MEASURING AGRICULTURAL POLICY BIAS: GENERAL EQUILIBRIUM ANALYSIS OF FIFTEEN DEVELOPING COUNTRIES

HENNING TARP JENSEN, SHERMAN ROBINSON, AND FINN TARP

Measurement is a key issue in the literature on price incentive bias induced by trade policy. We introduce a general equilibrium measure of the relative effective rate of protection, which generalizes earlier protection measures. For our fifteen sample countries, results indicate that the agricultural price incentive bias generally perceived to exist during the 1980s was largely eliminated during the 1990s. Results also demonstrate that general equilibrium effects and country-specific characteristics are crucial for determining the sign and magnitude of agricultural bias. Our comprehensive protection measure is therefore uniquely suited to capture the full impact of trade policies on relative agricultural price incentives.

Key words: agricultural policy, CGE models, effective protection, urban bias.

JEL codes: D58, O10, Q18.

“Getting prices right” was a rallying call when developing countries started reorienting their economic policies in the early 1980s. Trade and macroeconomic policies were perceived to favor urban industry over agricultural production. The existence of an incentive bias against agriculture was affirmed in the late 1980s by a major World Bank research project carried out under the direction of Anne O. Krueger (Krueger, Schiff, and Valdés 1988; Krueger 1992; Schiff and Valdés 1992; Bautista and Valdés 1993). More recently, issues such as food security and rural development have been raised in World Trade Organization and regional trade negotiations. This shift generated renewed interest in measuring relative price incentives and policy bias in agriculture, and led to the setting up of a new World Bank project on “Distortions to Agricultural Incentives,” under the direction of Kym Anderson (2006, 2007). The methodology of past World Bank projects has relied on partial equilibrium analysis and relative measures of nominal protection rates (NPRs), with little attention to intersectoral linkages, degrees of tradability, and feedback effects from changes in incomes and relative prices. However, the measurement of price incentive bias induced by trade policy is inherently a general equilibrium issue (Anderson 1970, 1998). This is confirmed by World Bank researchers who recognize that a relative measure of effective rate of protection (ERP) would be more appropriate (Krueger, Schiff, and Valdés 1988) and that it is important to capture general equilibrium effects (Anderson et al. 2008).

The adoption of a general equilibrium methodology has been facilitated over the past two decades by the increased availability of economy-wide Social Accounting Matrix (SAM) data sets. Anderson, Martin, and van der Mensbrugghe (2005, 2006a, 2006b) employ the dynamically recursive global computable general equilibrium (CGE) LINKAGE model to measure the welfare impact of trade distortions, arguing that the welfare changes reflect long-term efficiency gains. However, it is unclear to what extent these “efficiency gains” are due to static welfare gains from changes in relative price incentives and/or to dynamic welfare gains arising from increased capital.

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1 This discussion formed part of a broader debate about “urban bias” (Lipton 1977) and the effectiveness and impact of agricultural price policies (Tarp 1996).
accumulation due to tax reform–induced income redistribution between agents with different propensities to save.  

In contrast, this article employs a static single country CGE methodology, which allows for clean measurement of price incentive bias induced by trade policy. Focus is on relative measurement of classical (NPR and ERP) protection measures and, hence, on relative agricultural price incentives induced by own (single country) policies. The static single country methodology allows for tailoring models to incorporate the full range of country-specific distorting taxes and subsidies on both traded and nontraded goods. In addition, the methodology makes it possible to take account of intersectoral linkages, varying degrees of tradability, and feedback effects from relative price changes in the measurement of policy bias. This allows us to introduce a general equilibrium–based ERP (GE-ERP) measure, which transforms quantity effects into price effects and thereby provides a comprehensive measure of relative agricultural price incentive bias. Finally, the static single country methodology avoids capturing dynamic welfare effects unrelated to trade policy–induced price distortions.

In this study, we aim to demonstrate that accounting for intersectoral linkages and general equilibrium effects is crucial and that our comprehensive GE-ERP measure is necessary to capture the full extent of agricultural price incentive bias. The CGE model framework will be used as a measuring device rather than a tool for policy analysis. We apply the methodology to our sample of fifteen developing countries to study (a) the historical variation of protection rates that arises from existing trade policy distortions, and (b) the experimental variation in protection rates that arises from imposing standard trade policy distortions on distortion-free base economies. A Monte Carlo procedure provides a robustness check with respect to underlying tradability assumptions.

**Measuring Policy Incentive Bias**

A plethora of measures, including the NPR, ERP, and the producer subsidy equivalent (PSE), have been proposed for measuring how government interventions induce trade distortions, price incentive bias, and restrictions on market access. Schwarz and Parker (1988) argue that ERP is most appropriate for measuring price incentive bias, while Bureau and Kalaitzandonakes (1995) note that ERP is deficient because it ignores substitutability between intermediate inputs.

