ASSESSING THE IMPACTS OF WORKFORCE SKILL IMPROVEMENT ON INCOME TRANSFER PROGRAMME BENEFICIARIES IN BRAZIL

Abstract

This paper evaluates the economic impacts of workforce qualification through professional courses for beneficiary families of the Conditional Cash Transfer Program in Brazil using the DAYANE model, a computable, static, multiregional, and multisectoral general equilibrium model that divides Brazil into five macro-regions and families into ten income classes. It is developed in the GEMPACK language and disaggregates families' schooling into twelve different levels. Schooling improvement shocks were simulated for beneficiaries of the Bolsa Família Program. As a result, income transfers to these families decreased in proportion to the increase in wages. The results show that labour qualification policies for beneficiaries improve their economic situation, with income transfers gradually being replaced by higher salaries, indicating that government transfers can be reduced in response to improved gains in the labour market.

Keywords: Welfare. Cash Transfer Programs. Skill improvement. Labour market.

JEL classification: I38 . C68. J24.

Resumo

Este artigo avalia os impactos econômicos de uma qualificação da força de trabalho por meio de cursos profissionais para famílias beneficiárias do Programa de Transferência Condicionada de Renda no Brasil, utilizando o modelo DAYANE, um modelo computável de equilíbrio geral estático, multirregional e multissetorial que apresenta o Brasil dividido em cinco macro-regiões e famílias divididas em dez classes de renda. Ele é desenvolvido na linguagem GEMPACK e desagrega a escolaridade das famílias em doze níveis diferentes. Foram simulados choques de melhoria na escolaridade para os beneficiários do Programa Bolsa Família, e as transferências de renda para essas famílias diminuíram em proporção ao aumento nos salários. Os resultados mostram que políticas de qualificação da força de trabalho para os beneficiários melhoram sua situação econômica, com as transferências de renda sendo substituídas por ganhos salariais, o que indica que os repasses governamentais podem ser reduzidos em resposta a melhores ganhos no mercado de trabalho.

Palavras-chave: Bem-estar econômico. Programas de Transferência de Renda. Qualificação de mão de obra. Mercado de Trabalho.

1 Introduction

The concept of poverty can be defined as the deprivation of individuals basic capabilities apart from lower income, such as premature death, persistent morbidity, malnutrition and illiteracy, and other disabilities. Ensuring the individual's capacity to act is important for overcoming income poverty, because the more inclusive the reach of, for example, basic education and health services, the greater the likelihood that potentially poor people will also have a better chance to overcome poverty (Sen, 2001). For Soares et al. (2006) the eradication of poverty and the substantial reduction of inequality levels in Brazil would hardly be achievable without direct income redistribution mechanisms.

In Brazil, extreme poverty has been on the rise, increasing by 51.54% in the last 15 years after reaching its lowest level in 2014. This means that 4.6 million people now live in extreme poverty, which is 6.48% of the total population. The proportion of people living under the poverty line[1], the proportion of the Brazilian population increased to 11.90% in the same period. 5.5 million people are living under this line (24.52% of the population are poor) has also increased to 11.90%, meaning that 5.5 million people are living below the recommended US$5.50 a day Purchasing Power Parity (PPP) line. Additionally, Brazil has a high Gini[2] index

[1]The World Bank recommends the use of US$5.50 a day (PPP) line for upper-middle-income countries, a group to which Brazil belongs with another 46 countries

[2]The Gini index ranges from zero to one. The closer to zero, the better a country's income distribution, and the closer to one, the more unequal the economy.

of 0.543, ranking 9th out of 164 countries, indicating a large income inequality gap, with the top 1% earning 33.7 times more than the bottom 50% of earners[3] IBGE (2020); World Bank (2021).

Conditional Cash Transfer Social Programs are designed to prevent poverty and reduce inequality. They require beneficiaries to meet certain conditions in order to receive income transfers. These conditions typically involve investing in human capital, such as ensuring children attend school and maintain good health and nutrition. These programs serve as an alternative to traditional welfare programs and complement existing health and education services (Rawlings and Rubio, 2005).

Such programshave emerged in Latin America since the 1990s and have been adopted by many developing countries, becoming an essential part of their social protection systems. Several countries, such as Colombia (Families in Acción) Attanasio and Mesnard (2006), Mexico (Progresa) Coady and Parker (2004), Honduras (Family Assignment Program II), Nicaragua (Red de Protección Social), Jamaica (Program for Advancement Through Health and Education) Handa and Davis (2006), and Brazil (Bolsa Família Program) Hall (2008); Wolf et al. (2018) have successfully implemented these programs.

In 2003, Brazil established the Bolsa Família Program to tackle poverty and inequality. The program serves families with a per capita income of up to R$ 89.00 per month or those with incomes between R$ 89.01 and R$ 178.00, provided they have children aged between 0 to 17 years old. To be eligible for the transfers, families must meet certain requirements in the areas of health, education, and social assistance. If they fail to comply with these requirements, they may lose the benefit, albeit after receiving some warnings (MINISTRY OF CITIZENSHIP, 2021). In November 2021, the Bolsa Família Program was replaced by Auxílio Brasil[4], but the program's primary objective, conditionalities, and implementation remained the same, with only the grant amount updated.

Between 2001 and 2011, Brazil experienced significant improvements in its social and economic indicators. During this decade, average household income increased by more than 30%, while inequality, as measured by the Gini coefficient, fell by more than 10%. In addition, extreme poverty and poverty rates declined by 4 and 12 percentage points, respectively de Souza et al. (2019). Many studies have shown that income transfer programs have played a crucial role in reducing poverty and inequality in Brazil. For instance, researchers such as Araújo (2009), Barros et al. (2010), and Araujo and Morais (2014) have highlighted the positive impact of these programs on income distribution. However, Soares et al. (2006) have argued that focusing solely on income transfers without promoting broader social investments could undermine the goals of public social protection policies (Doraliza et al., 2008).

According to data from Neri (2018) and (IBGE, 2021), more families were entering than leaving the Bolsa Família program. However, recent data from FGV Social (2020) shows that the number of beneficiaries reached its maximum in 2019 and has since decreased, resulting in a net disconnection of 1.1 million families between May 2019 and January 2020. As a result, there is now an average annual queue of 500,000 families who are still waiting to be covered by the Bolsa Família program. This regression occurred during the economic crisis that began in late 2014, leading to a loss of welfare and an increase in the number of Brazilians in extreme social vulnerability. The Bolsa Família program, which is the main instrument to fight poverty, was affected by this crisis.

Soares, Ribas, and Osório (2010) argue that while compliance with the Bolsa Família

[3]The portion of workers with the highest income earned R$28,659 per month, on average, while the less favoured 50% earned R$850

[4]see https://www.caixa.gov.br/programas-sociais/auxilio-brasil/paginas/default.aspx

Program's educational requirements for children receives much attention, little attention is paid to the lack of job requirements for adults in recipient families. Furthermore, it cannot be conclusively determined that conditional school attendance has a significant, isolated positive effect on the program's performance. Although monitoring school attendance has been shown to reduce grade repetition rates, it does not appear to have a strong enough impact on educational outcomes to suggest that the program is solely responsible for improving student achievement. This is partly due to the fact that basic education in Brazil is almost universally accessible, disapproval rates are low, progression is high, and several policies supporting school attendance have been implemented for some time (Paiva et al., 2021).

The majority of households receiving the Bolsa Família program have heads of household with only elementary education VISDATA (2021). Therefore, it is important to consider training programs such as PRONATEC[5] as a means to improve job qualifications and increase income. Improving human capital through training can lead to higher individual productivity and earnings, with studies showing that training has a greater impact on wages for those with lower levels of education (Vignoles et al., 2004).

