

Alternative Macroeconomic Closures in Baseline Projections – Implications for Macro Outcomes and Sectoral Structure

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Abstract

This paper compares baseline projections for Italy over 2015-2044 in the recursive dynamic GTAP-RD model framework under three alternative macroeconomic closures: the trade balance adjusts as global investment flows to regions with the highest expected rates of return to capital, the trade balance adjusts as regions receive a fixed share of the global supply of savings, and the regional savings rate adjusts to maintain a fixed balance of trade as global investment flows shift. The macro behaviors that bring regional savings and investment into equilibrium in each closure are fundamentally different, and result in pronounced differences in macroeconomic baseline projection paths — either a rising capital account deficit, a falling capital account deficit, or a stable capital account balance with a change in the savings rate and a shift in the composition of aggregate demand. These outcomes have implications for sectoral structure, as a capital account deficit/trade surplus favors production of tradables, a capital account surplus/trade deficit favors the production of nontradables, and a fixed balance of trade favors more balanced sectoral growth. One of the main triggers for the differences in baseline outcomes across closures is that Italy is a slow-growing economy relative to the rest of the world.

1. Introduction

Macroeconomic closure in a computable general equilibrium (CGE) model describes how aggregate savings and aggregate investment are brought to equality following a shock, in the absence of financial markets or monetary signals such as interest rates. The modeler’s decision about which macro variable adjusts to equilibrate them is an important one because, as is well-known, the closure rule imposes a macro adjustment process that affects

model outcomes in significant ways. Furthermore, the differences in outcomes under alternative macro closures are likely to be more pronounced in recursive dynamic frameworks than in static models, because dynamic frameworks describe economic growth paths and the accumulation of savings and allocation of investment over long time periods. As recursive dynamic CGE models become more widely used, an empirical examination of the choice of macro closure rules within that framework seems timely.

The literature on macro closure begins with Sen (1963), who described the problem of how to equilibrate aggregate savings and aggregate investment in a general equilibrium framework without the system becoming over-determined. Sen explored alternative choices of equilibrating variables to accommodate a savings-investment equality constraint. A broad literature subsequently addressed the macro closure problem and the choice of macro closure rule, including Decaluwe et al., 1987; Dewatripont and Michel, 1987; Hertel and Tsigas, 1997; Robinson, 2006; and Bekkers, et al., 2020. Much of the CGE literature on macro closure has focused on examining the impacts of closure choices on macro variables, including the capital and current account balances and the terms of trade. Less attention has been given to the implications of alternative closure rules for sectoral structure.

In this paper, we compare the effects of alternative macro closure rules on both macro and sectoral outcomes in a baseline projection in a dynamic framework. We use the GTAP-Recursive Dynamic (GTAP-RD) model framework, a multi-region, multi-sector recursive dynamic CGE model (Aguiar, Corong, and Mensbrugghe, 2019). We apply and compare three different, commonly-used macro closure rules in that model in our development of a model baseline projection over 2015–2044. We examine the baseline projections for Italy as a case study.

The paper is organized as follows: Section 2 provides a brief introduction to the savings and investment behavior in the GTAP-RD model, explains the three different macro closure rules and describes the inputs into the baseline projection. Section 3 describes the baseline projection paths and discusses and compares macroeconomic and sectoral results for Italy

under the three different macro closure rules. Section 4 concludes the paper. An Appendix contrasts results for slow- and fast-growing regions.

2. Savings-Investment and Macro Closure in the GTAP-RD Model

Both the static and dynamic versions of the GTAP model describe aggregate savings and investment behavior in a similar way. Regions' savings are a share of regional income, and are aggregated into a global pool of savings.¹ Global savings are then invested across regions, with the allocation of regional investment being determined by the choice of a macro closure rule. The constraint that savings is equal to investment is therefore imposed at the global rather than regional level, a model feature that distinguishes CGE models in the GTAP tradition. In the static model, global capital flows have no effect on regional capital stocks or current productive capacity. The dynamic version of the GTAP model (GTAP-RD) is a series of single-period models, in which the investment accumulated in a region during a single period is added to its capital stock in the next period, minus depreciation.

Three closures are commonly used in the GTAP-RD model (table 1). The first is the default macro closure in the GTAP model. Savings, which are an aggregate of private household and government savings, are a fixed share of regional income. Regional savings are aggregated into the global supply of savings, which are invested across regions until percentage changes in expected regional rates of returns (RORE) on capital are equalized.

Expected rates of return to capital are determined in part by the net current rate of return to capital. The net current rate is the current capital rent, adjusted downward as the replacement cost of fixed capital investment goods or the depreciation rate rises. The expected rate of return rises when the current net rate of return increases. The expected return falls as the regional capital endowment increases and its marginal product falls, a

¹ Regional income is calculated as GDP minus depreciation.

negative relationship that is defined by an elasticity parameter (RORFLEX) in the GTAP model.

In the RORE closure, the value of investment inflows to a region can differ from the savings that the region transfers to the global bank, changing its capital account balance. The current account adjusts to changes in a region's capital account as global investment flows shift; the trade balance is therefore endogenous in the RORE closure. We can express this relationship in terms of the accounting identity $S - I = X - M$, which describes a region's capital account on the left side, and its current account on the right side. When a region's investment exceeds its regional savings, the region has a capital account surplus and a current account deficit, where the value of its imports exceeds its exports. When regional investment falls relative to regional savings, it has a capital account deficit and a trade surplus. Economies that are relatively fast-growing will have relatively high capital rents, which attract global capital and increase regional investment. Because regional savings are a fixed share of regional income, fast-growing economies also have relatively fast growth in savings. Slower-growing economies will tend to have relatively low capital returns and capital outflows, as well as slow growth in savings. Whether these economies run a capital account surplus or deficit depends on whether growth in regional savings surpasses the growth in regional investment. Over time, capital-deepening in faster growth economies and their declining marginal product of capital will tend to cause global capital to shift toward slower growth and relatively capital-scarce regions, so that slow-growth regions eventually run a capital account surplus and a trade deficit.

The second, commonly-used macro closure in the GTAP model assumes that regions maintain a fixed share of global investment funds (FIXSHR). As in the RORE closure, global investment is savings-driven and the regional balance of trade is endogenous. Regional savings are a fixed share of regional income that flow to the global bank. Changes in the global supply of savings then leads to changes of the same proportion in investment flows

into every region.² In this closure, there is no role in the global allocation for investors' expectations about regional returns to capital. Over a baseline projection period, when incomes can change by relatively large magnitudes, and regional variation in income growth can be significant, growth in regional savings can be substantial and may differ across regions by a lot. Because growth in regions' investment all change by the same proportion, this closure can lead to relatively large changes in capital account balances, with accompanying changes in trade balances. Faster-growth regions will tend to have higher growth in their savings relative to their investment inflows, causing a capital account deficit and a current account surplus, whereas slower-growth regions will tend to have a capital inflow and a trade deficit.

Table 1. Alternative macroeconomic closures in the GTAP-RD framework					
Name of Closure	Regional Savings	Global investment flows	Trade balance	Closure swap statement	RORDELTA
RORE rate of expected return	Fixed regional savings rates	Global investment flows equalize % changes in expected regional rates of return	Adjusts to clear regional savings— investment gap	None	1
FIXSHR fixed regional allocation shares	Fixed regional savings rates	Fixed regional shares of global savings	Adjusts to clear regional savings— investment gap	None	0
DPSAVE savings rate adjusts	Regional savings rates adjust to accommodate fixed trade balance	Global investment flows equalize % changes in expected regional rates of return	Fixed relative to global income	Swap del_tbalry _r = dpsave _r for n-1 regions	1
Notes: Del_tbalry is the change in trade balance of region r as a percentage of global income; dpsave is the savings rate parameter for region r in the regional household per capita utility function; parameter RORDELTA is a flag that turns on (1) or off (0), reflecting the response of capital flows to regional variation in the percentage changes in expected capital returns.					

² Under the FIXSHR closure, regional and global investment move together. For instance, if global savings increases by 10 percent, then investment in Italy and all other regions increases by 10 percent, whereas Italy's supply of domestic savings grows at the same rate as its GDP.