Our study focuses on another deficiency of the traditional ERP measure, namely that it is a partial equilibrium production concept, which “may be seen as an attempt to make enough assumptions so that demand may be ignored” (Anderson 1970) and which “breaks down in general equilibrium” (Anderson 1998). Two separate definitions of ERP were originally proposed (Corden 1966; Leith 1968; Anderson and Naya 1969). They include (a) the Corden-Anderson-Naya definition as “the proportionate increment in value-added per unit output over the free-trade value-added per unit output” and (b) the Corden-Leith definition of “the proportionate change in the ‘price of value-added’” (Bhagwati and Srinivasan 1973). The Corden-Leith definition has, generally, been favored due to ease of implementation. In what follows, the discussion refers to the Corden-Leith definition.

The historical ERP literature focused on the predictive power of ERP in terms of real value added, primary factor allocation, and gross output (Anderson 1970; Jones 1971; Bhagwati and Srinivasan 1973; Bruno 1973; Khang 1973). This body of work demonstrated that the predictive power of ERP is weak under general assumptions (Ethier 1977). Furthermore, a key assumption underlying the definition of the traditional ERP measure is that domestic and world market goods are perfect substitutes and, hence, that relative prices are fixed at world market levels. Relaxing this assumption within a general equilibrium framework has been shown to have a profound impact on ERP calculations (de Melo and Robinson 1981; Devarajan and Sussangkarn 1992). These single-country studies focus on the direct measurement of tariff-induced resource pulls, and the latter study finds that resource pulls, measured by general equilibrium changes in sector-level value added, may differ significantly from the traditional ERP measure in both magnitude and sign (Devarajan and Sussangkarn 1992).

In spite of widespread criticism, the ERP measure continues to be interpreted as an indicator of resource pulls, which can be usefully employed in trade negotiations (Schwarz and Parker 1988). As a consequence, it is crucial
to know whether the partial equilibrium measure is a good predictor of comprehensive general equilibrium measures of price incentive bias (with quantity effects transformed into price effects). The traditional NPR and ERP measures are typically calculated for a given production sector. A related measure has been employed extensively by World Bank researchers and others to study the trade policy impact on relative agricultural price incentives, defined as the ratio between specific agricultural sector NPRs and an average nonagricultural sector NPR (Krueger, Schiff, and Valdés 1988; Krueger 1992; Schiff and Valdés 1992; Bautista and Valdés 1993). For this type of measure, the key issue is whether it is a good predictor of comprehensive general equilibrium measures of relative price incentives bias. In what follows, the focus is on relative agricultural price incentives, and the terms “NPR” and “ERP” will be used to refer to the ratio between average agricultural and nonagricultural protection rates.

This study introduces a GE-ERP measure that translates general equilibrium quantity effects into price effects and provides a comprehensive indicator of relative agricultural price incentive bias. Our measure is based on relative factor returns (or, equivalently, relative value-added prices) and is methodologically in line with the static single country CGE methodology proposed by Jensen and Tarp (2002) and Bautista et al. (2001). We employ our model framework to simulate (a) the removal of historical trade policy distortions and (b) the imposition of experimental trade policy distortions in the form of uniform nonagricultural import tariffs and exchange rate overvaluation. If the removal/imposition of a policy distortion yields a new equilibrium in which the agricultural sector is “better off”/“worse off,” the policy distortion is said to generate a bias against agriculture. How to measure “better off”/“worse off” is an important issue. The classical Corden-Anderson-Naya choice is to use relative agricultural value-added shares. An increase in agricultural value-added shares can arise from two sources: (a) an increase in factor use in agriculture relative to nonagriculture and (b) an improvement of factor returns in agriculture relative to nonagriculture. Removal of policy distortions typically leads to changes in both prices and quantities. Under such circumstances, it is not appropriate to use the Corden-Leith definition and measure (the size of) agricultural policy bias in terms of relative prices.

In order to ensure that our GE-ERP measure is appropriate, we segment factor markets in our country models so that factors are allowed to move freely within agricultural and nonagricultural sector groups, but not to move between them. By restricting factor mobility in this way, agricultural supply response will be limited, and adjustment in nominal value added will be reflected in relative prices. With restricted factor mobility, our measure provides a theoretically appropriate indicator of agricultural policy bias, in the sense that it translates general equilibrium quantity effects into price effects and thereby provides a comprehensive measure of (the size of) agricultural price incentive bias.