Social Cash Transfer programs, which provide transfers from the government to low-income families, can affect the consumption patterns of the beneficiaries. The increased resources received by the families result in a shift towards more capital-intensive goods, such as agriculture and manufacturing, compared to the government's expenditure on services. This shift of government resources towards the poorest families leads to a relative increase in the price of capital in comparison to labour Wolf et al. (2018).

It's important to assess the impact of solutions that not only involve heads of households in the labour market but also provide training to improve their skills, making the effects of income transfers permanent rather than temporary. Improving education can lead to increased productivity and salary growth over time, making measures to enhance the education system significant for long-term income gains. Therefore, enhancing labour skills can pave the way for higher economic growth rates in the country.

2 DAYANE Model Description

The model used in this study is based on the PAEG (Teixeira et al., 2013; Gurgel et al., 2020) database, which is regionalized for the Brazilian economy in 2014, and compatible with database 10 of the GTAP (Aguiar et al., 2019,?). Unlike the PAEG developed in MPSGE (Rutherford, 1999) and GAMS[6], the model used here is designed in TABLO language using GEMPACK, based on version 6 of the GTAPinGEMPACK code (Pearson et al., 2004; Corong et al., 2017; Van der Mensbrugghe, 2018). The model is used for comparative-static simulations, with its assumptions, equations, and variables referring implicitly to the future economy.

2.1 The model database

In this study, we kept the original region and sector aggregation of the PAEG model, consisting of 19 sectors and 21 regions, including the 5 Brazilian macro-regions. Table 1 displays the aggregation between the regions and sectors considered in both models. However, there is flexibility to choose different aggregations of countries and products according to the research

[5]National Programme for Access to Technical Education and Employment – see https:/www.educamaisbrasil.com.br/pronatec

[6]http://www.mpsge.org/gtap6/

goal. The family aggregation in the Brazilian regions is the same as in PAEG, with 10 income and consumption classes. In contrast, the DAYANE model splits the labour factor into 12 different levels instead of considering only skilled and unskilled labour, capital, land and natural resources. Another important difference is that in the DAYANE model, family income includes disaggregated transfers and income tax payments to the government.

Table 1: Sectors and Regions of the Model

Sectors	Regions
Agriculture	Brazil - North (NOR)
Paddy rice (pdr)	Brazil - Northeast (NDE)
Cereal grains (gro)	Brazil - Midwest (COE)
Oil seeds (osd)	Brazil - Southeast (SDE)
Sugar cane; sugar industry (c_b)	Brazil - South (SUL)
Animal products (oap)	Rest of Mercosur
Milk and dairy products (rmk)	United States of America
Other agricultural products (agr)	Canada
Industry	Rest of Americas
Food products (foo)	Mexico
Textiles (tex)	European Union
Wearing apparel leather products (wap)	Rest of Europe
Wood products (lum)	Japan
Paper products publishing (ppp)	Russia
Chemical rubber plastic prods (crp)	China
Other manufacturing (man)	India
Services	Australia and New Zealand
Electricity, gas, water distribution (siu)	Fast development Asia
Construction (cns)	Africa
Trade (trd)	Middle East
Transport (otp)	Rest of Asia
Services (ser)	

The model's disaggregation of Brazilian households enables the evaluation of distributional effects of various policies, beyond just the aggregated effects. Income brackets are expressed in US dollars based on the 2014 minimum wage (MW):

1^{st} class - until 1 MW;
2^{nd} class - more than 1 MW until 2.5 MW;
3^{rd} class - more than 2.5 MW until 4 MW;
4^{th} class - more than 4 MW until 5 MW;
5^{th} class - more than 5 MW until 6 MW;
6^{th} class - more than 6 MW until 7 MW;
7^{th} class - more than 7 MW until 8 MW;
8^{th} class - more than 8 MW until 10 MW;
9^{th} class - more than 10 MW until 12 MW;
10^{th} class - more than 12 MW;

The income of Brazilian families was disaggregated into three components: labour income, capital income, and land income, based on data from the Family Budget Survey - POF 2017/2018 (IBGE, 2019). To account for the difference in base years between the POF and the computable general equilibrium model, the 2017/2018 POF values were adjusted for inflation (based on the IPCA) and converted to 2014 dollars. The model assumes that factor remuneration received by firms is fully owned by families and distributed according to the share of each income class in the total income of each factor. The distribution of family income was carried out using the following strategy:

(a) aggregate the remuneration of factors (labour, capital and land)[7] in the PAEG model;

[7] Llabour = skilled + unskilled work; capital = capital + natural resources

(b) calculate the share of income for each family within each region for each factor based on the POF.

(c) distribute the total PAEG income in each income class based on the proportions obtained in step b.

The model considers government transfers such as the Bolsa Família program, other social programs, income tax refunds, retirement benefits, and family transfers to the government in addition to factors remuneration. The calculation of savings for each income bracket takes into account the difference between total income and total consumption, ensuring that the sum received by each bracket equals the sum consumed. To allocate labour income to different levels, the model used the 2014 National Household Sample to determine the distribution of employment across individual income brackets, based on the hourly wages of heads of households in each sector. The qualification levels were further broken down by sector:

S1 - No Instruction;
S2 - Incomplete Basics;
S3 - Complete Basics;
S4 - Incomplete Fundamental;
S5 - Qualified Basics;
S6 - Complete Fundamental;
S7 - Incomplete High School;
S8 - Qualified Fundamental;
S9 - Complete High School;
S10 - Qualified High School;
S11 - Incomplete College;
S12 - Complete College;

To model the labor market, the study considered formal and informal workers aged between 18 and 65 years old, while excluding civil servants and military personnel as their wages are not determined by the market. Hourly earnings below R$1 and above R$100 were not taken into account. The person weights from the POF and PNAD surveys were used to expand the data. To match the labor market data, a scalar was calculated for the PNAD data using the POF data as a reference, according to the formula: $\texttt{Scalar} = \frac{\texttt{POF Value}}{\texttt{PNAD Value}}$.

It is crucial to note that for the labour market data in the model, the wages of each educational level must align with the value of the labour factor received by families in the model, and be distributed across economic sectors accordingly. To achieve this, the RAS method was used to generate a matrix with the dimensions of sector, income class, region, and qualification. This enables the simulation of changes in the labour market and their impact on the entire economy represented in the model. It is important to ensure that the PNAD data follows the POF data, and that the POF data follows the VFM (IO table data) to maintain consistency in the model.

The POF 2017-2018 provided data on household consumption for each region in the form of 110 products. These data were aggregated for the sectors in the model and then distributed among the different income brackets. Alternatively, to avoid changing the original data on total consumption by region, the share of consumption of each household in the total consumption in each sector was calculated for each Brazilian region. This contribution was then applied to the value of household consumption in the original PAEG database.

To run the PAEG model on the GEMPACK code, it is necessary to calculate the agent price for some flows, taking into account the power of the tax (1 + ad valorem tax rate). However, for other flows that use market prices, no new value needs to be calculated. It is important to consider taxes on flow value when calculating agent pricing. The model base data can be expressed in a Social Accounting Matrix transactions, which reports the agents in the economy that demand commodities, including activities, private households, government, investment, transport services, and foreign regions.

2.1.1 SAM Transactions

The model base data can be expressed in a Social Accounting Matrix transactions. The SAM reports the Agents in the economy that demand commodities: Activities, Private Households, Government, Investment, Transport Services, and Foreign Region (rest of the world). Flows are presented at market price (i.e., not considering taxes). The price paid by the agent, or the final price paid, can be found by adding the respective rate to the market value.

For domestically produced commodities market prices are the prices received by domestic activities. Hence, export taxes are considered expenditures on domestic commodity accounts. Domestic prices are derived from the production costs (made up of the costs of intermediate inputs plus the sales taxes, plus expenditure on primary factors usage and production taxes). The model considers the Neoclassical approach where total investments equal domestic savings.

