	authors
F	foreign capital inflows	-0.17	benchmark
L	total labor force	1	normalization

Notes: This table reports the parameter values we used in the base-case numerical solution of the model in Section 3. See the text for the description of sources.

In terms of the calibrated parameters, we normalize the labor force L to 1. We calibrate the expenditure share of traded goods η to 0.1, since the energy sector, which is a relatively small fraction of total domestic expenditures in Trinidad and Tobago, dominates the traded sector. Based on our rough employment estimates, we took a conservative approach and set the bias toward labor services in the nontraded sector ω equal to 0.6. However, we admit that both calibrated parameters η and ω are based on (incomplete) data and rough estimates. We set the elasticity of output with respect to labor in the the traded sector β equal to 0.4, which is lower than what is conventionally used for advanced industrial economies, but is appropriate for the capital-intensive energy sector. We normalize A_{N} to one and set A_{T}, so that we assign a relatively higher productivity factor to the traded sector. We set the value of the inverse of the foreign price elasticity of demand θ to 4.5, which is close to values typically found in the empirical literature. Since we do not have direct evidence for the government price elasticity for nontraded goods, we set ν equal to 9, implying a low price elasticity.

In terms of the benchmark parameters, we have several targets. One objective is to match the contribution of changes in the terms of trade to income growth from Section 2.2. So, we target a terms-of-trade

effect of about the same magnitude as the one reported in Table 2. In the case of Trinidad and Tobago, the ratio between the percentage change in the term of trade and the terms-of-trade effect is unitary (0.33/0.33). We roughly match this benchmark by setting the elasticity of substitution in production between labor and intermediate imported goods in the nontraded sector, μ. It turns out that the value of μ necessary to match this benchmark is significantly less than one, which is suggestive of limited substitutability in production between labor and intermediate imported inputs in the nontraded sector, and we set it equal to 0.1.[18]

We set the tariff rate, τ_M to 8.6 percent which is the actual average tariff rate in 2006. We were unable to obtain reliable estimates for the payroll taxes, so in the benchmark model, we set identical payroll tax rates across sectors at 20 percent, $\tau_N = \tau_T$. Given these tax rates, we set the value of A_G so that the model roughly matches the 11 percent G/Y ratio in the data. We also set the values of F and A_X so that the model matches the F/Y ratio in the data.

3.3 Adjustment to a change in the terms of trade

In this paper, we focus on the reallocation of labor across traded and nontraded sector as the main long-term adjustment mechanism to a sustained change in the terms of trade. In the model, this reallocation depends on the substitutability between labor and imported inputs, and changes in relative demands across sectors. For now, we take these substitution possibilities and economic policies as given, and investigate the consequences of changes in the terms of trade on the allocation of labor across sectors.

In our numerical analysis, changes in the terms of trade originate from an exogenous change in the foreign demand shifter A_{X}. In the model, an increase in A_{X} shifts the foreign demand for domestic traded good, which in turn leads to an increase in its export price, and hence an improvement in the terms of trade. Conversely, a reduction in A_{X} leads to a deterioration in the terms of trade.

Figure 4 illustrates the key implications of the parameterized version of the model. In each panel, the horizontal axis plots the foreign demand shifter. The vertical axes are as follows: Panel A plots the log of the terms of trade $P_{\mathrm{T}}/P_{\mathrm{M}}$ (an increase in $P_{\mathrm{T}}/P_{\mathrm{M}}$ corresponds to an improvement in the terms of trade); Panel B plots the domestic price level in terms of imported intermediate inputs; Panel C shows the employment share of the traded goods producing sector in total employment L_{T}; and Panel D shows the natural logarithm of real income Y. The vertical lines in all the panels show the values of these endogenous variables corresponding to the benchmark model for Trinidad and Tobago. We discuss adjustment to a change in the terms of trade by focusing on the responses of these endogenous variables as the value of A_{X} changes from its benchmark value.

The results show that, as foreign demand for domestic traded good increases, the terms of trade improves (panel a), the price price level rises relative to that of the imported intermediate input (panel b), labor reallocates from the traded-good to the nontraded-good producing sector (panel c), and real income rises (panel d). As we discuss below, the domestic prices of both the traded and nontraded goods rise relative to the price of the imported intermediate good, which remains constant in all the scenarios we report below.