The implementation of our methodology is based on a “standard” trade-focused neo-classical CGE model with profit- and utility-maximizing individuals, where competitive product and factor markets are cleared by flexible prices and factor returns (Löfgren, Harris, and Robinson 2002). Household demand is based on an LES (linear expenditure system) demand system, while a nested production function structure is employed based on CES (constant elasticity of substitution) aggregation of primary production factors, Leontief aggregation of intermediate inputs, and CES aggregation of composite factor and intermediate goods aggregates. The extreme dichotomy between tradable and nontradable goods, present in the partial equilibrium approach, is softened by assuming varying degrees of tradability on the import (CES specification) and export side (CET [constant elasticity of transformation] specification). This provides a realistic link between world market prices and domestic prices of traded goods.

Our analyses of the GE-ERP measure focuses on key structural determinants, including relative trade shares and intersectoral linkages, and key general equilibrium effects: (a) trade policy–induced exchange rate adjustment, and (b) trade policy– and exchange rate– induced adjustment in relative input costs (the input cost channel) and marketing margins (the marketing cost channel). We evaluate the input cost channel by comparing our GE-ERP measure with a general equilibrium version of the nominal protection rate (GE-NPR) measure, defined in terms of relative output prices. This comparison also allows us to evaluate the sensitivity of our results to the choice of protection measure.
Table 1. Sample Country Data

<table>
<thead>
<tr>
<th>Country</th>
<th>SAM Year</th>
<th># SAM Sectors</th>
<th>Agriculture</th>
<th>Nonagriculture</th>
<th>Factors</th>
<th>Marketing Margins</th>
<th>GNP per Capita (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique</td>
<td>1995</td>
<td>12</td>
<td>27</td>
<td>4</td>
<td></td>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1992</td>
<td>21</td>
<td>34</td>
<td>7</td>
<td>*</td>
<td>3</td>
<td>120</td>
</tr>
<tr>
<td>Malawi</td>
<td>1998</td>
<td>7</td>
<td>26</td>
<td>11*</td>
<td>0</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Zambia</td>
<td>1995</td>
<td>14</td>
<td>14</td>
<td>10*</td>
<td>3</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>1991</td>
<td>24</td>
<td>12</td>
<td>9*</td>
<td>3</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>1997</td>
<td>13</td>
<td>14</td>
<td>5</td>
<td>*</td>
<td>790</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>1995</td>
<td>5</td>
<td>18</td>
<td>23*</td>
<td>3</td>
<td>980</td>
<td></td>
</tr>
<tr>
<td>Morocco</td>
<td>1994</td>
<td>31</td>
<td>10</td>
<td>14*</td>
<td>0</td>
<td>1110</td>
<td></td>
</tr>
<tr>
<td>Tunisia</td>
<td>1996</td>
<td>2</td>
<td>17</td>
<td>4</td>
<td></td>
<td>1820</td>
<td></td>
</tr>
<tr>
<td>Costa Rica</td>
<td>1991</td>
<td>5</td>
<td>17</td>
<td>13</td>
<td>0</td>
<td>2610</td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>1996</td>
<td>57</td>
<td>14</td>
<td>45*</td>
<td>3</td>
<td>3320</td>
<td></td>
</tr>
<tr>
<td>Venezuela</td>
<td>1995</td>
<td>12</td>
<td>40</td>
<td>3</td>
<td></td>
<td>3020</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>1995</td>
<td>36</td>
<td>6</td>
<td>39*</td>
<td>0</td>
<td>3640</td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>1993</td>
<td>13</td>
<td>31</td>
<td>3</td>
<td>0</td>
<td>8030</td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>1990</td>
<td>12</td>
<td>28</td>
<td>3</td>
<td>0</td>
<td>9700</td>
<td></td>
</tr>
</tbody>
</table>


Note: An asterisk (⁎) indicates that land is included as a factor.

Country Models and Data Sets

Our CGE model framework is used to calibrate country-specific models for each of the fifteen sample countries listed in table 1. The applications are necessarily somewhat stylized to achieve comparability, neglecting country-specific institutional details while capturing country-specific differences in economic structure. The country models are calibrated on a sample data set of Social Accounting Matrices (SAM) from the 1990s, which include significant agricultural detail. The SAM data sets differ in terms of (a) the disaggregation of production sectors, (b) the disaggregation of primary factors of production, and (c) the inclusion of marketing costs and home consumption of own production. The differences can be gauged from table 1. All data sets account separately for value added by labor and capital, and nine out of fifteen data sets include land as an agriculture-specific production factor. Nevertheless, capital was disaggregated into agricultural and nonagricultural capital so as to create agriculture-specific production factors in all country models.

Seven of the country data sets account for marketing margins. Marketing margins provide an important example of how intersectoral linkages can affect the determination of agricultural policy bias. On average, domestic nonagricultural marketing costs are relatively low, while nonagricultural marketing costs for imports are relatively high. The structure of marketing margin rates, therefore, tends to provide a relative incentive bias against agricultural production. An increase in the price of marketing services tends to increase industrial protection afforded by relatively high industrial import margin rates and to reduce agricultural protection due to relatively high agricultural domestic margin rates.