Exports at F.O.B. valued at prices (`VXWD`) considers the exports valued at market prices (`VXMD`) added the export taxes (`TEX`). Expenses on imported commodities valued at C.I.F. prices (`VIWS`) considers exports at F.O.B. prices and payment for international transport (`VTWR`). Revenues on imported commodities depend on the consumption of agents (`VIFM`; `VIPM`; `VIGM`), including imported investment goods (`VIFM("cgds"))`. Imports valued at market prices (`VIMS`) consider the values of imports at world prices (C.I.F.) added the taxes on imports (`TIM`).

The link between imports and exports on the international market is:

$$\mathtt{VXMD + TEX = VXWD} \tag{1}$$

$$\mathtt{VXWD + VTWR = VIWS} \tag{2}$$

$$\mathtt{VIWS + TIM = VIMS} \tag{3}$$

The global transport sector corresponds to the difference between the F.O.B. and C.I.F. for a particular commodity shipped along a specific route: `VTWR = VIWS - VXWD`. The sum of all commodity routes is equal to the total demand for international transport that is provided by individual regional economies, which export them to the global transport sector (`VST`), transport supply.

The Value of Firms consumption at Agent's prices (`VFA`) includes: Value of Domestic Consumption of Firms at Market prices (`VDFM`) and imported intermediate consumption - Value of Imported Consumption of Firms (`VIFM`); the payment of factors at market prices - Value of Factor at Market prices (`VFM`); tariffs on imported intermediate consumption (`IFTAX`), and domestic (`DFAX`); payment of fees on the use of factors (`TFU`); and tariffs on production (`PTAX`).

Combining intermediate consumption at market prices (`VDFM and VIFM`) and use of factors at market prices (`VFM`), firms produce the output (`VOM`). Let `VIFA` be the Value of intermediate consumption Imported at Agent prices; `VDFA` Value as Domestic Intermediate Consumption at Agent prices , and; $(\mathtt{VFA}_{\mathtt{fact}})$ the Value paid by firms for the use of Factors at

Agent prices:

$$\mathrm{VIFM + IFTAX = VIFA} \tag{4}$$

$$\mathrm{VDFM + DFTAX = VDFA} \tag{5}$$

$$\mathrm{VFM_{fact} + TFU = VFA_{fact}} \tag{6}$$

$$\mathrm{VOM = VIFM + VDFM + VFM} \tag{7}$$

$$\mathrm{VOA = VIFA + VDFA + VFA_{fact}} \tag{8}$$

$$\mathrm{VOM + PTAX = VOA} \tag{9}$$

Exports are accounted for as part of the domestic accounts. Therefore, the domestic supply must consider both domestic consumption and exports. Thus, the output value (VOM) must equal the total demanded internally; government and private agent (VDFM + VDGM + VDPM) and the value of exports at market price (VXMD), and the Value of Supplied Transport at market price (VST), in addition to domestic investments (VDIM = VDFM("cgds")):

$$\mathrm{VOM = VDFM + VDPM + VDGM + VDIM + VXMD + VST} \tag{10}$$

The Value of Private consumption at Agent prices (VPA) includes the Value of Domestic Private consumption at Market prices (VDPM), and Imported consumption at Market prices (VIPM); in addition to Domestic Private Taxes on consumption (DPTAX) and on Imported consumption (IPTAX). The model considers that firms remunerate private agents, thus, representative agents receive the Output Value at Market prices of the use of the factors ($\mathrm{VOM_{fact}}$). The difference between total consumption and total income is considered private savings (PSAVE):

$$\mathrm{VIPM + IPTAX = VIPA} \tag{11}$$

$$\mathrm{VDPM + DPTAX = VDPA} \tag{12}$$

$$\mathrm{VOM_{fact} = VIPA + VDPA} \tag{13}$$

$$\mathrm{PSAVE = [VOM_{fact}] - [VIPA+VDPA]} \tag{14}$$

In the case of Brazilian regions, household expenses still consider Income Taxes (ITAX), and government Transfers (TRANSF) as income:

$$\mathrm{VOM_{BRA_{fact}} - ITAX_{BRA} + TRANSF_{BRA} = VIPA_{BRA} + VDPA_{BRA}} \tag{15}$$

$$\mathrm{PSAVE_{BRA} = [VOM_{BRA_{fact}} - ITAX_{BRA} + TRANSF_{BRA}] - [VIPA_{BRA} + VDPA_{BRA}]} \tag{16}$$

The Value of Government consumption at Agent prices (VGA = VDGA + VIGA) considers domestic (VDGM) and imported (VIGM) consumption; tariffs on domestic (DGTAX) and imported (IGTAX) consumption. Government revenue includes indirect taxes (INDTAX = IFTAX + IPTAX + IGTAX + DFAX + DPTAX + DGTAX + TFU + TOUT), and income taxes (ITAX). Government collections must equal the total spent, the difference is considered savings (GSAVE):

$$\mathrm{VIGM + IGTAX = VIGA} \tag{17}$$

$$\mathrm{VDGM + DGTAX = VDGA} \tag{18}$$

$$\mathrm{INDTAX + ITAX = VIGA + VDGA} \tag{19}$$

$$\mathrm{GSAVE = [INDTAX + ITAX] - [VIGA + VGA]} \tag{20}$$

In the case of Brazil, government spending must include transfers to families:

$$\mathrm{INDTAX_{BRA} + ITAX_{RBA} - TRANSF_{BRA} = VIGA_{BRA} + VDGA_{BRA}} \tag{21}$$

$$\mathrm{GSAVE_{BRA}[= INDTAX_{BRA} + ITAX_{RBA} - TRANSF_{BRA}] - [VIGA_{BRA} + VDGA_{BRA}]} \tag{22}$$

2.2 Firms Behaviour

The model assumes that each industry produces only one type of commodity. In order to produce the total supply, each industry uses inputs such as domestic and imported raw materials, labour (disaggregated at different levels in Brazil), land (in certain sectors), capital, and natural resources (in certain sectors). Firms produce for both domestic consumption and export. The production process is made explicit by a set of assumptions of separability. The assumption of input-output separability leads to a generalized production function for an industry.

$$\mathtt{F}_{\mathtt{input,\ output}} = 0 \tag{23}$$

can be write as (at agents price):

$$\mathtt{G}_{\mathtt{inputs}} = \mathtt{VOA}_{\mathtt{j,r}} = \mathtt{H}_{\mathtt{outputs}}$$

where $\mathtt{VOA}_{\mathtt{j,r}}$ is the commodity $\mathtt{j}$ produced in region $\mathtt{sr}$.

The production function G is organized into several nesting levels, where each production activity combines intermediate goods and factors to produce output. The production structure is based on a sequence of nested Constant Elasticity of Substitution (CES) functions, which aim to represent the substitution possibilities across the entire input set. The nested structure is depicted in Figure 1. The topmost nest combines commodities (firms consumption) and production factors using a Leontief function, which means they are combined in fixed proportions. Each commodity link is represented by a CES function that determines the substitution between domestic and imported commodities. In Brazil, the labour factor between different levels is combined using a CES function.

This production framework accommodates technological progress, which is captured by variables denoted with the initial letter of the size they pertain to. Technological change affects production in three ways: (1) by decreasing the input needed to produce a given output, (2) by altering the effective price of inputs, and (3) by changing the unit cost of production and, consequently, output prices through the zero profits condition.

2.3 The labour income and labour market

In Brazilian regions the industry also have to choose the skills combination. Each industry $\mathtt{j}$,choose to minimize labour cost:

$$\sum_{\mathtt{s}} [\mathtt{pfe\_lab}_{\mathtt{j,bra,s}}.\mathtt{qfe\_lab}_{\mathtt{j,bra,s}}]$$

such that

$$\mathtt{qfe\_lab}_{\mathtt{j,bra,s}} = \mathtt{CES[all,s,SKL:\ qfe\_lab}_{\mathtt{j,bra,s}}\mathtt{]}$$

The DAYANE model does not explicitly include labour supply theory. However, the model assumes that workers of different skill levels are not perfect substitutes for each other. This means that it is not easy to replace skilled workers with low-skilled workers. This assumption aligns with the research of Andrade and Menezes-Filho (2005) and Freire (2017).