The third macro closure in the GTAP-RD model (DPSAVE) fixes the trade balance relative to global income. It is fixed as a ratio rather than fixed in nominal terms, thereby allowing current account balances in the initial period to grow at the same pace as the world economy. Fixing the current account ratio also fixes the capital account ratio. As in the RORE closure, global investment flows are allocated across regions until percentage changes in expected regional rates of returns are equalized. In our accounting identity, the fixed trade balance on the right side of the equation is equilibrated by the change in regional savings on the left side of the equation. It is an investment-driven closure at the regional level, in which the regional savings rate must change to accommodate changes in the region's investment flow. For example, a fast-growing region will attract global capital. If growth in its investment is greater than growth in its savings at the initial savings rate, creating pressures to run a trade deficit, its savings rate must rise and consumption fall. Slower growth in domestic consumption will slow the growth in demand for imports and accelerate the supply of exports, maintaining the initial trade balance ratio. If a slow-growing country has a capital outflow, creating pressure to move toward a trade surplus, its savings rate will tend to fall and its consumption rise to equilibrate its fixed trade balance ratio. Note that in the GTAP model, public and private savings are aggregated, so that a change in the savings rate affects private household and government consumption by the same proportion.

This paper uses the GTAP-RD model, with a base year of 2014. The model has 13 regions, 65 production activities and 65 commodities.³ The baseline projection is run from 2014 to 2044 and includes projections for growth in real GDP, population, and the skilled and unskilled labor supply for all regions.⁴ The baseline projection information comes from the SSP2 projections of the Shared Social-Economic Pathways (SSP) database. The baseline projection is run under the three macroeconomic closures.

³ The 13 regions are Oceania, East Asia, Italy, France, Spain, Rest of EU-25, Southeast Asia, South Asia, North America, Latin America, MENA, SSA and Rest of the World.

⁴ In the baseline projections, we make the GDP per capita exogenous, and make the variable reflecting labor productivity endogenous, in order to project the growth of GDP per capita in every region.

Our discussion of results is focused on Italy, as a case study. We explore differences in both macroeconomic and sectoral results in Italy across the three macro closures. We organize our discussion of sectoral results by categorizing and grouping sectors based on their tradability and capital intensity. These characteristics are the most likely to affect sectors’ sensitivity to changes in global capital flows and the balance of trade, and the sectoral groupings facilitate our analysis and discussion.

3. Baseline Projection Results

Results for Macro Variables

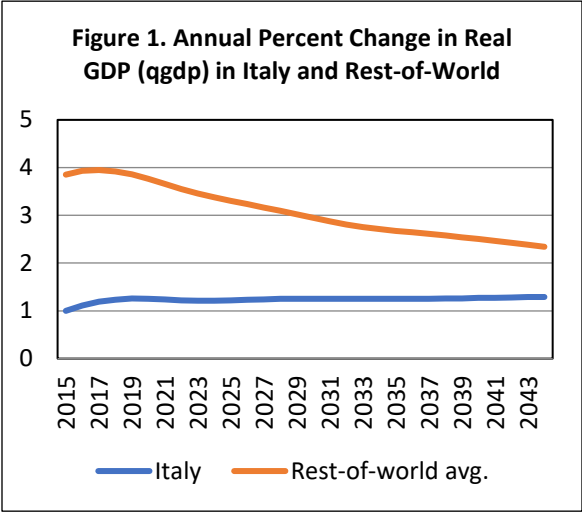


Figure 1 shows the baseline projection results for the annual percentage changes in the real GDP of Italy, compared to the rest-of-world average, from 2015 to 2044.⁵ The results for annual percent changes in real GDP for both Italy and the rest-of-world are identical across the three macroeconomic closures.⁶ This is because projections for growth in real GDP per capita and population in every region are both baseline projection shocks, and are

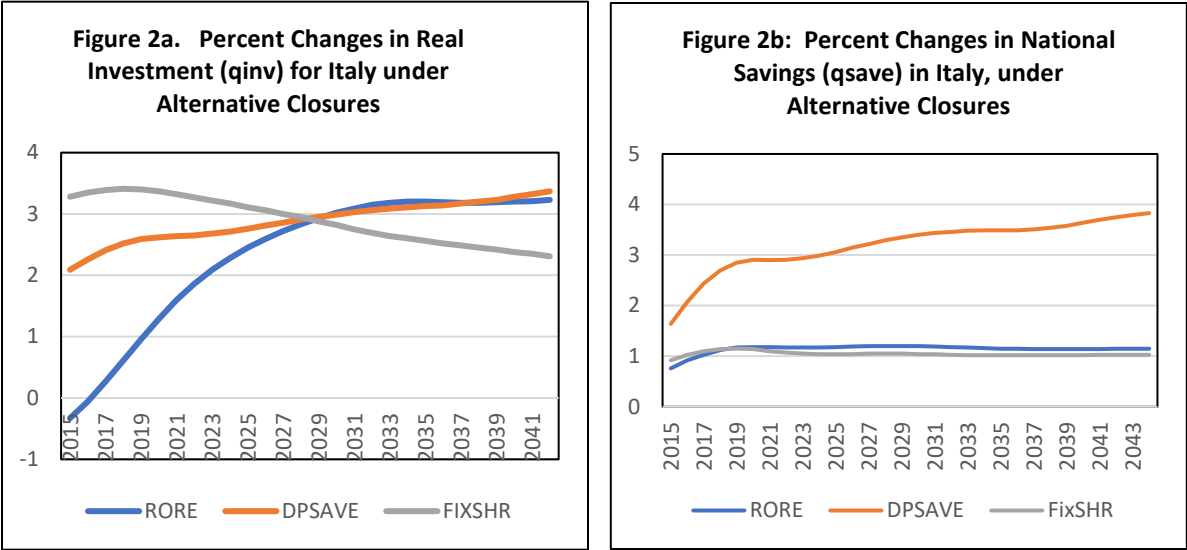
therefore exogenously determined in the model. As can be seen in figure 1, Italy’s economy is projected to grow at a much slower rate compared to the rest of the world from 2015 to 2044.

The flow of global savings into Italy determines the level of regional investment spending. The RORE and FIXSHR closures describe opposite outcomes for capital flows and real investment in the early projection period (figure 2a). In the RORE closure, Italy’s relatively

⁵ The rest-of-world average real GDP growth rate is calculated from the baseline projection results as the simple average of real GDP growth of every region except Italy.

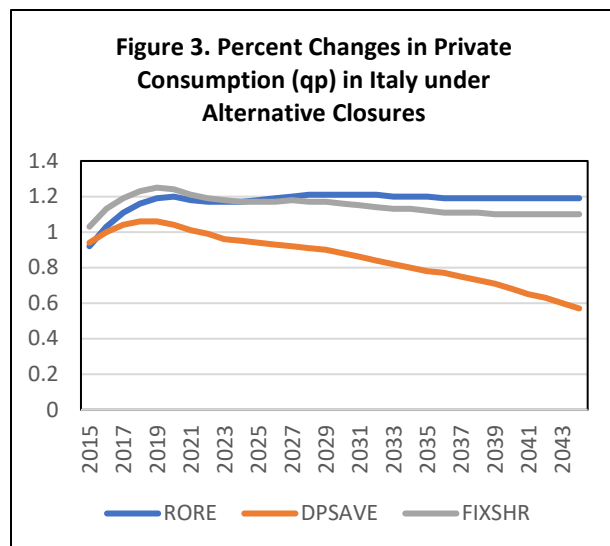
⁶ Figure 1 shows the baseline projection results under the RORE closure. The results for changes in real GDP are the same under the FIXSHR closure and the DPSAVE closure.

slow GDP growth initially results in relatively low returns to capital and a capital outflow. Investment spending is therefore lowest among the closures, declining 0.3 percent in 2015. The early contraction in Italy’s investment spending under the RORE closure is followed by very strong growth later in the baseline projection. Italy’s capital outflow diminishes over time, and its capital account deficit eventually reverses into a capital account surplus, as the gap between Italy’s and the rest-of-world’s GDP growth rates narrows and capital deepening in the rest of the world lowers growth in their returns to capital relative to Italy.