Turning to the structure of indirect taxes and tariffs, export taxes are virtually nonexistant, whereas import tariff rates, in most cases, vary between 0% and 25%. Industrial tariff rates are higher than agricultural tariff rates, with a few major exceptions (Korea, Morocco, and Venezuela). Furthermore, tariff rates are in most cases higher than domestic indirect tax rates. Production taxes do not consistently favor any particular sector, while consumption

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3 Country-specific differences in sector aggregation can be used to investigate the sensitivity of our results to model specification. We exploit this feature to analyze the importance of accounting for marketing margins. However, it is not possible to distinguish the impact of variation in production sector and primary factor disaggregation from fundamental differences in country-specific characteristics (table 1). In order to assess the importance of model specification (and the choice of the 1990s as sample period), we extracted SAMs with matching sector and factor disaggregation from the GTAP 7 database (Narayanan and Walmsley 2008) for each of our fifteen sample countries (base year 2004); and after a complete rerun of simulations and sensitivity analyses, we found no qualitative differences from the results presented here.
tax rates in most cases are lower for agricultural goods.

Simulation Results

This section presents simulations to measure historical and experimental variation of protection rates. The measurement of historical protection focuses on eliminating existing indirect tax and tariff structures, while the measurement of experimental protection focuses on imposing standard trade policy distortions, including uniform nonagricultural import tariffs and overvalued exchange rates. All simulations are carried out using a balanced macro closure in which aggregate investment is specified as a fixed share of total absorption. This simple macro closure assumes no major swings in macro aggregates and maintains focus on the key issues of modeling methodology, tradability assumptions, country-specific characteristics, and the choice of protection measure. To keep investment fixed as a share of nominal absorption, household savings rates vary proportionately.

Furthermore, in line with the public finance literature, all simulations are carried out using a revenue-neutral specification of the government budget. In order to fix government revenue, household tax rates vary proportionately. The factor market closure specifies full employment of available factor supplies. Finally, all simulations are carried out using a flexible real exchange rate and fixed foreign savings inflows, except for the experimental exchange rate simulations where a pre-set level of exchange rate appreciation is analyzed. To increase comparability, similar production substitution elasticities (between primary factors: 0.8; between composite factor and intermediate goods aggregates: 0.6) and trade elasticities are imposed on all country models. To increase comparability with historical partial equilibrium studies, we impose a relatively high agricultural trade elasticity (1.8) and a relatively low nonagricultural trade elasticity (0.6).

Historical Variation in Policy Bias during the 1990s

The historical variation of agricultural policy bias is assessed through four simulations, which measure the cumulative impact of eliminating production taxes (TA), consumption taxes (TQ), export taxes (TE), and import tariffs (TM). Results are presented in table 2.

The data in table 2 indicate that trade distortions significantly discriminated against agriculture in only one country (Malawi), were largely neutral in five countries (Argentina, Brazil, Costa Rica, Indonesia, and Zimbabwe), provided a moderate subsidy to agriculture in five countries (Egypt, Mexico, Tanzania, Venezuela, and Zambia), and strongly favored agriculture in four countries (Korea, Morocco, Mozambique, and Tunisia).

Malawi, a small, poor, densely populated country, is the only sample country where indirect taxes and tariffs discriminated significantly against agriculture. Consumption taxes, derived from processed food, account for the major share of domestic indirect tax revenues, and table 2 confirms that consumption taxes represent the main source of bias against agriculture. Furthermore, the effective protection index (GE-ERP = 107.2) is higher than the nominal protection index (GE-NPR = 105.5). Hence, Malawi is the only sample country where the input cost channel works in favor of the non-agricultural sector.

At the other extreme, Morocco is the sample country where indirect taxes and tariffs discriminated most strongly in favor of agriculture. The entire Moroccan tax structure, including production and consumption taxes but especially import tariffs, contributes to improving agricultural price incentives. A highly dispersed tariff structure with high import tariffs on both agricultural imports (e.g., wheat, livestock) and manufactured imports is protecting agricultural production and taxing manufacturing sectors by increasing their input costs. As a consequence, Morocco is also the sample country (together with Korea) where the input cost channel works most strongly in favor of the agricultural sector.

Among the remaining thirteen countries, three groups with broadly similar characteristics can be identified. The first, including Argentina, Brazil, Costa Rica, and Zimbabwe, have indirect tax structures that are relatively neutral with respect to relative price incentives. Argentina and Brazil are upper middle-income countries with developed and

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4 For an extended analysis, including agricultural export taxes, see Jensen, Robinson, and Tarp (2002).