[18] In the benchmark model, the ratio between the percentage change in the term of trade and the terms-of-trade effect is slightly higher than one (1.4). However, a value of $\mu = 0.1$ is delivers a ratio between the percentage change in the term of trade and the terms-of-trade effect close to unitary for a range of parameter values. These parameter combinations we considered include ($\omega = 0.42, \beta = 0.4, \eta = 0.5$), with different benchmark values for $A_{_G}, A_{_X}, F$. We also experimented with values of $\mu = 0.9$. We don't report the results of these sensitivity analysis to conserve space. In the model, there is no growth and foreign trade is always in balance, so GDP and the trade-balance effects from Section 2.2 are zero.

Given that the prices of foreign nontraded goods are also fixed, the domestic real exchange rate *appreciates.* So, as the terms of trade improves, and the real exchange rate appreciates, the economy reallocates labor from the traded-good to the nontraded-good producing sector. In the case of Trinidad and Tobago, this increase in demand for its exports is equivalent to an increase in energy exports, and the reallocation of labor from traded to nontraded sector is reminiscent of the familiar "Dutch disease."[19]

There are combined supply-side and demand-side responses driving these results. In terms of *relative prices*, as foreign demand for domestic traded good rises, firms in the traded sector increase production and demand for labor and imported intermediate inputs. All else equal, higher demand for labor by the traded goods sector puts upward pressure on the economy-wide wage rate and hence on income. A rise in the wage rate increases the marginal cost of production in the domestic traded sector, and given that our small open economy faces an infinitely elastic supply of intermediate inputs, import prices remain constant, and the terms of trade $P_{\mathrm{T}}/P_{\mathrm{M}}$ rise (Figure 4a).

Higher foreign demand for domestic traded good also changes (decreases) the relative price of traded to nontraded goods $P_{\mathrm{T}}/P_{\mathrm{N}}$, despite the fact that the marginal cost of production increases in both the domestic traded and nontraded sectors. This is so because, in the parameterized model, the share of labor in production in the nontraded sector differs from that in the traded sector: see equations (20) and (21), where P_{T} and P_{N} depend on β and ω. However both prices increase, leading to an increase in the price of domestic good P relative to the price of the foreign good, which is constant (Figure 4b).

[19]See, for instance, Corden (1984) for a survey of the Dutch disease literature. In our context, an improvement in the terms of trade is associated with a real exchange rate appreciation, and as we discuss below, triggers supply-side and demand-side responses. The responses we discuss overlap with those noted by the Dutch disease literature, which associated these responses with distinct income and substitution effects. Relative strengths of these income and substitution effects and their implications for labor reallocation are ultimately quantitative and empirical matters. Our simulation analysis provides a quantitative assessment of these responses in the case of Trinidad and Tobago. A complementary approach, pursued by Egert and Leonard (2008) in the case of Kazakhstan, is to assess these responses using an econometric model.