The wage paid to workers depends on the wage rates, $\mathtt{plabj,bra,s}$, and the overall price of labor, $\mathtt{pavelabj\ ,bra}$. When the prices of different types of skills change, employers may hire relatively cheaper workers instead. The ease with which employers can substitute different skill levels is measured by the elasticity $\mathtt{ESKL}_{\mathtt{j,s}}$. A lower elasticity means that it is more difficult for less-skilled workers to replace more highly skilled workers.

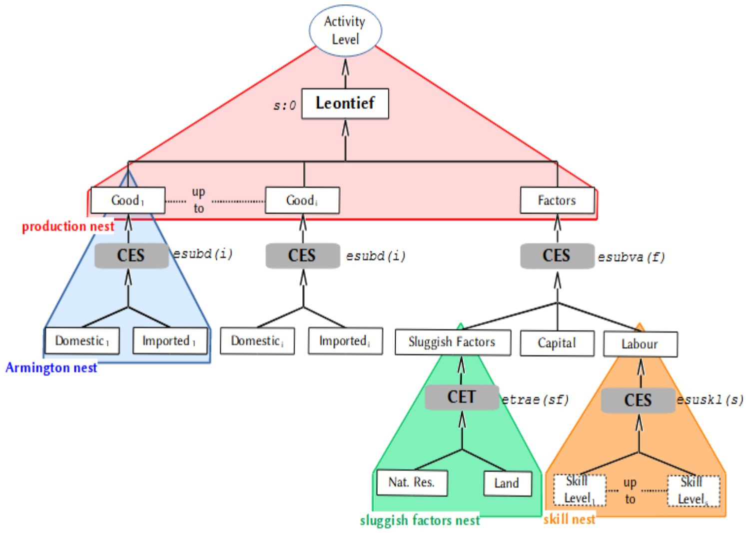

Figure 1: Production structure

esubd(i) – region-generic elasticity of substitution between domestic and imported good *i* for all agent
esubva(f) – elasticity of substitution between factors (capital/labor/land), in production of value added in sector *j*
etrae(sf) – elasticity of transformation for sluggish primary factor endowments

esuskl(s) – elasticity of substitution between different *s* skill types

Another way to understand the elasticity of substitution between different qualifications is by considering how many workers with lower qualifications are needed to replace those with higher qualifications. Therefore, the lower the elasticity `ESKLj,s`, the less easily workers of different skill levels can replace each other. Conversely, the higher the elasticity `ESKLj,s`, the more easily different qualifications can substitute for one another. In the DAYANE model, the elasticity of substitution among different skills is assumed to be 0.5 for all regions and sectors.

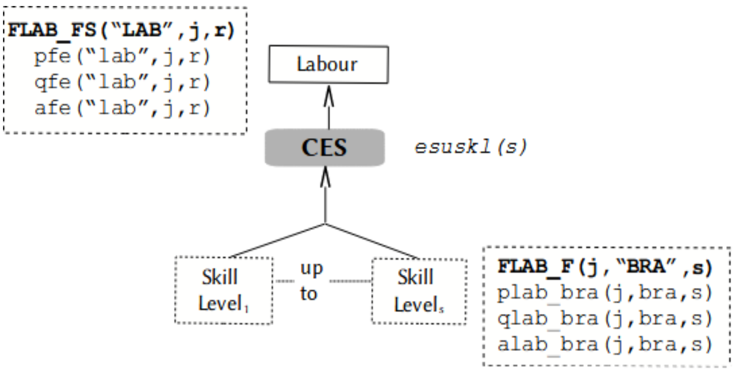

Figure 2: Labour factor nest
FLAB_F(j,"bra",s) – industry wage bills summed over family *fam* in Brazilian regions *bra*; **FLAB_FS("lab",j,r)** – Total labour bill by industry *j* in Brazilian region *r*;
plab_bra(j,bra,s) – market unit wages by industry *j* and skills *s* in Brazilian region *r*; **pfe(i,j,r)** – firms' price for endowment *i* for use by sector *j* in *r*;
qlab_bra(j,bra,s) – employment by industry *j* and skill *s* in Brazilian region *r*; **qfe(i,j,r)** – demand for endowment *i* for use by industry *j* in region *r*;
alab_bra(j,bra,s) – labour-augmenting technical change by sector *j* and skill *s* in Brazilian regions; **afe(i,j,r)** – primary factor *i* augmenting technical change by sector *j* of region
esuskl(s) – elasticity of substitution between skill types *s*.

Equation (2) determines the percentage changes in employment by industry and skill. The market price of labour in each industry is determined by (3). Equation (4) shows the market clearing condition for wages.

$$\begin{aligned} qlab\_bra_{j,bra,s} &= qfe_{"lab",j,bra} - alab\_bra_{j,bra,s} \\ &- ESKL_{j,s}.[plab_{j,bra,s} - alab\_bra_{j,bra,s} - pavelab_{j,bra}] \end{aligned} \quad (24)$$

$$FLAB\_FS_{j,bra}.pavelab_{j,bra} = \sum_{s} FLAB\_F_{j,r,s}.[plab_{j,bra,s} - alab\_bra_{j,bra,s}] \quad (25)$$

$$plab_{j,bra,s} = plabdem_{bra,s} \quad (26)$$

where $FLAB\_FS_{j,bra}$ is the total value of labour bill in sector j in region bra summed over family and skill; $FLAB\_F_{j,r,s}$ is the sector j wage bills, by s, skill in Brazilian region r summed over families.

For regions other than Brazil, the value of $qofac_{"lab",r}$ is exogenous and fixed. However, for Brazilian regions, $qofac_{"lab",r}$ is the sum of labour weighted by both sector and skill levels. To calculate an individual's weighted salary, we multiply their base salary by the number of other workers in the same category who earn that amount. We then divide this figure by the weighted average salary in that category to obtain the weighted salary. The demand for labor by firms will increase as the wage in each skill level decreases. Thus, by substituting $qofac_{"lab",r}$ for $labslack$ (which is a slack variable used to make $qofac$ endogenous in Brazilian regions), we can model this relationship in the DAYANE model.

$$\sum_{j} FLAB\_FS_{j,r}.[pmfac_{"lab",r} + labslack_{r}] = \sum_{j} FLAB\_FS_{j,r}.pavelab_{j,r} \quad (27)$$

The percentage changes on wage costs (or the producer expenditure in labour), $wfmbra_{j,r}$, in each j sector, is therefore:

$$\sum_{j} FLAB\_FS_{j,r} wfmbra_{j,r} = \sum_{s} FLAB\_F_{j,r,s}.[plab_{j,r,s}.qlab\_bra_{j,r,s}] \quad (28)$$

The family (f) labour income in each region (bra) for each skill (s), $wlabinc_{f,bra,s}$ is determined by equation (7).

$$FLAB\_C_{f,bra,s}.wlabinc_{f,bra,s} = \sum_{j} FLAB_{j,f,bra,s}.works_{j,f,bra,s}.plabf_{j,f,bra,s} \quad (29)$$

$$plabf_{j,f,bra,s} = plab\_bra_{j,bra,s} \quad (30)$$

The family labour income summed over skill and sector, is:

$$FWAGE_{f,bra}.wlabinc\_s_{f,bra} = \sum_{s} FLAB\_C_{f,bra,s}.wlabinc_{f,bra,s} \quad (31)$$

where:

$$FLAB\_C_{f,r,s} = \sum_{c} FLAB_{c,f,r,s};$$

$$FWAGE_{f,r} = \sum_{s} FLAB\_C_{f,r,s};$$

The change in employment by industry and skill type $(works_{j,f,bra,s})$ follows $qlab\_bra_{j,bra,s}$ variation. However, it is necessary that the add-up over sectors of $workrs_{c,f,r,s}$ to be equal to the exogenous $\texttt{workrs\_c}_{f,r,s}$, hence the slack variable $\texttt{emplslack}$ on equation (10).

$$\texttt{workrs}_{j,f,r,s} = \texttt{qlab\_bra}_{j,r,s} + \texttt{empslack}_{f,r,s} \tag{32}$$

$$\texttt{WORKERS\_C}_{f,r,s}.\texttt{workrs\_c}_{f,r,s} = \sum_{j} \texttt{WORKERS}_{j,f,r,s}.\texttt{workrs}_{j,f,r,s} \tag{33}$$

where $\texttt{WORKERS}_{j,f,r,s}$ is the total employment from families.