5 Protection indices for Morocco (GE-ERP = 78.4; GE-NPR = 92.6) and Korea (GE-ERP = 82.2; GE-NPR = 93.4) indicate that the input cost structure strongly reinforces agricultural protection in these countries.
Table 2. Relative Agricultural Protection (GE-ERP) in the 1990s (empirical indirect tax simulations)

<table>
<thead>
<tr>
<th></th>
<th>Base Run (INDEX)</th>
<th>Sim. 1 (TA)</th>
<th>Sim. 2 (TQ)</th>
<th>Sim. 3 (TE)</th>
<th>Sim. 4 (TM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malawi</td>
<td>100.0</td>
<td>100.0</td>
<td>106.3</td>
<td>106.5</td>
<td>107.2</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>100.0</td>
<td>99.2</td>
<td>99.2</td>
<td>99.2</td>
<td>104.2</td>
</tr>
<tr>
<td>Argentina</td>
<td>100.0</td>
<td>99.6</td>
<td>98.8</td>
<td>98.8</td>
<td>102.0</td>
</tr>
<tr>
<td>Brazil</td>
<td>100.0</td>
<td>97.0</td>
<td>97.0</td>
<td>97.0</td>
<td>98.0</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>100.0</td>
<td>97.7</td>
<td>96.0</td>
<td>91.2</td>
<td>96.6</td>
</tr>
<tr>
<td>Mexico</td>
<td>100.0</td>
<td>95.4</td>
<td>94.4</td>
<td>94.4</td>
<td>94.3</td>
</tr>
<tr>
<td>Indonesia</td>
<td>100.0</td>
<td>100.0</td>
<td>98.9</td>
<td>98.9</td>
<td>97.0</td>
</tr>
<tr>
<td>Tanzania</td>
<td>100.0</td>
<td>97.5</td>
<td>94.3</td>
<td>94.3</td>
<td>92.6</td>
</tr>
<tr>
<td>Zambia</td>
<td>100.0</td>
<td>96.5</td>
<td>94.5</td>
<td>94.5</td>
<td>92.4</td>
</tr>
<tr>
<td>Mozambique</td>
<td>100.0</td>
<td>99.7</td>
<td>92.1</td>
<td>92.1</td>
<td>88.0</td>
</tr>
<tr>
<td>Egypt</td>
<td>100.0</td>
<td>99.1</td>
<td>95.5</td>
<td>95.5</td>
<td>91.6</td>
</tr>
<tr>
<td>Venezuela</td>
<td>100.0</td>
<td>98.9</td>
<td>93.6</td>
<td>93.6</td>
<td>90.9</td>
</tr>
<tr>
<td>Tunisia</td>
<td>100.0</td>
<td>99.7</td>
<td>93.2</td>
<td>93.2</td>
<td>89.1</td>
</tr>
<tr>
<td>Korea</td>
<td>100.0</td>
<td>84.7</td>
<td>84.7</td>
<td>84.7</td>
<td>82.2</td>
</tr>
<tr>
<td>Morocco</td>
<td>100.0</td>
<td>93.9</td>
<td>90.7</td>
<td>90.7</td>
<td>78.4</td>
</tr>
</tbody>
</table>

Note: The elimination of indirect taxes is measured additively. Simulation 1 represents the elimination of taxes on production (TA), while Simulation 4 represents the elimination of all taxes on production (TA), consumption (TQ), exports (TE), and imports (TM).

competitive agricultural sectors, specialized in livestock and cash crops, while Zimbabwe and Costa Rica have competitive agricultural export sectors based on large-scale commercial farming, specialized in the production of cash crops. In general, domestic indirect taxes tend to support relative agricultural price incentives, while import tariffs protect nonagricultural production in this group of countries. Brazil represents a special case. The effective protection index (GE-ERP = 98.0) and the nominal index (GE-NPR = 105.4) suggest different signs for the policy-induced price incentive bias. This demonstrates that the input cost channel plays a key role in measuring the size—and potentially the sign—of policy-induced price incentive bias, and highlights that the choice of protection measure is critical.

The second group consists of Indonesia and three southern African countries: Mozambique, Tanzania, and Zambia. They can be characterized as low-income countries with relatively large and underdeveloped agricultural sectors. Trade in agricultural goods is generally low. Consequently, taxation of nonagricultural production and imports is the only viable means of raising indirect tax revenue. Since agricultural production technologies are very rudimentary, while nonagricultural production technologies are more input intensive, this tends to lower nonagricultural price incentives by increasing intermediate input costs. Table 2 shows that the tax structure discriminates against nonagricultural production at all levels. The implicit level of agricultural protection ranges from 3% in Indonesia, to 7–12% in the three southern African countries.