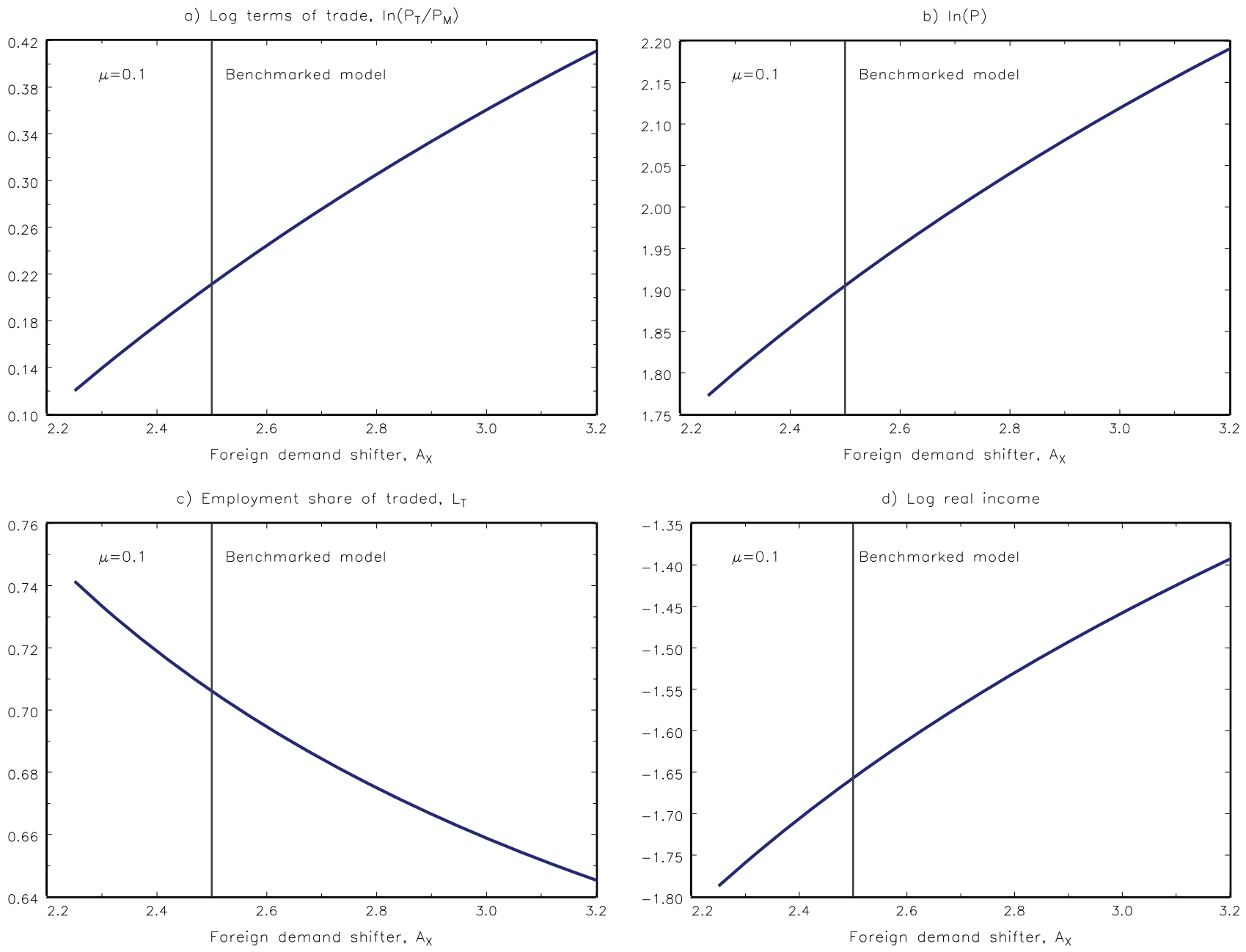

Figure 4: Simulation results for a calibrated model of Trinidad and Tobago

Notes: See Table 3 for the parameter values.

The adjustment in the labor market is closely related to these changes in relative prices. As the wage rate and income rise, demand for the nontraded good also rises. So, increased foreign demand for domestic traded good tends to increase labor demand in both sectors. Moreover, as labor becomes more expensive relative to intermediate inputs, firms in both sectors substitute away from labor. So, there are two opposite effects: the demand for labor in both sectors tends to rise through the income effect and to decrease through the substitution effect.

Overall, firms in both sectors attempt to adjust in similar directions to changes in demand and relative prices. Since labor supply is fixed, the labor market responds by reallocating labor across sectors in order to accommodate the *structural differences* between them, as well as differences in *demand shifts* across sectors. The key structural difference in the model is the sectoral differences in elasticity of substitution between labor and imported intermediate input. In the parameterized version of the model, the traded sector has unitary elasticity of substitution between labor and imported intermediate input, whereas nontraded sector has a relatively high elasticity of substitution. This determines the slopes of the sectoral labor demand curves. At the same time, the demand for labor depends on the sectoral marginal value product. So, the new equilibrium allocation of labor across sectors depends on both the elasticity parameters (including η) and the changes in relative prices.