It is possible to consider workers' mobility among skills (instead of changes in wages prices). Equation (12) shows the key to change workers (families heads) between different skills.

$$\texttt{WORKERS\_C}_{f,r,"s-1"}.\texttt{workrs\_c}_{f,r,"s-1"} = -\texttt{WORKERS\_C}_{f,r,"s"}.\texttt{workrs\_c}_{f,r,"s"} + \texttt{ffskl}_{f,r} \tag{34}$$

The equation indicates that replacing ffskl with workers_c leads to a decrease in the number of workers in S3 and an increase in the number of workers in S5. As a result, families in S3 will earn higher wages while families in S5 will experience a reduction in labor income. The magnitude of the effect depends on the "award" given and the percentage change in income. However, if the income in S5 is lower than that of S3, the impact would be negative.

2.3.1 Top production nest

The top level nest is composed of two aggregate composite bundles: intermediate demand and value added. The second level nests decompose each of the two aggregate nests into their components: on the one hand demand for intermediate goods and demand for individual factors. The composite index of output from activity j, represented by $\texttt{qo}_{j,r}$, is a combination of an intermediate demand bundle, $\texttt{qf}_{i,j,r}$, with the value added bundle, $\texttt{qva}_{j,r}$.

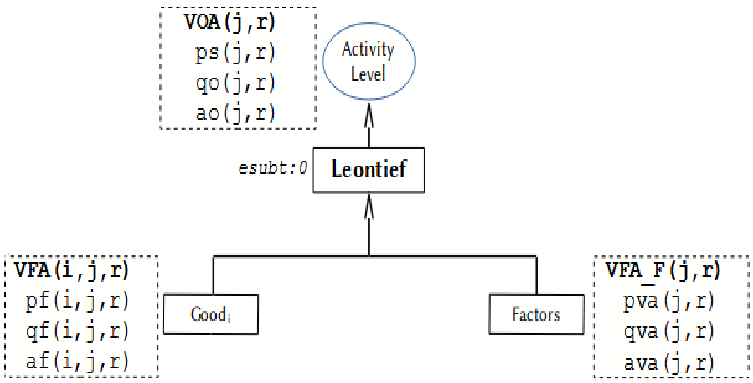

Figure 3: Top Production Nest

VFA(i,j,r) – producer expenditure on good *i* by sector *j* in region *r* valued at agent's prices; **VFA_F(j,r)** – producer expenditure on good *i* by sectorj in region *r* valued at agent's prices summed over factors;**VOA(j,r)** – value of good *i* output in region *r* at agent's prices;
ps(i,r) – Supply price of commodity i in region r; **pf(i,j,r)** – firms' price for good *i* for use by sector *j* in *r*; **pva(j,r)** – firms' price of value added in industry *j* of region *r*;
qo(i,r) – industry output of good *i* in region *r*; **qf(i,j,r)** – demand for good *i* for use by industry *j* in region *r*; **qva(j,r)** – value added in industry j of region r;
ao(j,r) – output augmenting technical change in sector *j* of region *r*; **af(i,j,r)** – composite intermediary input *i* augmenting technical change by sector *j* of region *r*; **ava(j,r)** – value added augmenting technical change in sector i of r ;
esubt – elasticity of substitution among composite intermediate inputs in production.

Equations (35) and (36) define the demand for the two top level bundles where the key substitution elasticity is $\texttt{ESUBT}_j (= 0)$. Equation (37), presented as a levels equation, represents the clearing (zero-profit) condition for j – the total revenue of this sector must be equal to the sum of all the input costs. Equation (37) can be totally differentiated to give $(37')$.

$$\mathtt{qf}_{\mathtt{i,j,r}} = \mathtt{qo}_{\mathtt{j,r}} - \mathtt{af}_{\mathtt{i,j,r}} - \mathtt{ao}_{\mathtt{j,r}} - \mathtt{ESUBT}_{\mathtt{j}}.[\mathtt{pf}_{\mathtt{i,j,r}} - \mathtt{af}_{\mathtt{i,j,r}} - \mathtt{ps}_{\mathtt{j,r}} - \mathtt{ao}_{\mathtt{j,r}}] \tag{35}$$

$$\mathtt{qva}_{\mathtt{j,r}} = \mathtt{qo}_{\mathtt{j,r}} - \mathtt{ava}_{\mathtt{i,j,r}} - \mathtt{ao}_{\mathtt{j,r}} - \mathtt{ESUBT}_{\mathtt{j}}.[\mathtt{pva}_{\mathtt{j,r}} - \mathtt{ava}_{\mathtt{j,r}} - \mathtt{ps}_{\mathtt{j,r}} - \mathtt{ao}_{\mathtt{j,r}}] \tag{36}$$

$$\mathtt{PS}_{\mathtt{j,r}}.\mathtt{QO}_{\mathtt{j,r}} = \mathtt{PF}_{\mathtt{i,j,r}}.\mathtt{QF}_{\mathtt{i,j,r}} + \mathtt{PVA}_{\mathtt{j,r}}.\mathtt{QVA}_{\mathtt{j,r}} \tag{37}$$

$$\mathtt{ps}_{\mathtt{j,r}} = \sum_{\mathtt{e}} \mathtt{STC}_{\mathtt{e,j,r}}.[\mathtt{pfe}_{\mathtt{e,j,r}} - \mathtt{afe}_{\mathtt{e,j,r}} - \mathtt{ava}_{\mathtt{j,r}}] + \sum_{\mathtt{i}} \mathtt{STC}_{\mathtt{i,j,r}}.[\mathtt{pf}_{\mathtt{i,j,r}} - \mathtt{af}_{\mathtt{i,j,r}} - \mathtt{ava}_{\mathtt{j,r}}] - \mathtt{ao}_{\mathtt{j,r}} \tag{37'}$$

where $\mathtt{STC}_{\mathtt{k,j,r}} = \dfrac{\mathtt{VFA}_{\mathtt{k,j,r}}}{\sum_{\mathtt{i}} \mathtt{VFA}_{\mathtt{k,j,r}}}$, $\mathtt{k} \in \mathtt{DEMD\_COMM}$[8], is the share of $\mathtt{i}$ in total costs of $\mathtt{j}$ in $\mathtt{r}$.

2.3.2 Intermediate Consumption Composite Nest

At this point, the intermediate nest describes the composition of the commodity bundle – imported and domestic produced $\mathtt{i}$, $\mathtt{qf}_{\mathtt{i,j,r}}$. Domestic inputs are represented by $\mathtt{qfd}_{\mathtt{i,j,r}}$ and imported by $\mathtt{qfm}_{\mathtt{i,j,r}}$.