In the FIXSHR closure, the percent change in Italy’s real investment tracks the percent change in the global supply of savings over time. Because growth in Italy’s GDP and savings are relatively low, it receives an outsized share of global investment, and has the highest rate of growth in investment spending among the closures in the early period of the baseline. As growth in world GDP and the global supply of savings slow over time, Italy’s capital inflow and capital account surplus diminish. This leads to the slowest growth in its real investment relative to other closures. Changes in domestic savings are approximately the same under the two closures given the fixed savings rate and identical growth in GDP (figure 2b).

The DPSAVE closure is in the middle — investment in Italy increases by 2.1 percent in 2015. However, it does converge with the result under the RORE closure by about 2044, when



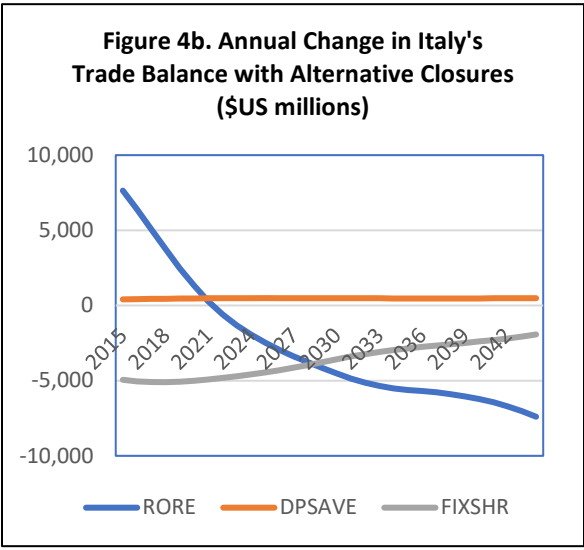
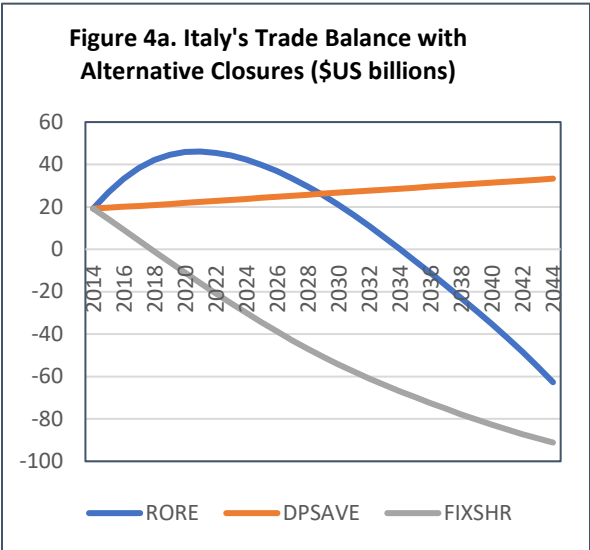
Italy's investment grows by 3.3 percent under the RORE closure, and 3.4 percent under the DPSAVE closure. As in the RORE closure, the global investment allocation in the DPSAVE closure follows the rate of return approach, equalizing regional expected rates of return. The increase in Italy's investment under this closure is higher than under the RORE closure in the early projection period. This is because

Italy's small, fixed trade surplus imposes a smaller capital outflow than under the RORE closure. Moreover, the savings rates in most regions rise in the early projection period in order to maintain their fixed trade balance ratios, resulting in a higher global supply of savings and therefore a lower outflow from Italy in the DPSAVE than in the RORE closure. With its trade balance ratio fixed at its initial surplus, Italy's savings must increase over time as global capital-deepening makes it more attractive to global investment flows. Its savings rate rises over the baseline period, although more slowly than in high growth regions. Italy's higher savings rate slows the growth in its consumption and demand for imports, and contributes to growth in export supply, thereby maintaining the fixed trade balance ratio (figure 3).

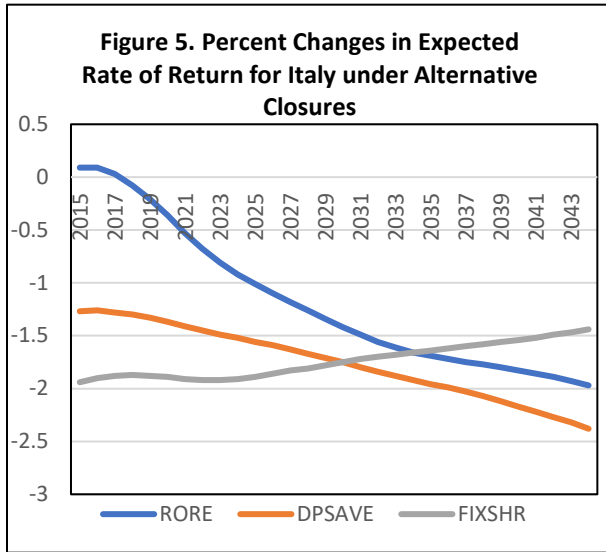
Changes in Italy's current account (X-M) mirror the changes in its capital account (S-I) account. Figure 4a shows the trade balance in Italy during 2014-2044 under the three closures. Figure 4b shows the annual change in Italy's trade balance during that period. Similar to the capital account, changes in the trade balance initially move in opposite directions under the RORE and FIXSHR closures. In the historical baseline statistics, Italy runs a trade surplus of \$19.2 billion in 2014. Under the RORE closure, Italy's trade surplus increases by 7.6 billion, to 26.8 billion in 2015, the first year of the projection period, due to its capital outflow. Its trade surplus continues to grow until 2021, when it begins to decline and eventually becomes a steadily growing trade deficit after 2034, as capital-deepening in

the rest-of-world makes investment in Italy relatively more attractive. Under the FIXSHR closure, Italy’s trade surplus in 2014 declines beginning in 2015 due to its capital inflow, with a trade deficit by 2018. The deficit continues to grow at a diminishing rate over the baseline projection period as growth in the global pool of savings slows.

Under the DPSAVE closure, the trade balance in every region (minus 1 region) is fixed as a share of world income. Therefore, Italy continues to have the same trade surplus over the baseline that was observed in 2014, adjusted for the growth in world income.



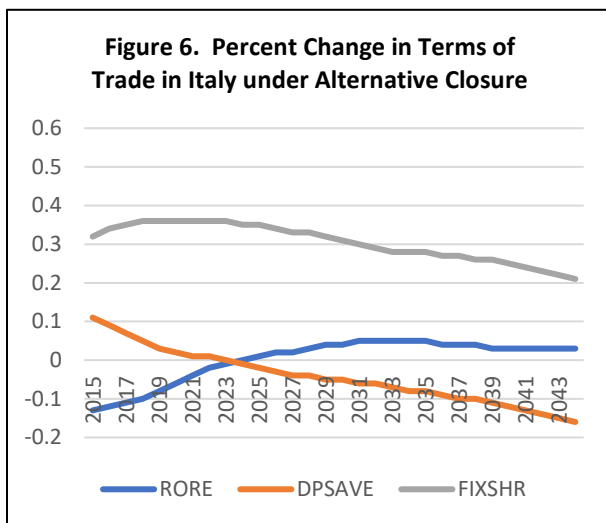
Changes in the supply of capital affect the marginal product of capital, which declines as the capital stock grows, and in turn affects the expected rate of return. In the RORE closure, the percent changes in expected returns to capital are equalized across countries, so the RORE in Italy reflects global economic conditions. The changes in Italy’s expected returns to capital are initially positive, declining gradually as global incomes and savings increase and lead to global capital-deepening and falling global capital returns (figure 5). The slow economic growth in Italy would otherwise reduce the relative returns to capital in that region, so the equalization of expected returns in the RORE closure leads to its initial capital outflow and trade surplus.



The expected rate of return has no influence on global capital flows in the FIXSHR closure so it may diverge across regions. In the FIXSHR closure, the outsized inflow of global capital increases Italy's capital stock, causing the fastest decline in expected returns among the closures. This decline slows over time as Italy's GDP growth rate moves closer to the world average and the disproportion in its capital

inflow diminishes.