The *domestic-demand* side of the model also responds to changes in relative relative prices and income. In particular, higher income increases the private consumption demand for both traded and nontraded goods. Government consumption demand also changes: since government demand for the nontraded good is highly price inelastic, it predominantly responds to rising government revenues from payroll taxes. At the same time, private consumption tends to switch toward the traded good in response to the increase in the relative price of nontraded good. However, the unitary elasticity of substitution in consumption between the traded and nontraded goods implies that households keep the ratio of traded to nontraded expenditures constant—though, since the weight of the traded good in the consumption aggregate is low ($\eta = 0.1$), the demand for nontraded increases by more as income rises. As a result, the change in the relative quantities demanded is always proportional to the change in the price of traded-to-nontraded goods. In the concrete example we are considering, a fall in the relative price $P_{\mathrm{T}}/P_{\mathrm{N}}$ leads to a rise in the demand for the traded good by households.

The third dimension of the adjustment process is the *external* sector. The increase in foreign demand for domestic traded good improves the terms of trade. In the absence of a change in domestic production, this leads to a trade surplus. In equilibrium this is not feasible. The endogenous responses of the economy from both the supply and demand sides bring the economy back to a trade balance. In line with the discussion above, there are two equilibrium responses: while imports (intermediate inputs) rise as the domestic production of both the traded and nontraded goods increases, *quantity* of domestic traded exports need not increase because of the improvement in the terms of trade, which in turn reduces demand for labor in the traded sector. In our parameterized version of the model, an improvement in the terms of trade relocates labor from traded to nontraded sector, because the combined influences of government and foreign sectors outweigh the response of the private sector demand, leading to a decrease in traded employment (Figure 4c).

While substitution away from labor toward relatively cheaper imported input in both the traded and nontraded sectors contains the increase in wage and hence income, it is not sufficient to prevent it altogether.

The income effect exceeds the substitution effect, so the net impact of an improvement in the terms of trade triggered by the increase in foreign demand affects is an increase in real income (Figure 4d).

4 Policy experiments

We now use this model to analyze how several economic policies could influence the impact of terms of trade on income through sectoral reallocation of labor. We consider two fiscal policy instruments (payroll taxes and government consumption expenditures), one trade policy instrument (import tariff rate), and economic policies related to foreign income inflows (such as remittances).

Figure 5 shows, for each policy experiment and the baseline model, the relation between the foreign demand shifter A_{X} and the four variables we focus on—the terms of trade $P_{\mathrm{T}}/P_{\mathrm{M}}$, the price level P, the employment share in the traded sector L_{T}, and real income Y (the benchmark value of A_{X} is marked by a vertical line). We report the relative prices for completeness, but in our discussion below we will (i) compare the *levels* of employment share of traded sector and aggregate income under each policy scenario with the levels of those same variables in the baseline model evaluated at the benchmark parameter values ("benchmark model"); and (ii) compare the *change* in income under each policy scenario due to a particular change in the terms of trade with the change in income in the benchmark model.[20]

4.1 Economic policy, sectoral allocation of labor, and income

A reduction in government expenditures: In this scenario, we reduce the share of government expenditures from about 11 percent of the GDP in the benchmark model to slightly less than 8 percent of GDP by reducing the government consumption demand shifter A_{G} from .25 to 0.15. In other words, this experiment effectively renders government expenditures more responsive to relative prices. We keep the remaining model parameters at their levels in the benchmark model.

In terms of *levels*, compared to the baseline model, a reduction in A_{G} corresponds to a lower share of employment in the traded sector (Figure 5c), and higher income (Panel D). Since government consumption expenditures fall on the nontraded good, a reduction in A_{G} releases resources for more domestic private consumption. In this parametrization, the expenditure share of traded goods η is low (0.1), so households spend those additional resources largely on the nontraded good. In addition, while a reduction in A_{G} reduces the amount of resources absorbed by the government sector, relative to the benchmark model, it also increases income. Both of these *income effects* stimulate demand for nontraded goods, and end up increasing employment in the nontraded sector. Also, in the simulations reported, the value of μ is relatively low ($\mu = 0.1$), so in the nontraded sector domestic labor and imported inputs have limited substitutability. Given that the *substitution effect* is relatively weak, a relatively higher increase in the demand for nontraded goods ends up pulling labor into the nontraded sector.[21]

[20] Our results depend on the specific parameter values we use in the numerical examples. The general point we stress, however, is the economically significant influence of policy variables on the transmission of changes in the terms of trade to income through sectoral reallocation of labor.