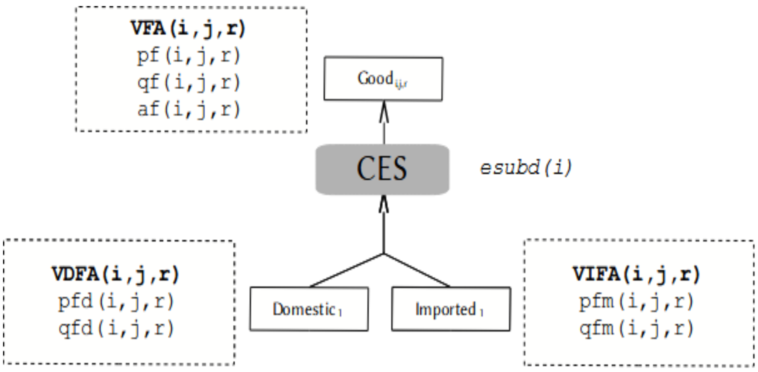

Figure 4: Intermediate Consumption Composite Nest

VDFA(i,j,r) – purchases of domestic *i* for use by *j* in region *r* ; **VIFA(i,j,r)** – purchases of imported *i* for use by *j* in region *r*; **VFA(i,j,r)** – producer expenditure on good *i* by sector *j* in region *r* valued at agent's prices;
pf(i,j,r) – firms' price for good *i* for use by sector *j* in *r*; **pfd(i,j,r)** – price index for domestic purchases of good *i* by sector *j* in region *r*; **pfm(i,j,r)** – price index for imports of good *i* by *j* in region *r*;
qf(i,j,r) – demand for good *i* for use by industry *j* in region *r*; **qfd(i,j,r)** – domestic good *i* demanded by industry *j* in region *r* ; **qfm(i,j,r)** – demand for *i* by industry *j* in region *r*; **af(i,j,r)** – composite intermediary input*i* augmenting technical change by *j* of *r*;
esubd(i) – region-generic elasticity of substitution between domestic and imported good *i* for all agent.

Equations (38) and (39) determine firms demand for domestically produced goods and the composite import good. The key substitution elasticity is $\mathtt{ESUBD}_{\mathtt{i}}$ – the Armington elasticity that determines the degree of substitutability between domestic and imported goods (is used in the Goverment Household, Private Household, and Firms). Equation (40) defines the price of the composite and $(40')$ gives the percentage change form of $\mathtt{pf}_{\mathtt{i,j,r}}$, the price index

[8] See Appendix **??**

for domestic purchases of $\mathtt{i}$ by $\mathtt{j}$ in region $\mathtt{r}$.

$$qfm_{i,j,r} = qf_{i,j,r} - ESUBD_i.[pfm_{i,j,r} - pf_{i,j,r}] \quad (38)$$
$$qfd_{i,j,r} = qf_{i,j,r} - ESUBD_i.[pfd_{i,j,r} - pf_{i,j,r}] \quad (39)$$
$$PF_{i,j,r}.QF_{i,j,r} = PFD_{i,j,r}.QFD_{i,j,r} + PFM_{i,j,r}.QFM_{i,j,r} \quad (40)$$
$$pf_{i,j,r} = [FMSHR_{i,j,r}.pfm_{i,j,r}] + [(1 - FMSHR_{i,j,r}.pfd_{i,j,r})] \quad (40')$$

where $FMSHR_{i,j,r} = \frac{VIFA_{i,j,r}}{\sum_i VFA_{i,j,r}}$, $i \in COMM$, is the share of firms' imports in domestic composite at agent's prices.

2.3.3 Value Added Nest

The next technology tree explains the composition of demand for production factors, that is, the added value. In each region, the sectors will seek to minimize costs with the primary factors of production according to function:

$$VFA\_F_{j,r} = CES\left[\frac{VFA_{"sf",j,r}}{AFE_{"sf",j,r}}, \frac{VFA_{"lab",j,r}}{AFE_{"lab",j,r}}, \frac{VFA_{"cap",j,r}}{AFE_{"cap",j,r}}\right]$$

Tthe value added bundle, $qva_{j,r}$, is a CES aggregation of $qfe_{i,j,r}$, where $\mathtt{i}$ its de endowment (sluggish, $\mathtt{sf}$, or mobile factors – $\mathtt{cap;\ lab}$), as given in equation (41).

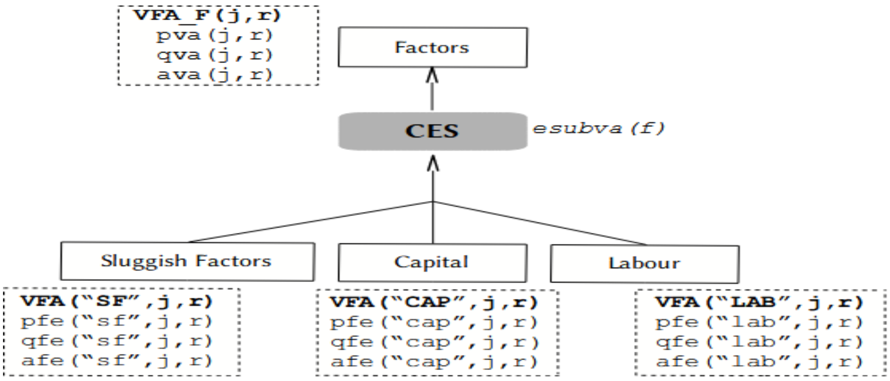

Figure 5: Value Added Nest

VFA(i,j,r) – producer expenditure on factor *i* by sector *j* in region *r* valued at agent's prices; **VFA_F(j,r)** – producer expenditure on factor *i* by sectorj in region *r* valued at agent's prices summed over factors;
pfe(i,j,r) – firms' price for endowment *i* for use by sector *j* in *r*; **pva(j,r)** – firms' price of value added in industry *j* of region *r*;
qfe(i,j,r) – demand for endowment *i* for use by industry *j* in region *r*; **qva(j,r)** – value added in industry j of region r;
afe(i,j,r) – primary factor *i* augmenting technical change by sector *j* of region *r*; **ava(j,r)** – value added augmenting technical change in sector *j* in region *r* ;
esubva(f) – elasticity of substitution between factors (capital/labor/land), in production of value added in sector *j*.

The key substitution elasticity is $ESUBVA_j$ which is differentiated by produced commodity. The price of the value-added bundle, $PVA_{j,r}$ is given by equation (42), where $PFE_{i,j,r}$ is the sector and factor-specific price of endowment $\mathtt{i}$.

$$qfe_{i,j,r} = qva_{j,r} - afe_{i,j,r} - ESUBVA_j.[pfe_{i,j,r} - afe_{i,j,r} - pva_{i,j,r}] \quad (41)$$

$$PVA_{j,r}.QVA_{j,r} = \sum_i PFE_{i,j,r}.QFE_{i,j,r} \quad (42)$$

$$pva_{j,r} = \sum_i SVA_{k,j,r}.[pfe_{i,j,r} - afe_{k,j,r}] \quad (42')$$

where $\mathtt{SVA}_{\mathtt{k,j,r}} = \frac{\mathtt{VFA}_{\mathtt{k,j,r}}}{\sum_{\mathtt{i}} \mathtt{VFA}_{\mathtt{k,j,r}}}$, $\mathtt{k} \in \mathtt{ENDW\_COMM}$, is the share of k in total value added in j in r.