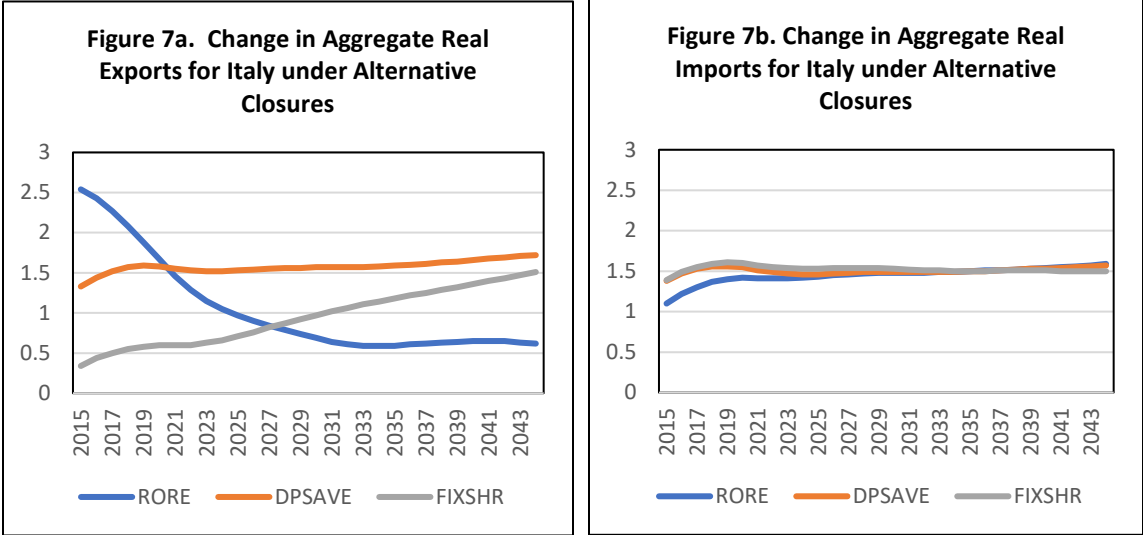
Under the DPSAVE closure, the percent changes in the expected rates of return are equalized across regions, but the global rate of return falls faster than in the RORE closure. This is because savings rates rise faster in fast-growing countries than in slow-growth regions such as Italy early in the baseline projection period. Increased global savings leads to higher global capital stocks over time in the DPSAVE closure compared to the RORE closure.



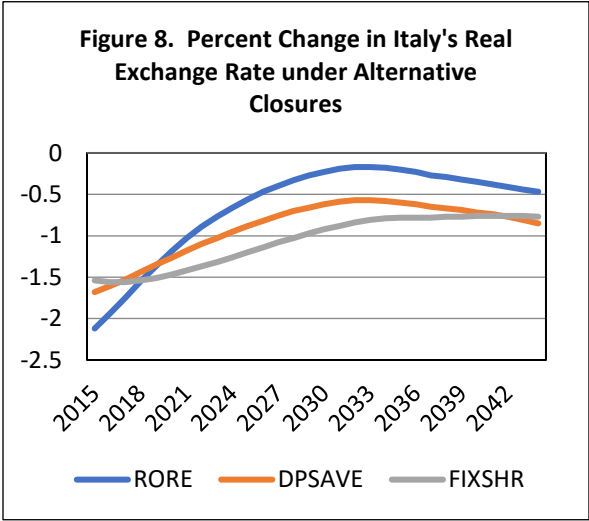
Terms of trade, the relative prices of exports and imports, provide the price signals that equilibrate the balance of trade. Under the RORE closure, with an initial capital outflow and trade surplus, Italy's terms of trade deteriorate at first (figure 6), boosting the demand for its exports relative to growth in its demand for imports (figures 7a and 7b). As Italy's

current account balance reverses over time, a continuing improvement in its terms of trade supports its switch to a growing trade deficit, by slowing growth in its exports relative to imports.

In contrast, the terms of trade continually improve in the FIXSHR closure. Italy’s outsized capital inflow moves the region from a trade surplus to a trade deficit, supported by a terms of trade improvement that boosts growth in Italy’s import demand relative to demand for its exports. The gradual slowing of the growth in Italy’s trade deficit moves together with the slowing of its terms of trade gains.



In the DPSAVE closure, an initial terms of trade gain allows Italy to maintain growth in its import demand and its fixed current account surplus despite a decline in its consumption relative to savings. Italy’s terms of trade gradually deteriorate over the baseline period, accommodating its continued trade surplus as the global capital supply grows and its inflows increase.



The real exchange rate mechanism in the GTAP-RD model is the *pfactor* variable, which describes the percent change in an index of a region’s factor prices relative to the global average. Changes in the index reflect the paths of capital rents and wages over the baseline projection period and, for Italy, declines under all three closures (figure 8). Capital rents fall over the baseline under all three closures due to the steady

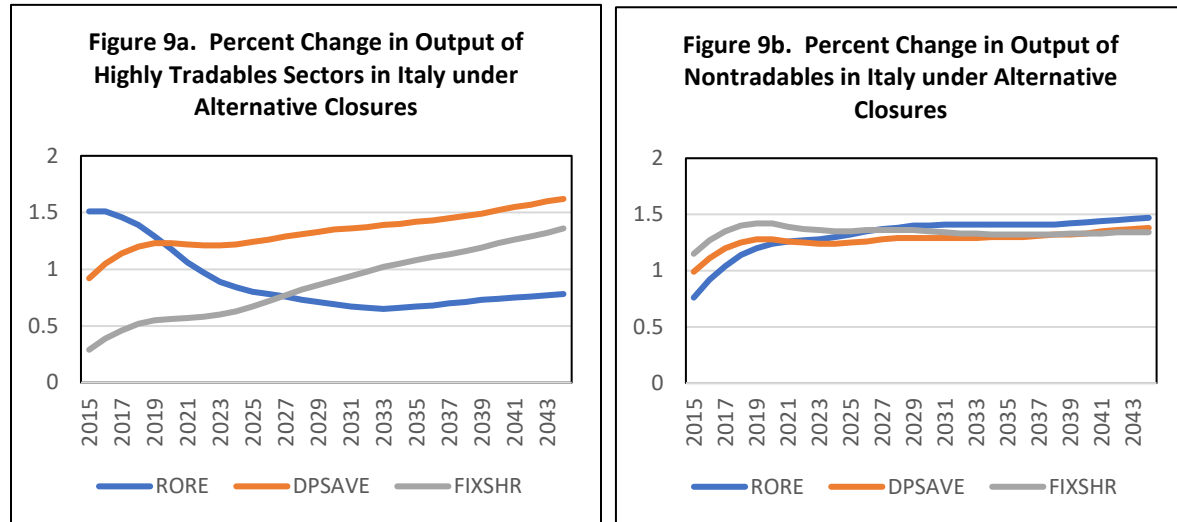
accumulation of capital over time. Over most of the projection period, capital rents fall the least in the RORE closure and the most in the FIXSHR closure. The wage-rental ratio in Italy is projected to rise under all three closures because Italy’s labor force is projected to shrink at an accelerating rate.

Sectoral Results and Structural Implications

To explore the role of sectoral characteristics in driving structural differences across closures, we categorize the 65 GTAP sectors based on tradability and capital intensity. We calculate the 65 sectors’ tradability as (import share in final demand)* (export share in production) * ESUBVA. We then rank the 65 sectors’ tradability from high to low. The top 20 sectors are termed tradable sectors; the bottom 20 sectors are termed non-tradable, although some trade occurs in these sectors. Tradable sectors consist mainly of manufacturing, while non-traded sectors are predominantly services (Appendix table 1).

To explore the sectoral characteristic of capital intensity, we group the 65 GTAP sectors based on the capital-labor ratio of each sector in Italy, using the 2014 baseline statistics. The top 20 sectors are grouped as sectors with high capital intensity, while the bottom 20 sectors are grouped as sectors with low capital intensity. Sectors with high capital intensity

include extractive and primary industries (Appendix table 2). Low capital intensity sectors are mainly services, processed food and downstream manufacturing industries.