Like Morocco, the countries in the third group—Egypt, Venezuela, Tunisia, and Korea—are characterized by relatively small agricultural sectors. In order to maintain some level of self-sufficiency, tax structures favor agricultural production. While Morocco relies strongly on agricultural import tariffs (e.g., to protect production of soft wheat), Korea relies more heavily on domestic differences between nonagricultural taxation and agricultural subsidization (e.g., to protect production of rice). The overall level of agricultural protection varies from 9% in Venezuela and 18% in Korea to between 8% and 32% in the northern African group of countries. Finally, Mexico stands out as an open economy with a relatively balanced trade account. In line with Korea, the main policy bias arises from domestic differences between nonagricultural taxes and (small) agricultural subsidies, resulting in a relative level of agricultural price support of 6%.

Overall, there are few signs of indirect tax and tariff policy–induced agricultural bias among our sample countries. This indicates that the historical trade policy bias against agriculture was largely eliminated during the
Experimental Variation in Policy Bias

In this subsection, we measure the experimental variation in policy bias by imposing standard trade distortions, including a uniform 25% nonagricultural import tariff and a 10% exchange rate appreciation, on distortion-free base economies, derived through the elimination of indirect taxes and current account imbalances from individual country models. The counterfactual measurement of policy bias, on the basis of distortion-free base economies, is important, since it allows for the elimination of sample variation in trade distortions. Accordingly, this allows us to focus on the importance of country-specific characteristics for the determination of the GE-ERP policy bias measure.

Nonagricultural import tariffs

Figure 1 presents results from imposing a uniform 25% tariff on nonagricultural imports. On balance, the GE-ERP measure of agricultural protection increases. The individual country impact varies between 15% agricultural protection (Tunisia) and 13% nonagricultural protection (Costa Rica). Two main groups of countries may be identified. The first (Argentina, Costa Rica, Malawi, and Zimbabwe) consists of countries with high relative agricultural trade shares where agricultural protection declines. The second (Egypt, Indonesia, Korea, Mozambique, Tanzania, Tunisia, Venezuela, and Zambia) consists of countries with low relative agricultural trade shares where agricultural protection increases. Three countries (Brazil, Mexico, and Morocco) fall outside the two main groups.

The results show that the GE-ERP impact is negatively related to the relative agricultural trade share. This relationship points to the importance of accompanying tariff-induced exchange rate appreciation, which tends to worsen relative price incentives for the types of goods that are traded most intensively. The real exchange rate appreciates by 4–10% in all cases, but leads to an average 7.1% decline (5.6% increase) in effective agricultural protection in the group with high (low) relative

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6 The analysis of exchange rate overvaluation depends on the specification of a sustainable current account deficit. Regardless of the choice of sustainable upper bound for the external deficit, most countries in our sample show no signs of agricultural bias in the 1990s.

7 In the derivation of the distortion-free base economies, the elimination of indirect taxes was accompanied by a revenue-neutral uniform increase in household tax rates.

8 The relative agricultural trade share is defined as the ratio of agricultural versus nonagricultural trade shares. A trade share ratio greater than one indicates that the initial trade share in agriculture (agricultural imports plus agricultural exports divided by agricultural GDP) is higher than in nonagriculture.
agricultural trade shares. These results indicate that general equilibrium effects, in the form of tariff-induced exchange rate adjustment, play a crucial role in measuring the size and sign of the trade policy bias.

Furthermore, a comparison of the GE-ERP and GE-NPR results in figures 1 and 2 highlights the importance of the input cost channel. In most cases, the GE-NPR measure underestimates effective agricultural protection among countries with low relative agricultural trade shares (average GE-NPR = 101.5; average GE-ERP = 105.6), while it underestimates effective nonagricultural protection among countries with high relative agricultural trade shares (average GE-NPR = 95.0; average GE-ERP = 92.9). On average, the input cost channel accounts for 4.1 percentage points (or 73%) of effective agricultural protection among countries with low relative agricultural trade shares, and 2.1 percentage points (or 29%) of effective nonagricultural protection among countries with high relative agricultural trade shares.

The results also demonstrate the importance of the marketing cost channel. Marketing costs are accounted for in seven country models. The price of marketing services declines in all cases (due to reduced demand for transportation of traded goods), and as explained above, this trend to increase relative agricultural price incentives. The results indicate that the three countries with the largest increase in effective agricultural protection—Indonesia, Mozambique, and Tunisia—experience an average 7.9% decline in marketing costs.

Overall, the results demonstrate the key importance of accounting for country-specific characteristics and general equilibrium effects when measuring the relative size and sign of tariff-induced policy bias. This has important implications. The existence of large general equilibrium effects and the importance of intersectoral linkages mean that it is crucial to use the GE-ERP measure in the evaluation of agricultural policy bias. The GE-NPR measure (as well as the classical ERP and NPR measures based on partial equilibrium analysis) does not provide a satisfactory measure of relative agricultural price incentives.