[21] By contrast, when in the nontraded sector labor and imported inputs are strongly gross substitutes (the elasticity of substitution between labor and imported inputs is relatively high), nontraded producers can switch toward imported inputs with more ease, which translates into higher employment in the traded sector. Thus, the resource reallocation effect can dominate the income effect, resulting in a reallocation of labor toward the traded sector. For instance, in our simulations this happens when $\mu = 0.9$.

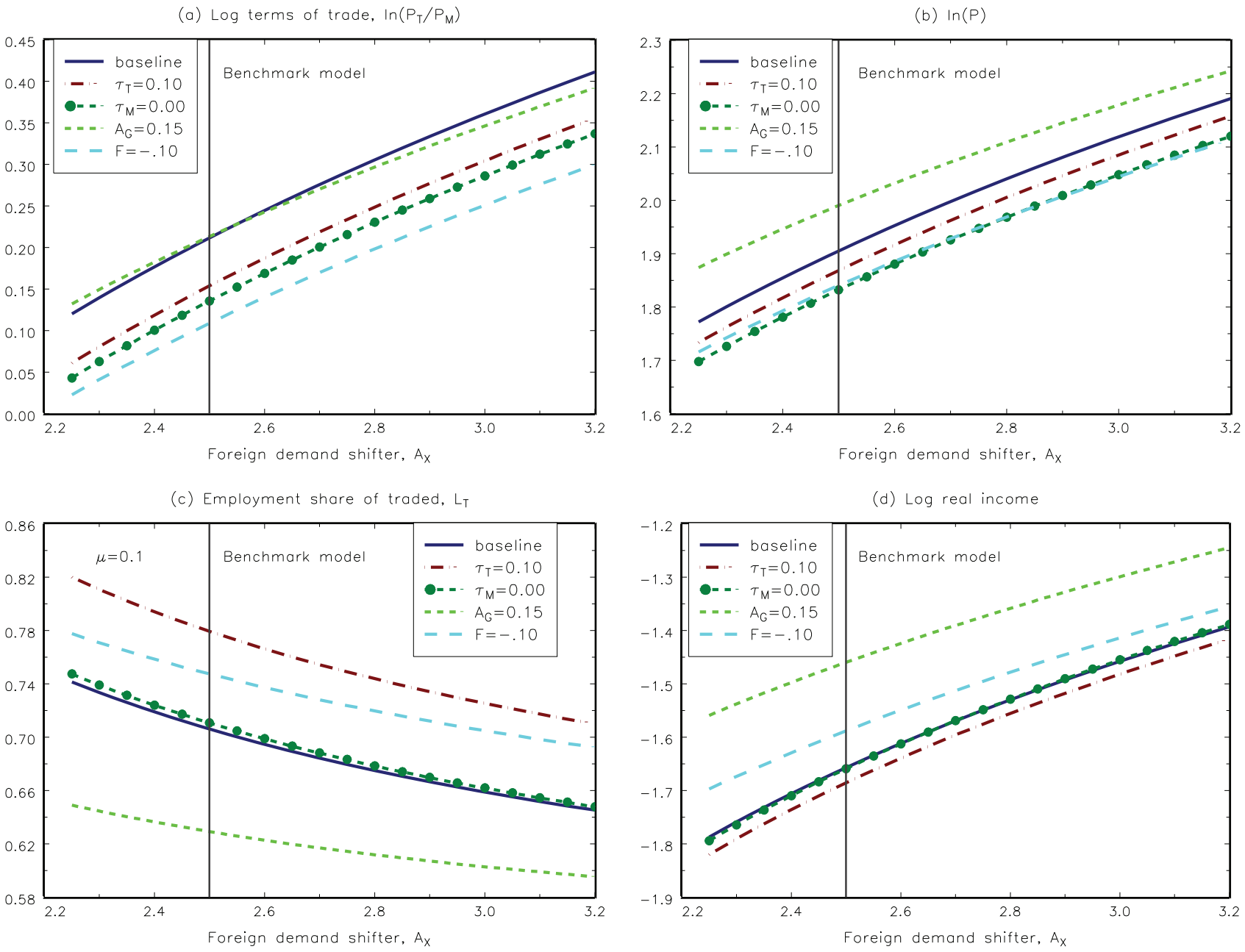

Figure 5: Policy experiments for Trinidad and Tobago

Notes: See Table 3 for the baseline model's parameter values.