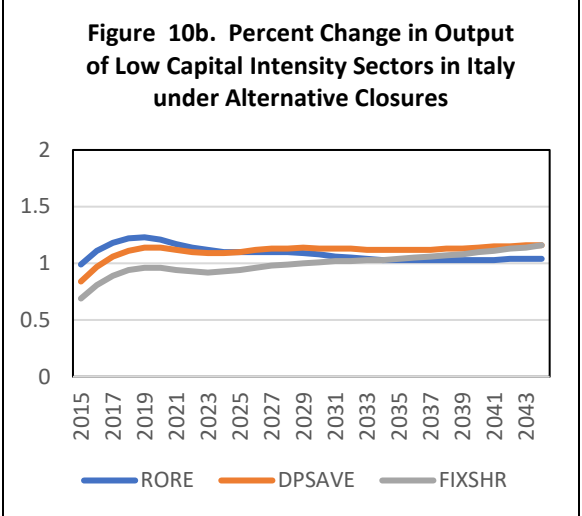
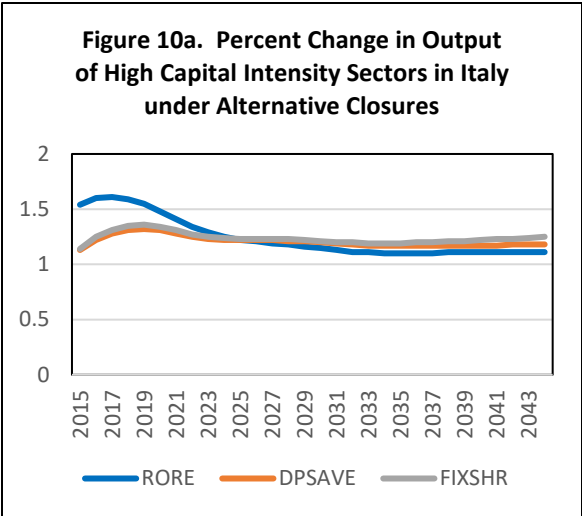


Changes in the current account are accommodated by changes in the supply and demand for traded goods and services. In the RORE closure, Italy has a capital account deficit and current account surplus in the early part of the baseline path. During its trade surplus period, when exports exceed imports, the output of tradable sectors increases more than in the other closures (figure 9a). Faster economic growth in the world, relative to Italy, contributes to a demand-side stimulus for Italy’s exportables and import substitution contributes to an increase in importables’ output. Under the RORE closure, as output of Italy’s tradables rises and draws in productive resources, growth in production of its nontradables is initially the slowest among the alternative closures (figure 9b). In the later years of the baseline projection, when the gradual reduction of Italy’s trade surplus leads to a trade deficit, its production patterns reverse. A RORE closure that leads to a growing capital inflow and a trade deficit favors the output of nontradables relative to tradables. Income growth in Italy over the baseline projection period also supports faster growth in the production of nontradables because many of the sectors in this grouping are characterized by relatively high income elasticities.

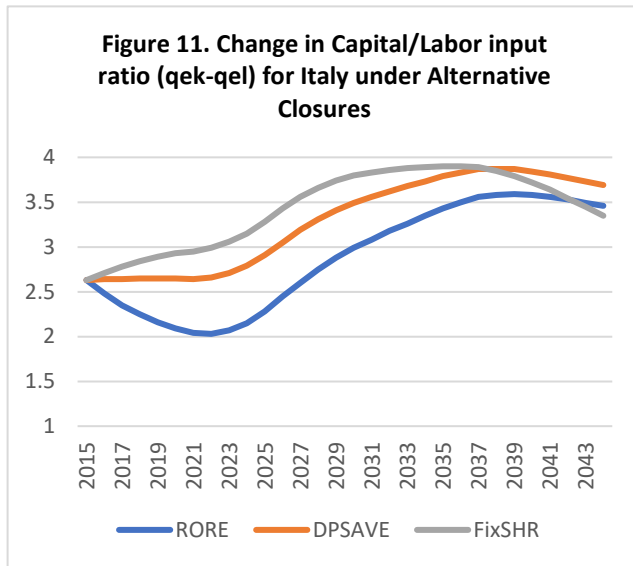
In the FIXSHR closure, the slower per capita GDP growth rate in Italy relative to the world leads to a continuing outsized inflow of capital from the global bank and a sustained, though slowing growth in its trade deficit over the projection period. As imports increase relative to exports, growth in the production of import substitutes and exportables slows. Resources shift from tradables toward the production of nontradables, for which growth is strongest under the FIXSHR closure than under alternative closures during the early projection period. Growth in production of tradables and nontradables equalize over time as Italy’s trade deficit diminishes.

Under the DPSAVE closure, Italy’s small trade surplus remains fixed relative to world income. To accommodate this constraint, growth in output of tradables is slightly higher than growth in output of nontradables over the baseline period. The DPSAVE closure therefore represents a relatively balanced growth path in terms of sectoral structure over the full baseline period compared to the other closures.

Figures 10a and 10b show the output of high and low-capital intensity sectors under the three closures. We find that differences in output based on capital intensity are relatively small, and are most pronounced early in the baseline projection period. Output growth is slightly higher for capital-intensive goods compared to low capital-intensive goods over the baseline under all three closures, which is consistent with the accumulation of capital and



negative growth in Italy’s labor force over the baseline, and the resulting increase in the wage-rent ratio.



In the RORE closure, capital rents fall the fastest among the closures in the early baseline period, which is the cause of Italy’s capital outflow and a relatively slow growth in its capital-labor ratio (figure 11). The low price of capital encourages capital-intensive production. In the FIXSHR closure, Italy’s outsized capital inflow increases the stock of capital, causing capital rents to fall and

encouraging a shift in production toward more capital-intensive goods. This resource movement diminishes as Italy’s capital account surplus falls over time. Under the DPSAVE closure, the increase in the savings rate helps to shift demand from consumer goods toward investment goods, which tend to be more capital intensive.

4. Conclusions

Macro closure in a CGE model defines which macro variable will adjust to equilibrate aggregate savings and investment following a model shock. This paper uses the recursive dynamic GTAP-RD framework to compare the baseline projections for Italy over 2015-2044 under three alternative macroeconomic closures: the trade balance adjusts as global investment flows to regions with the highest expected rates of return to capital, the trade balance adjusts as regions receive a fixed share of the global supply of savings, and the regional savings rate adjusts to maintain a fixed balance of trade as global investment flows shift. The macro adjustment processes in the three closures are fundamentally different and result in differences in macroeconomic and sectoral outcomes that are most pronounced early in the baseline projection paths. One of the main triggers for the differences in

baseline outcomes is that Italy is a slow-growing economy relative to the rest of the world. In the dynamic models that are becoming widely used today, income growth over time can be substantial. Global differences in regional growth rates can cause the macro balances and sectoral structure of a region to diverge substantially over alternative baseline projection paths.

In the case of Italy, the alternative macro closures describe Italy's early baseline projection path as either a growing capital account deficit, a diminishing capital account deficit, or a fixed capital account/balance of trade but an increase in the savings rate and a shift in the composition of aggregate demand. These outcomes have implications for sectoral structure: A capital outflow and trade surplus favor the production of tradables relative to nontradables; a capital inflow and trade deficit favor the production of nontradables relative to tradables, and a fixed balance of trade favors relatively balanced sectoral growth.

The practical guidance for modelers that has broadly emerged from the literature on macro closure in CGE models has emphasized that there is no right macro closure rule and an empirical rather than a theoretical foundation usually is used to guide this choice. The chief criteria are that the macro behavior imposed by the closure be appropriate for the research question and that the macro outcomes be consistent with observed experience. This paper underscores that advice. We add to it an emphasis on the importance of understanding the adjustment behavior that drives the macroeconomic and sectoral outcomes in the model. The adjustment process will differ in important ways among CGE models, not only due to different closure rules but also due to differences among models' macroeconomic structures. We compared alternative macro closure rules in the GTAP-RD CGE model, in which the savings-investment equilibrium is imposed at the global rather than the regional level.