Equation (43) and (44) links the equilibrium market price of endowments, $\mathtt{pmfac}_{\mathtt{i,r}}$ – for mobile endowmnets, and $\mathtt{pmes}_{\mathtt{i,r}}$ – for sluggish endowment, to the producer price, $\mathtt{pfe}_{\mathtt{i,j,r}}$, that includes an endowment and activity-specific tax – the power of the tax is identified with $\mathtt{tf}_{\mathtt{i,j,r}}$.

$$\mathtt{pfe}_{\mathtt{i,j,r}} = \mathtt{pmfac}_{\mathtt{i,r}} + \mathtt{tf}_{\mathtt{i,j,r}}, \qquad \mathtt{i} \in \mathtt{ENDWM\_COM} \tag{43}$$

$$\mathtt{pfe}_{\mathtt{i,j,r}} = \mathtt{pmes}_{\mathtt{i,j,r}} + \mathtt{tf}_{\mathtt{i,j,r}}, \qquad \mathtt{i} \in \mathtt{ENDWS\_COM} \tag{44}$$

Equation (45) represents the equilibrium condition for mobile endowments where $\mathtt{QOFAC}_{\mathtt{i,r}}$ represents the (fixed) aggregate endowment and $\mathtt{QFE}_{\mathtt{i,j,r}}$ is demand for endowment e by activity a.

$$\mathtt{QOFAC}_{\mathtt{i,r}} = \sum_{\mathtt{i}} \mathtt{QFE}_{\mathtt{i,j,r}} \tag{45}$$

$$\mathtt{qofac}_{\mathtt{i,r}} = \sum_{\mathtt{j}} \mathtt{SHREM}_{\mathtt{i,j,r}} . \mathtt{qfe}_{\mathtt{i,j,r}} \tag{45'}$$

$$\mathtt{psfac}_{\mathtt{i,r}} = \mathtt{pmfac}_{\mathtt{i,r}} \tag{46}$$

where $\mathtt{SHREM}_{\mathtt{i,j,r}} = \frac{\mathtt{VFM}_{\mathtt{i,j,r}}}{\sum_{\mathtt{i}} \mathtt{VOM}_{\mathtt{i,r}}}$, $\mathtt{i} \in \mathtt{ENDWM\_COMM}$, is the share of mobile endowment, i used by sector j at market prices.

2.4 Trade market

2.4.1 Sourcing of imports

At this conjuncture, all agents in the economy have a well-specified commodity-specific demand for domestic and composite imported goods. The sourcing of imports by region of origin is done at the regional level in the destination country.

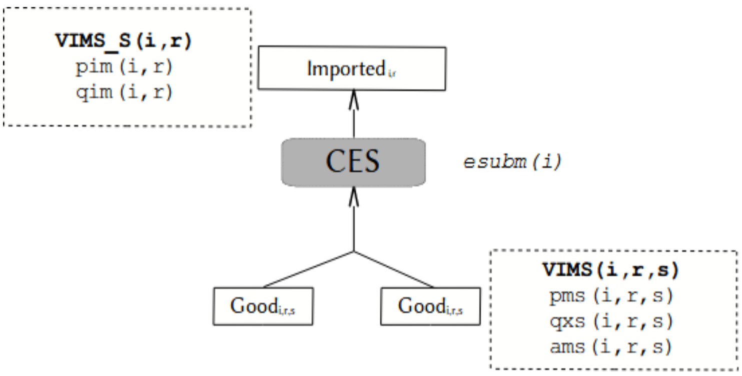

Figure 6: Imported Nest

VIMS(i,r,s) – imports of commodity *i* of region *r* from source region *s* valued at domestic market prices; **VIMS_S(i,r)** – imports of commodity *i* of region *r* summed over source region valued at domestic market prices;
pms(i,r,s) – domestic price for good *i* supplied from *r* to region *s*; **pim(i,r)** – market price of composite import *i* in region *r*;
qxs(i,r,s) – export sales of commodity *i* from *r* to region *s*; **qim(i,r)** – aggregate imports of *i* in region *r*, market price weights;
ams(i,r,s) – import of commodity *i* from region *r* augmenting technical change in source region *s*;
esubm(i) – region-generic elasticity of substitution among imports of *i* in Armington structure.

With a CES preference function for the sourcing of imports, the demand for each good by region of origin is given by equation (61), where $\mathtt{ESUBM}_{\mathtt{i}}$ is the substitution elasticity for imports by commodity and the price $\mathtt{pms}_{\mathtt{i,r,s}}$ is the domestic price for good $\mathtt{i}$ supplied from $\mathtt{r}$ to region $\mathtt{s}$. The aggregate import price, $\mathtt{PIM}_{\mathtt{i,s}}$ is defined in equation (62).

$$\mathtt{qxs}_{\mathtt{i,r,s}} = \mathtt{qim}_{\mathtt{i,s}} - \mathtt{ams}_{\mathtt{i,r,s}} - \mathtt{ESUBM}_{\mathtt{i}}.[\mathtt{pms}_{\mathtt{i,j,r}} - \mathtt{ams}_{\mathtt{i,r,s}} - \mathtt{pim}_{\mathtt{i,s}}] \tag{47}$$

$$\mathtt{PIM}_{\mathtt{i,s}}.\mathtt{QIM}_{\mathtt{i,s}} = \sum_{\mathtt{r}} \mathtt{PMS}_{\mathtt{i,r,s}}.\mathtt{QXS}_{\mathtt{i,r,r}} \tag{48}$$

$$\mathtt{pim}_{\mathtt{i,s}} = \sum_{\mathtt{r}} \mathtt{MSHRS}_{\mathtt{i,r,s}}.[\ \mathtt{pms}_{\mathtt{i,r,s}} - \mathtt{ams}_{\mathtt{i,r,s}}] \tag{62'}$$

where $\mathtt{MSHRS}_{\mathtt{i,r,s}} = \frac{\mathtt{VIMS}_{\mathtt{i,r,s}}}{\sum_{\mathtt{r}} \mathtt{VIMS}_{\mathtt{i,r,s}}}, \quad \mathtt{r} \in \mathtt{REG}_{\mathtt{dest}}$ is the Share of imports from r in import bill of s at mkt prices

2.4.2 International trade and transport margins

Trade flows from region $\mathtt{r}$ to region $\mathtt{s}$ generate demand for trade and transport services. Demand is in fixed proportion to the quantity being delivered, with the possibility of improvements in transport efficiency, captured by the technical coefficient $\mathtt{atmfsd}$ efficiency of Transportation. Equation (49) describes the demand for trade and transport service $\mathtt{m}$, to deliver good $\mathtt{i}$ from region $\mathtt{r}$ to region $\mathtt{s}$. The global demand for margin service m is the sum of demand across all commodities and across all bilateral trade nodes, as shown in Equation (50).

$$\mathtt{qtmfsd}_{\mathtt{m,i,r,s}} = \mathtt{qxs}_{\mathtt{i,r,s}} - \mathtt{atmfsd}_{\mathtt{m,i,r,s}} \tag{49}$$

$$\mathtt{QTM}_{\mathtt{m}} = \sum_{\mathtt{i}} \sum_{\mathtt{r}} \sum_{\mathtt{s}} \mathtt{QTMFSD}_{\mathtt{m,i,r,s}} \tag{50}$$

$$\mathtt{qtm}_{\mathtt{m}} = \sum_{\mathtt{i}} \sum_{\mathtt{r}} \sum_{\mathtt{s}} \mathtt{VTMUSESHR}_{\mathtt{m,i,r,s}}.[\mathtt{qtmfsd}_{\mathtt{m,i,r,s}}] \tag{50'}$$

where $\mathtt{VTMUSESHR}_{\mathtt{m,i,r,s}}$ is the share of $\mathtt{i,r,s}$ usage in global demand for $\mathtt{m}$.

The variable $\mathtt{qtmfsd}$ computes the bilateral demand for international transportation services. It reflects the fact that the demand for services along any particular route is proportional to the quantity of merchandise shipped, $\mathtt{QXS}_{\mathtt{i,r,s}}$. The potential for input-augmenting technical change, $\mathtt{atmfsd}_{\mathtt{m,i,r,s}}$, which is commodity and route-specific.