**Exchange rate overvaluation**

Figure 3 presents the results of a 10% real exchange rate appreciation and shows that there exists a strong negative relationship between the GE-ERP impact and the relative agricultural trade share. This confirms the importance of tariff-induced exchange rate appreciation in the previous analyses. Again, two groups of countries may be identified. The first (Argentina, Costa Rica, Malawi, Mexico, and Zimbabwe) consists of countries with high relative agricultural trade shares where agricultural protection declines. The second (Egypt, Korea, Indonesia, Tanzania, Tunisia, and Venezuela) consists of countries with low relative agricultural trade shares where agricultural protection increases. Four countries (Brazil, Morocco, Mozambique, and Zambia) fall outside the two main groups.

A comparison of the GE-ERP and GE-NPR results in figures 3 and 4 indicates that...
the GE-NPR measure, in line with the import tariff simulations, tends to underestimate effective nonagricultural protection among countries with high relative agricultural trade shares (average GE-NPR = 90.4; average GE-ERP = 84.2). However, in contrast to the import tariff simulations, the GE-NPR measure tends to be fairly accurate when it comes to effective agricultural protection among countries with low relative agricultural trade shares (average GE-NPR = 102.7; average GE-ERP = 103.0). The input cost channel is important mainly among countries where agricultural (export) trade shares are relatively high and agricultural production makes intensive use of nonagricultural production inputs.

The results of the exchange rate simulations put further perspective on the transmission of nonagricultural tariffs to the domestic price system. The results indicate that exchange rate appreciation—whether imposed exogenously or induced by other trade policies—works mainly through its impact on nominal protection, in favor of goods sectors with low relative trade shares. The main exception (in the current sample) consists of countries...
Table 3. Statistics of GE-ERP Measure Due to Monte Carlo Simulations (25% nonagricultural import tariff experiment)

<table>
<thead>
<tr>
<th>Country</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costa Rica</td>
<td>85.4</td>
<td>84.3</td>
<td>87.4</td>
<td>0.76</td>
</tr>
<tr>
<td>Argentina</td>
<td>91.2</td>
<td>89.3</td>
<td>94.3</td>
<td>1.37</td>
</tr>
<tr>
<td>Malawi</td>
<td>94.6</td>
<td>93.6</td>
<td>96.3</td>
<td>0.71</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>94.9</td>
<td>93.8</td>
<td>96.3</td>
<td>0.61</td>
</tr>
<tr>
<td>Brazil</td>
<td>95.5</td>
<td>94.3</td>
<td>96.6</td>
<td>0.53</td>
</tr>
<tr>
<td>Morocco</td>
<td>100.1</td>
<td>97.2</td>
<td>104.1</td>
<td>1.55</td>
</tr>
<tr>
<td>Mexico</td>
<td>100.4</td>
<td>99.9</td>
<td>101.5</td>
<td>0.34</td>
</tr>
<tr>
<td>Zambia</td>
<td>100.6</td>
<td>99.7</td>
<td>102.1</td>
<td>0.60</td>
</tr>
<tr>
<td>Venezuela</td>
<td>104.2</td>
<td>102.4</td>
<td>106.0</td>
<td>0.75</td>
</tr>
<tr>
<td>Tanzania</td>
<td>104.7</td>
<td>103.7</td>
<td>106.3</td>
<td>0.53</td>
</tr>
<tr>
<td>Korea</td>
<td>105.4</td>
<td>104.8</td>
<td>106.5</td>
<td>0.37</td>
</tr>
<tr>
<td>Egypt</td>
<td>105.9</td>
<td>104.5</td>
<td>107.2</td>
<td>0.69</td>
</tr>
<tr>
<td>Indonesia</td>
<td>107.0</td>
<td>105.2</td>
<td>109.7</td>
<td>0.98</td>
</tr>
<tr>
<td>Mozambique</td>
<td>112.9</td>
<td>111.6</td>
<td>114.2</td>
<td>0.71</td>
</tr>
<tr>
<td>Tunisia</td>
<td>116.6</td>
<td>114.3</td>
<td>119.3</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Note: The sensitivity analysis was based on 1,000 simulations for each single-country model. All simulations were measured relative to a distortion-free base run, which included the elimination of indirect taxes and current account deficits and surpluses. Uniform agricultural and nonagricultural trade elasticities were in each case drawn from a uniform distribution with a basis of [0.5; 2.0]. The only exception was Venezuela, where strong trade adjustment in the derivation of the base run (due to a large initial current account imbalance) meant that uniform nonagricultural trade elasticities had to be drawn with a basis of [0.6; 2.0].