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Appendix 1. Sectors with High and Low Tradability in Italy			
High tradability		Low tradability	
atp	Air transport	afs	Accommodation, food and service activities
b_t	Beverages and tobacco products	c_b	Sugar cane, sugar beet
bph	Basic pharmaceutical products	cmn	Communication
chm	Chemical products	cns	Construction
eeq	Electrical equipment	ctl	Bovine cattle, sheep and goats, horses
ele	Computer, electronic and optical products	edu	Education
i_s	Ferrous metals	ely	Electricity
lea	Leather products	frs	Forestry
mvh	Motor vehicles and parts	gdt	Gas manufacture, distribution
nfm	Metals nec	hht	Human health and social work activities
nmm	Mineral products nec	ins	Insurance
ome	Machinery and equipment nec	ofi	Financial services nec
omf	Manufactures nec	osg	Public administration and defense
otn	Transport equipment nec	pdr	Paddy rice
rpp	Rubber and plastic products	rmk	Raw milk
tex	Textiles	ros	Recreational and other services
v_f	Vegetables, fruits	rsa	Real estate activities
vol	Vegetable oils and fats	trd	Trade
wap	Wearing apparel	whs	Warehousing and support activities
wtp	Water transport	wtr	Water

Appendix 2. Sectors with High and Low Capital-Intensity in Italy			
High Capital-Intensity		Low Capital-Intensity	
atp	Air transport	afs	Accommodation, food, service activities
bph	Basic pharmaceuticals	b_t	Beverages and tobacco products
c_b	Sugar cane, beet	cmt	Bovine meat products
coa	Coal	edu	Education
ctl	Bovine cattle, sheep and goats, horses	eeq	Electrical equipment
fsh	Fishing	fmp	Metal products
gas	Gas	hht	Human health and social work activities
gro	Cereal grains nec	mil	Dairy products
lum	Wood products	obs	Business services nec
oap	Other animal products	ofi	Financial services nec
ocr	Other crops	ome	Machinery and equipment nec
oil	Oil	omf	Manufactures, nec
osd	Oilseeds	omt	Other meats
oxt	Other extraction	osg	Public administration and defense
pdr	Paddy rice	otn	Transport equipment nec
pfb	Plant based fibers	otp	Transport nec
rmk	Raw milk	p_c	Petroleum, coal products
rsa	Real estate activities	pcr	Processed rice
v_f	Fruits, vegetables	ros	Recreational and other services
wol	Wool	rpp	Rubber and plastic products

APPENDIX 3: Slow Growth Versus High Growth Regions

The appendix provides a brief summary and contrast of the macroeconomic and sectoral outcomes across alternative closures in the cases of a fast-growing region (Sub-Saharan Africa) versus Italy.

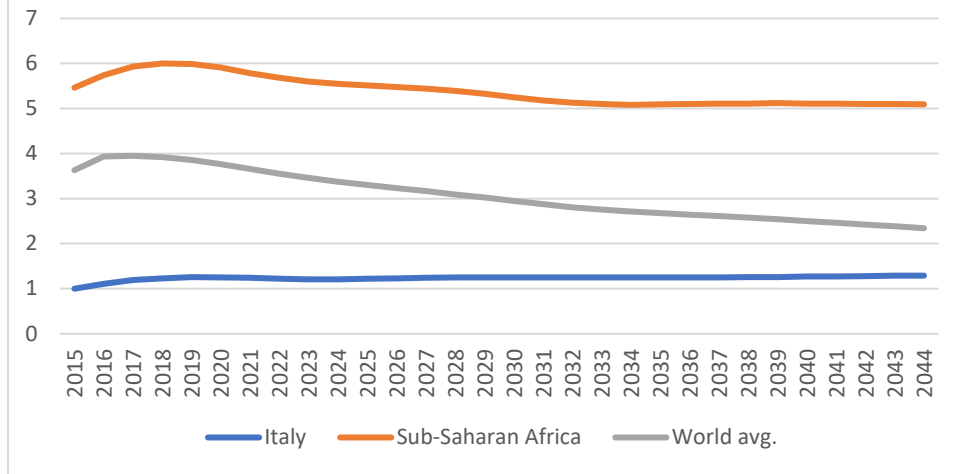
Key observations:

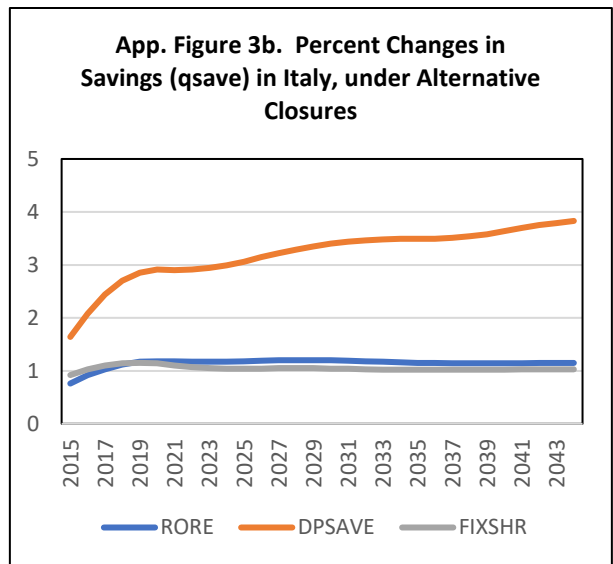
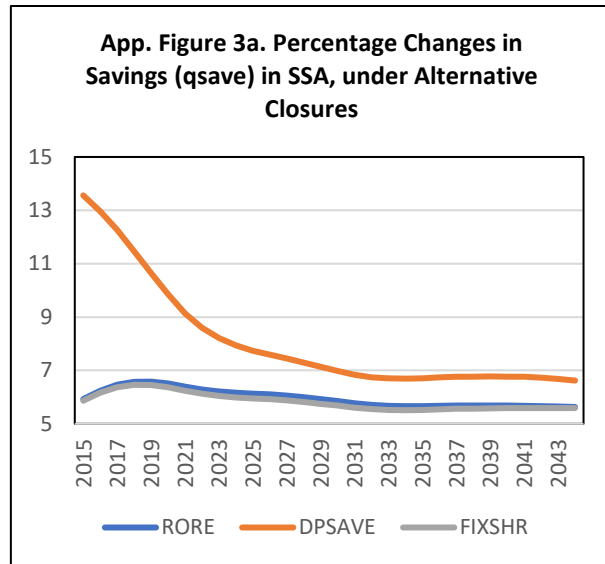
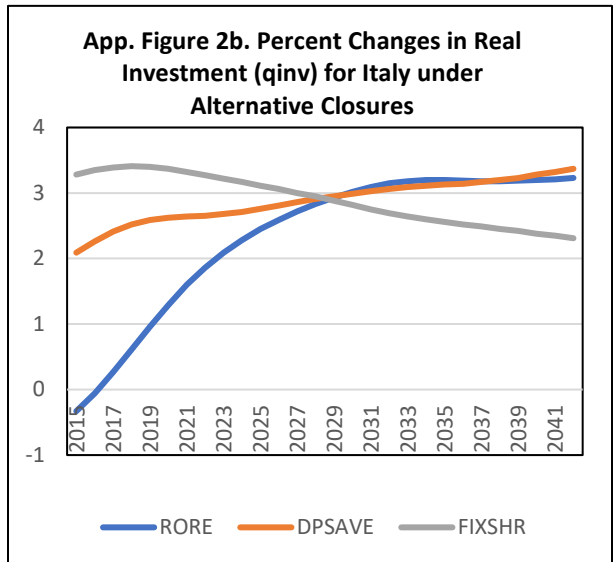
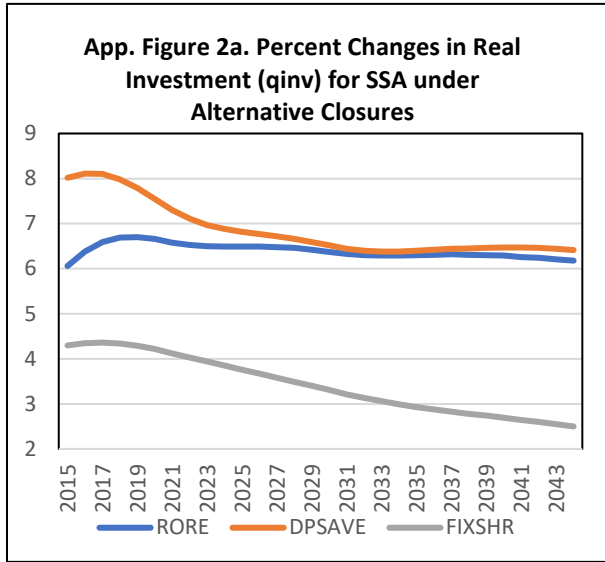
1. SSA is a fast-growing region, with a GDP growth rate that is faster than the global average. Italy is a slow-growth region (App. figure 1).
2. Fast-growing regions attract more global savings than slow-growth countries, as shown in the RORE and DPSAVE closures. Under the FIXSHR closure, investment in all regions grows by the same percentage as global savings, so changes in investment in both Italy and SSA track closely the change in the world average GDP growth rate (App. figures 2a and 2b).
3. Due to the fixed savings rate in the RORE and FIXSHR closures, regional savings grow at the same rate as regional GDP; savings therefore grows faster in SSA than in Italy (App. figures 3a and 3b). In the DPSAVE closure, savings rates adjust to accommodate the fixed trade balance. The savings rate rises in fast-growing SSA as the capital inflow increases. The savings rate also increases in Italy, but at a much lower pace.
4. The gap between domestic savings and investment drives changes in the trade balance. SSA has an initial trade deficit of \$33 billion, and Italy has an initial trade surplus of \$19 billion. In SSA, the fast growth in investment inflows leads to growing trade deficits under the RORE approach. In Italy, capital outflows under the RORE closure results in initial trade surpluses, which diminish over time. Under the FIXSHR approach, SSA receives a smaller share of global savings than it deposits in the global bank, so savings exceeds its investment and it runs declining trade deficits/growing trade surpluses. In the FIXSHR closure, Italy receives a disproportionately large share of world savings, so investment exceeds savings and it runs declining trade