A reduction in the traded sector payroll tax rate: In this scenario, we reduce the payroll tax rate in the traded sector from 0.2 to 0.1. Given the relatively inelastic demand for government consumption, which falls on nontraded goods, this policy change increases the relative tax burden on the nontraded sector. The revenue shortfall is primarily financed by relocating labor into the traded sector. In addition, for the government consumption expenditures to fall (to balance the government budget constraint), the relative price of the nontraded good increases relative to the baseline model. A higher price of the nontraded good contributes to additional demand for the traded good. The combination of these two forces result in higher employment in the traded sector (Figure 5c). In fact, a lower payroll tax reduces the cost of labor in the traded sector, and hence the terms of trade (Figure 5a). Also, since higher employment in the traded sector is not sufficient to close the shortfall in tax revenues, and since the relative price of the nontraded good rises by so much, the real income is lower than the baseline model (Figure 5d). This policy shifts the burden of taxation (which is necessary for the provision of government services) onto the nontraded sector, ends up relocating labor to traded, but it comes at the cost of real income.

A reduction in the tariff rate on imported goods: In this scenario, we eliminate the 8.6 percent tariff on imported intermediate goods. Relative to the baseline model, the elimination of the tariff reduces the domestic price of the imported intermediate input and the production costs of the domestic traded good, which leads to a weaker terms of trade (Panel A). Cheaper intermediate inputs 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, the prices of traded and nontraded goods tend to fall. Because of the asymmetries in the production function of the two sectors, it is much easier to substitute away from labor in the nontraded sector. So, relative to the benchmark model, in equilibrium, the economy employs relatively higher share of its labor force in the traded sector—though not by much, because the share of traded in total expenditures is relatively low (Figure 5c). Due to declining prices of the traded and nontraded goods, income increases slightly in equilibrium (Figure 5d).

Increase in foreign income inflows: In this scenario, we increase net foreign income from abroad from about -8.5 percent of GDP to about -5.5 percent of GDP by increasing F from $-.17$ to $-.10$. An increase in income from abroad increases domestic demand for both traded and nontraded goods. This higher demand for goods increases demand for labor demands in both sectors. This tends to put upward pressure on the wage rate and income compared to the baseline model (Figure 5d). 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 toward the traded sector (to meet the *external* balance). This leads to a rise in the traded share of employment (Figure 5c).

4.2 Economic policy, reallocation and terms-of-trade effects

How do the individual economic policies considered above influence the vulnerability of a small open economy such as Trinidad and Tobago? The magnitude of the change in income due to a change in the terms of trade is a natural measure of vulnerability, and we refer to it as the model-based "terms-of-trade effect." Since in the model, the sectoral reallocation of labor is a significant determinant of the terms-of-trade effect, we calculate the change in the employment share of traded sector in response to a change in the terms of

Table 4: Policy experiments, the terms-of-trade effect, and labor reallocation

	Relative to the benchmark economy			
	$A_{_G} = 0.15$	$\tau_{_T} = 0.10$	$\tau_{_M} = 0.00$	$F = -0.10$
Terms-of-trade effect	0.86	1.02	1.03	0.90
Reallocation effect	0.65	1.06	1.05	0.84

Notes: This table reports, for alternative policy experiments, the model-based terms-of-trade effect, defined as the percent change in real income due to a 10 percent improvement in the terms of trade in the benchmark economy, and the relocation effect, defined as the percent change in the employment share of traded sector in response to a 10 percent improvement in the terms of trade in the benchmark economy, all relative to the baseline benchmark model economy. The change in the terms of trade is due to a change in the external demand shifter A_{X}. See Table 3 for the parameter values in the baseline benchmark model economy. The policy experiments are, relative to the benchmark parameter values, a reduction in the government consumption demand shifter $A_{_G} = 0.15$, a reduction in the traded sector payroll tax rate $\tau_{_T} = 0.10$, a reduction in the tariff rate on imported goods $\tau_{_M} = 0.00$, and an increase in foreign income inflows $F = -0.10$.

trade, and we refer to it below as the "reallocation effect." As we will see, there are economically significant differences in the terms-of-trade and reallocation effects across the policy scenarios we consider.