Monte Carlo Simulations

The experimental simulations indicate that nonagricultural tariffs and exchange rate overvaluation may reduce or increase agricultural protection rates, depending on whether relative agricultural trade shares are greater or smaller than one. Due to the assumption of imperfect tradability, the results could potentially depend on the choice of relative trade elasticities. We therefore undertake a set of robustness checks to investigate how the choice of trade elasticities affects the sign and size of the impact of trade policies on the GE-ERP measure. Results are reported for the nonagricultural import tariff experiments.9

Following Abler, Rodriguez, and Shortle (1999), we employ a Monte Carlo procedure to investigate the sensitivity of our GE-ERP results with respect to variations in trade elasticities. The procedure was based on 1,000 sets of independent draws of uniform agricultural and nonagricultural trade elasticities from a rectangular distribution over the interval [0.5; 2.0].10 The number of independent draws ensures that for each sample country, the average point estimate has a precision of 0.1 percentage points at the 95% confidence level.11 Each set of trade elasticities consists of one uniform agricultural trade elasticity and one uniform nonagricultural trade elasticity. Moreover, for each set of trade elasticities, the country model in focus was recalibrated and subjected to the uniform 25% nonagricultural import tariff experiment. Statistics of the results for the fifteen sample countries are given in table 3.

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9 Monte Carlo simulations for the exchange rate experiments gave, qualitatively, similar results.
10 Low and high trade elasticity values of 0.5 and 2.0 are standard choices in the literature (Dawkins, Srinivasan, and Whalley 2001).
11 The number of independent draws needed to achieve a precision of 0.1 percentage points for the average point estimate varied between 45 draws in the case of Mexico and 919 draws in the case of Morocco.
The average GE-ERP protection rates vary between 85.4 (Costa Rica) and 116.6 (Tunisia). Ten countries have point estimates above 100, while five countries have point estimates below 100. This mirrors our previous results, where nonagricultural import tariffs gave rise to agricultural protection in nine countries and nonagricultural protection in six countries. Moreover, the variability of the protection rates indicates that nonagricultural import tariffs may lead to anything between 16% nonagricultural protection (Costa Rica) and 19% agricultural protection (Tunisia). Again, this mirrors our previous results, where tariff-induced policy bias varied between 13% nonagricultural protection (Costa Rica) and 15% agricultural protection (Tunisia).

The results from the Monte Carlo procedure confirm that our conclusions are robust to variation in relative trade elasticities. Average GE-ERP point estimates vary strongly among sample countries. This confirms that country-specific characteristics—including relative trade shares and intersectoral linkages—play a crucial role in determining the size and sign of price incentive bias induced by trade policy. Furthermore, the sign of country-specific point estimates is independent of the variation in trade elasticities in all but a few cases. Sign variation occurs for only three countries (Morocco, Mexico, and Zambia), and size variation typically lies within a 3–5 percentage point range. This indicates that trade elasticities have only a minor impact on the size of relative price effects and that country-specific analyses are likely to provide reliable point estimates even when uncertainty surrounds relative trade elasticity estimates.

Conclusion

Measurement is a key issue in the literature on trade policy–induced agricultural price incentive bias. Historically, World Bank projects have used a partial equilibrium approach to measure relative agricultural vs. nonagricultural NPRs. At the same time, World Bank researchers acknowledge that it is more appropriate to use ERP measures (Krueger, Schiff, and Valdes 1988) and that it is important to capture the general equilibrium effects of trade distortions (Anderson et al. 2008). We combine these ideas in our general equilibrium approach to measuring agricultural policy bias and develop a general equilibrium version of the relative ERP measure (GE-ERP), which translates general equilibrium quantity effects into price effects and thereby provides a comprehensive measure of relative agricultural price incentives induced by trade policy.

Based on a sample SAM data set from the 1990s (and the 2000s), we calibrated fifteen country models to undertake historical and experimental simulations. Our historical simulations support the view that agricultural price incentive bias was largely eliminated during the 1990s, while our experimental simulations show that traditional trade policies affect relative price incentives in strongly divergent directions. Country-specific characteristics—including relative trade shares and intersectoral linkages—are crucial for determining the sign and magnitude of the policy bias. Hence, there are no simple rules of thumb. Country-specific analysis of trade policy bias is a necessity. A Monte Carlo procedure confirms that our conclusions are robust to underlying tradability assumptions. Hence, country-specific analyses are likely to provide reliable point estimates, even when uncertainty surrounds relative trade elasticity estimates.

Finally, our analyses demonstrate that the choice of protection measure is crucial. The GE-NPR nominal protection measure (as well as the classical ERP and NPR measures based on partial equilibrium analysis) does not fully capture the protective impact of traditional trade policies, since general equilibrium price effects—transmitted through input and marketing cost structures—account for a large part of the policy bias. Instead, proper measurement of the price incentive bias requires use of the GE-ERP measure.

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