surpluses/growing trade deficits. The DPSAVE closure assumes trade balances are fixed relative to income in all regions (App. figures 4a and 4b).

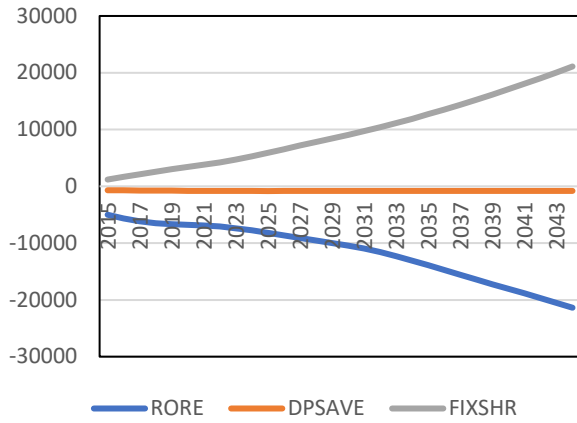
5. With global capital deepening, expected rates of return to capital diminish in both regions and for all closures, except for the FIXSHR closure in SSA (App. figures 5a and 5b). In this case, the outflow of capital creates a scarcity that raises the SSA returns to capital.
6. Terms of trade changes differ between SSA and Italy because they support different directional changes in their trade balances (App. figures 6a and 6b).
7. Sectoral results for SSA show stronger growth for tradables than for nontradables under all three closures, except for the early baseline period under the RORE closure. SSA's trade deficit is largest under RORE, and its production of non-tradables is highest and of tradables is the lowest among the closures. SSA's growing trade surplus under the FIXSHR closure leads to faster growth in output of tradables than of nontradables over the baseline path. The small, fixed trade deficit under the DPSAVE closure also leads to a shift toward production of tradables, indicating that the structural effects of a trade deficit in this closure is dominated by other general equilibrium impacts (App. figures 7a-d).
8. Sectoral results for SSA based on capital intensity show that the growing capital account surplus under the RORE closure leads to capital-deepening but slightly slower growth in production of more capital-intensive goods than less capital-intensive goods until the late projection period. In the FIXSHR closure, capital-deepening is the lowest among the closures, which contributes to faster growth in the production of less capital-intensive goods than more capital-intensive goods. In the DPSAVE closure, SSA's persistent trade deficit and capital inflow result in faster growth in production of more capital-intensive goods compared to less capital-intensive goods (App. figures 8a-d and App. figure 2a).

App. Figure 1. Annual Percent Change in Real GDP in Italy, Sub-Saharan Africa and World Average

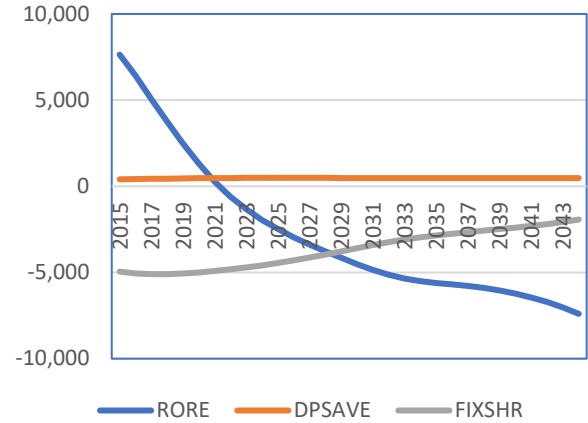




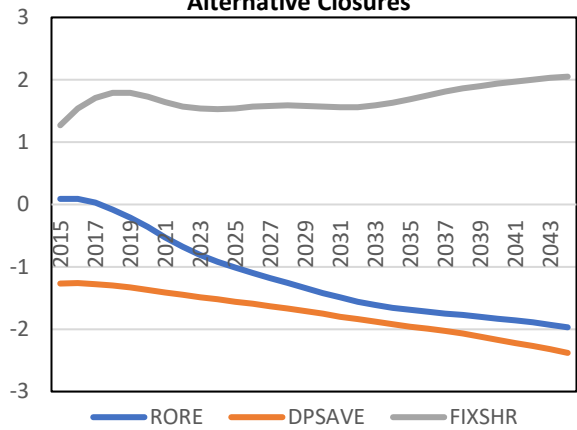
App. Figure 4a. Annual Changes in SSA's Trade Balance under Alternative Closures (\$US millions)



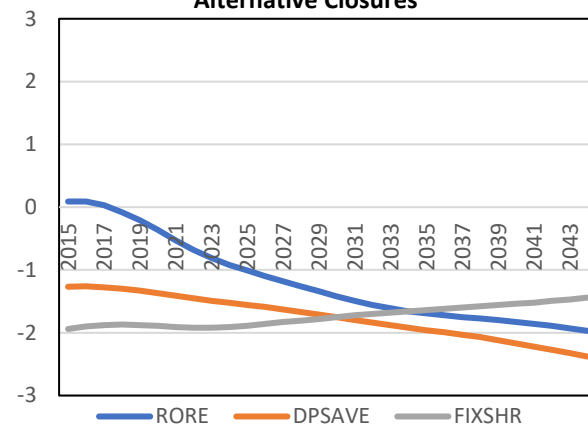
App. Figure 4b. Annual Changes in Italy's Trade Balance under Alternative Closures (\$US millions)



App. Figure 5a. Percent Changes in Expected Rate of Return for SSA under Alternative Closures



App. Figure 5b. Percent Changes in Expected Rate of Return for Italy under Alternative Closures



App. Figure 6a. Percent Changes in Terms of Trade in SSA under Alternative Closures