In particular, we start with a 10 percent improvement in the terms of trade in the benchmark economy—again due to a shift in foreign demand for domestic goods, and compute the terms-of-trade and reallocation effects. We then compute the terms of trade and reallocation effects under different economic policy experiments corresponding to the same shift in foreign demand for domestic goods.

We report the results for the terms-of-trade and reallocation effects for each policy *relative* to the benchmark economy in Table 4. The results are striking in two respects. First, policies that lower government demand, and generate higher foreign income inflows correspond to lower terms-of-trade effects relative to the benchmark model. By contrast, policies that result in lower traded sector payroll tax rate, and lower tariff rate on imported intermediate inputs correspond to higher terms-of-trade effects relative to the benchmark model. While we are careful not to interpret these results from an optimal policy and welfare perspective, the results point to differential ramifications of economic policies in terms of the vulnerability of open economies.

Our second set of findings is that (i) a policy experiment that increases the vulnerability of the economy to changes in its terms of trade also increases the magnitude of the reallocation effect, and (ii) reallocation effects do not align perfectly with the terms-of-trade effects. Specifically, the two experiments that reduce the terms-of-trade effect ($A_{_G} = 0.15$ and $F = -0.10$) also have the lowest reallocation effects relative to the benchmark model. In fact, the policy experiment with lower government demand shifter not only leads to lower vulnerability, but also *reduces* sectoral reallocation of labor substantially relative to the benchmark model. By contrast, the two policy experiments ($\tau_{_T} = 0.10$ and $\tau_{_M} = 0.00$) that exhibit higher terms-of-trade effects relative to the benchmark model also have higher reallocation effects. So, while under these policy experiments there is substantial sectoral labor reallocation relative to the benchmark model, their terms-of-trade effects are nevertheless larger.

Also, the rankings across policy experiments of the terms-of-trade and reallocation effects are different. For instance, while the policy experiment that reduces payroll tax rate in the traded sector has a lower terms-

of-trade effect compared to the policy experiment that reduces the tariff rate, the payroll-tax experiment has a higher labor reallocation effect compared to the tariff-rate experiment. These comparisons across policy experiments thus reveal that equilibrium reallocations may look sluggish but nevertheless be sufficiently strong to buffer the economy from changes in its terms of trade. In other words, this model suggests that the degree with which an economy reallocates its labor across sectors is not necessarily a good indicator of its vulnerability to changes in the terms of trade.

5 Conclusion

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

We then related these effects to the reallocation of labor across production sectors in response to a change in the terms of trade with the aid of a general equilibrium, open economy model, calibrated to the economy of Trinidad and Tobago. The analysis highlighted the importance of substitution in production between labor and imported intermediate inputs as an adjustment mechanism, as well as the interrelatedness of the general equilibrium effects triggered by the presence of the government budget constraint and the external balance.

The paper also discussed alternative policy responses to long-term changes in the terms of trade that may influence their incidence on income growth through the sectoral reallocation of labor. Our main finding is that the degree with which an economy reallocates its labor across sectors ("flexibility") is not necessarily a good indicator of its vulnerability to changes in its terms of trade.

A Data

Data for Kohli's (2004) decomposition come from the Inter-American Development Bank (IADB) database, with specific accounts given in parentheses below.

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

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

- G/Y: Government expenditures and nominal GDP in domestic currency units are from IMF, *International Financial Statistics*.
- F/Y: Financial inflows as a percent of GDEP flows are from IADB, *External Accounts* database.
- τ_M: Tariff rates are from IADB database on tariffs.
- ω: Share of labour in nontraded sector. We provided a benchmark value for this parameter by using the estimates of persons employed in the nontraded sector (in thousands) and value of imports of goods (imports in millions of USD). The data source underlying the employment shares is ILO, *Laborsta* database.
- μ: Elasticity of substitution between labour and imports in the nontraded CES production function. We provide a benchmark estimate for this parameter based on relation between the change in (log) employment in nontraded and the change in (log) imports.
- η: Expenditure share of traded good. We provide 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, *Trade Profiles*, and sectoral output is World Bank, *World Development Indicators*.

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