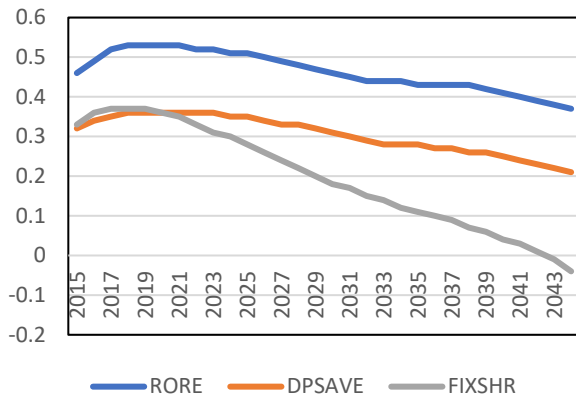
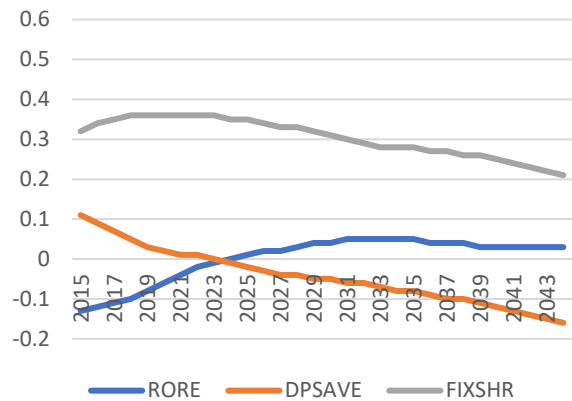
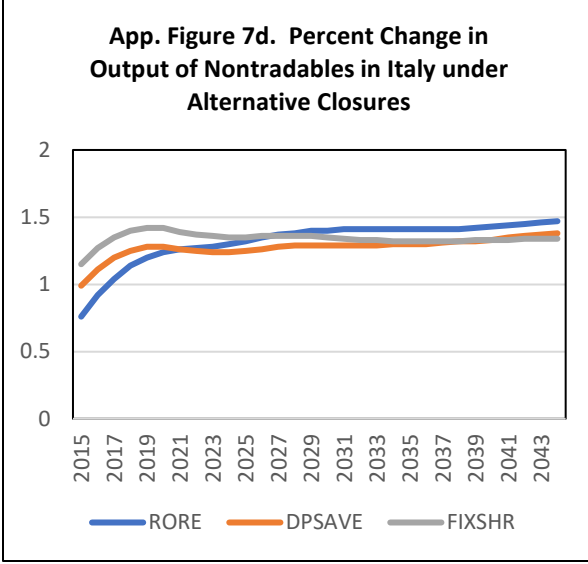
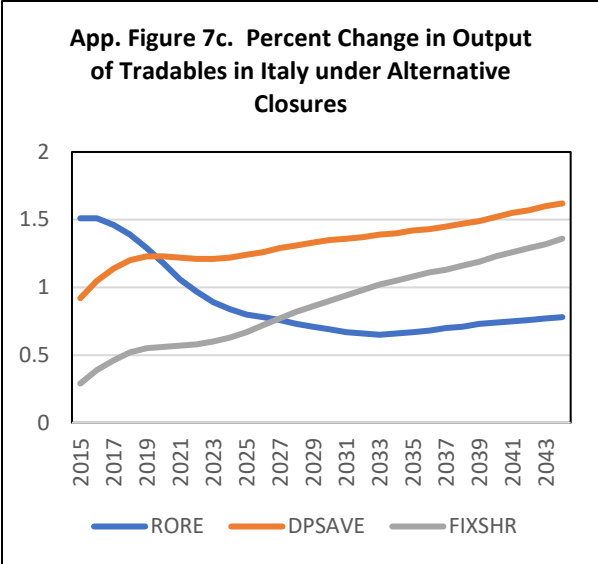
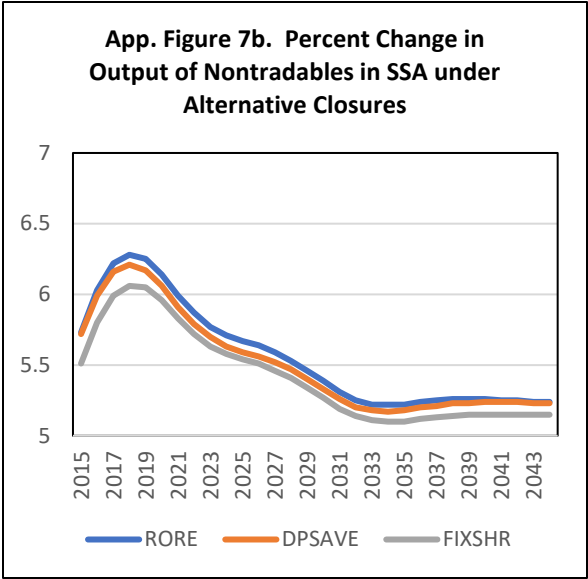
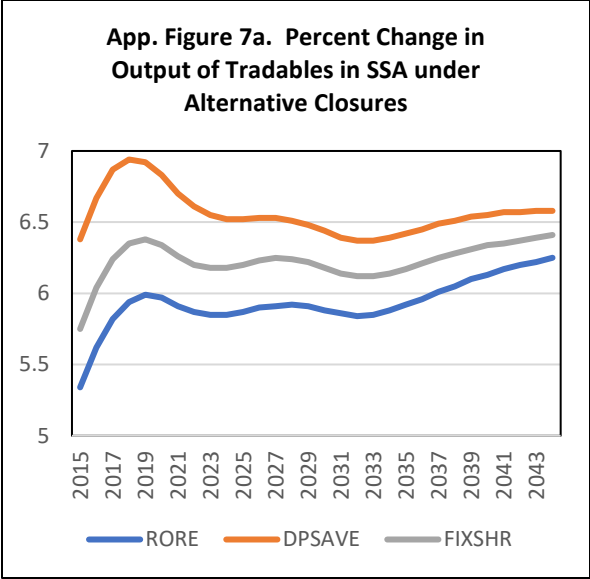
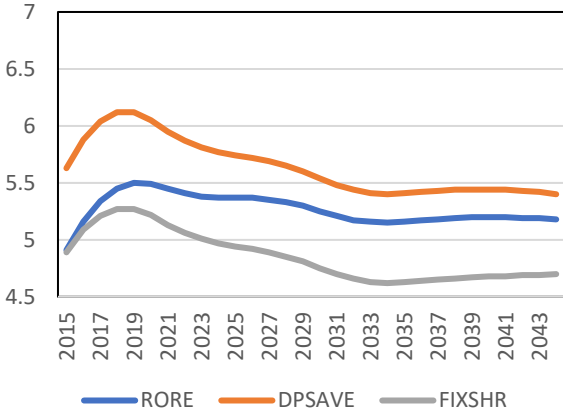


Figure 6b. Percent Changes in Terms of Trade in Italy under Alternative Closure

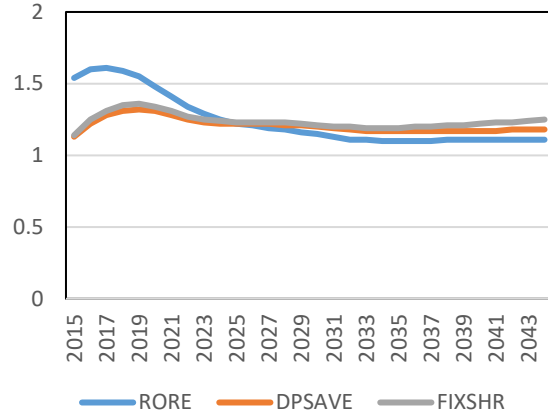




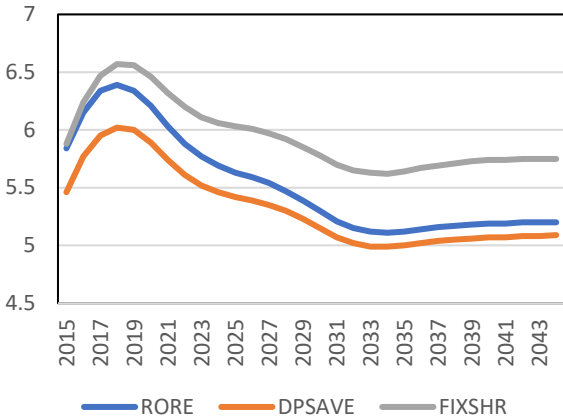
App. Figure 8a. Percent Change in Output of High Capital Intensity Sectors in SSA under Alternative Closures



App. Figure 8b. Percent Change in Output of High Capital Intensity Sectors in Italy under Alternative Closures



App. Figure 8c. Percent Change in Output of Low Capital Intensity Sectors in SSA under Alternative Closures



App. Figure 8d. Percent Change in Output of Low Capital Intensity Sectors in Italy under Alternative Closures