Thus, in the levels: $\mathtt{ATMFSD}_{\mathtt{m,i,r,s}}.\quad \mathtt{QTMFSD}_{\mathtt{m,i,r,s}} = \mathtt{QXS}_{\mathtt{i,r,s}}$; where $\mathtt{QTMFSD}$ is the amount of composite margins services m used along this route. Technological improvements are reflected by atmfsd(i,r,s) > 0, and these reduce the margins of services required for this i,r,s triplet. Tech. Change also dampens the cost of shipping, thereby lowering the CIF price implied by a given FOB value

Given the lack of bilateral supplies of shipping services, each mode of transport, $\mathtt{m}$, is supplied at a uniform price $\mathtt{PT}_{\mathtt{m}}$ across the world. This global transport price is a composite based on the price of national margin services exports, as shown in equation (51).

$$\mathtt{PT}_{\mathtt{m}}.\mathtt{QT}_{\mathtt{m}} = \sum_{\mathtt{r}} \mathtt{PM}_{\mathtt{m,r}}.\mathtt{QST}_{\mathtt{m,r}} \tag{51}$$

$$\mathtt{pt}_{\mathtt{m}} = \sum_{\mathtt{r}} \mathtt{VTSUPPSHR}_{\mathtt{m,r}}.[\mathtt{pm}_{\mathtt{m,r}}] \tag{51'}$$

where $\mathtt{VTSUPPSHR}_{m,i,r,s}$ is the share of region r in global supply of margin m.

The variable $\mathtt{pt}_{(m}$ generates a price index for transportation services based on zero profits. Sales to international transportation are not subject to export tax (this is why costs are based to the transport sector on market prices of the goods sold to international transportation). It is assumed that the supply shares for margin services are uniform across freight, source of freight, and destination.

To compute the composite FOB-CIF margin, it is necessary to aggregate these modal specific prices overall relevant modes of transport for that particular commodity. Any transport efficiency changes enter into this calculation as well, giving equation (66). There is a 'global' transport sector that purchases the services m from each region. The global purchaser wishes to minimize the cost of purchasing the services across regions, subject to a CES preference function. Optimal demand is given by equation (67), which determines $\mathtt{QST}_{m,r}$, the regional supply of trade service m.

$$\mathtt{ptrans}_{i,r,s} = \sum_{m} \mathtt{VTFSD\_MSH}_{m,i,r,s} . [\mathtt{pt}_{m} - \mathtt{atmfsd}_{m,i,r,s}] \tag{52}$$

$$\mathtt{qst}_{m,r} = \mathtt{qtm}_{m} + [\mathtt{pt}_{m} - \mathtt{pm}_{m,r}] \tag{53}$$

where $\mathtt{VTFSD\_MSH}_{m,i,r,s}$ Share of region r in global supply of margin m.

Variable qst generates the international transport sector's derived demand for regional supplies of transportation services. It reflects a unitary elasticity of substitution between transportation services inputs from different regions.

2.5 Private Expenditure

The domestic market is comprised of goods that are produced domestically and those that are imported, and these goods are aggregated using the CES method by assumption. Consumers in this market aim to acquire a specific quantity of goods while minimizing their expenditures, considering the prices of both imported and domestic products. The optimal proportion of domestic and imported goods is determined by the relative prices and elasticity of substitution, which can be obtained by solving the problem of minimizing consumption expenditure, subject to the CES aggregation function.

2.5.1 Government Consumption

Government expenditure (GOVEXP) in each region r is derived by combining each commodity indexed by i. At the highest level of the government's technological consumption tree, the goods are combined using a fixed-proportions Leontief function ($\mathtt{ESUBG}_{i}$: 0). The second-level technology tree shows that the government decomposes the domestic and imported goods from individually consumed goods (at the Armington level), and the elasticity of substitution of the single good composite (domestic and imported) is represented by esubd(i).

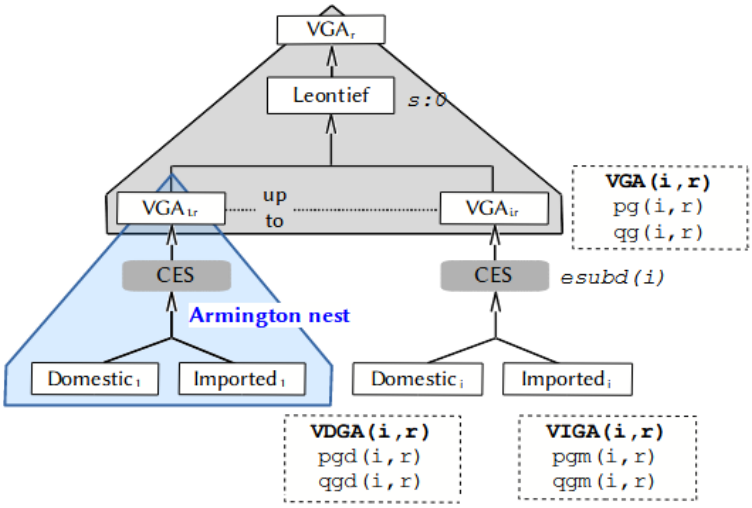

Figure 7: Government Technological Tree

VDGA(i,r) – government consumption expenditure on domestic good *i* in region *r* - valued at agent's prices; **VIGA(i,r)** – government consumption expenditure on imported good *i* in region *r* - valued at agent's prices; **VGA(i,r)** – government consumption expenditure on good *i* in region *r* valued at agent's prices; **VGA(r)** – government expenditure in region *r* ;
pgd(i,r) – price of domestic *i* in government consumption in *r*; **pgm(i,r)** – price of imports of *i* in government consumption in region *r*; **pg(i,r)** – government consumption price for commodity *i* in region *r*
qgd(i,r) – government demand for domestic *i* in region *r*; **qgm(i,r)** – government demand for imported *i* in region *r*; **qg(i,r)** – government demand for commodity *i* in region *r*;
esubd(i) – region-generic elasticity of substitution domestic/imported for all agents.

Equation (54) determines composite commodity demand by the government for commodity i in region r. The government expenditure price index is provided in equation (55).

$$\mathtt{qgov}_r = \sum_i \left[\frac{\mathtt{VGA}_{i,r}}{\mathtt{GOVEXP}_r}\right] . \mathtt{qg}_{i,r} \tag{54}$$

$$\mathtt{pgov}_r = \sum_i \left[\frac{\mathtt{VGA}_{i,r}}{\mathtt{GOVEXP}_r}\right] . \mathtt{pg}_{i,r} \tag{55}$$

Public expenditures on the composite goods are subsequently decomposed into demand for domestic and imported goods using a CES sub-utility preference function. Equations (56), (57) and (58) determine public demand for domestic goods in r ($\mathtt{qgm}_{i,r}$), imported goods ($\mathtt{qgd}_{i,r}$) and the government price of the composite good ($\mathtt{pg}_{i,r}$).

$$\mathtt{qgm}_{i,r} = \mathtt{qg}_{i,r} - \mathtt{ESUBD}_i . [\mathtt{pgm}_{i,r} - \mathtt{pg}_{i,r}] \tag{56}$$

$$\mathtt{qgd}_{i,r} = \mathtt{qg}_{i,r} - \mathtt{ESUBD}_i . [\mathtt{pgd}_{i,r} - \mathtt{pg}_{i,r}] \tag{57}$$

$$\mathtt{PG}_{i,r} . \mathtt{QG}_{i,r} = \mathtt{PGD}_{i,r} . \mathtt{QGD}_{i,r} + \mathtt{PGM}_{i,r} . \mathtt{QGM}_{i,r} \tag{58}$$

$$\mathtt{pg}_{i,r} = [\mathtt{GMSHR}_{i,r} . \mathtt{pgm}_{i,r}] + [(1 - \mathtt{GMSHR}_{i,r} . \mathtt{pgd}_{i,r})] \tag{58'}$$

The government consumption expenditure :

$$\mathtt{ygov}_r = \mathtt{pgov}_r + \mathtt{qgov}_r \tag{59}$$

2.5.2 Private Agent Expenditure

Private consumption follows a similar process to that of the Government, starting from the Armington Nest and combining the consumption of domestic and imported goods using a CES function with an elasticity denoted as esubd. At the highest level of the consumption tree, the various goods are combined using a CES function of unit elasticity (s:1), which means that

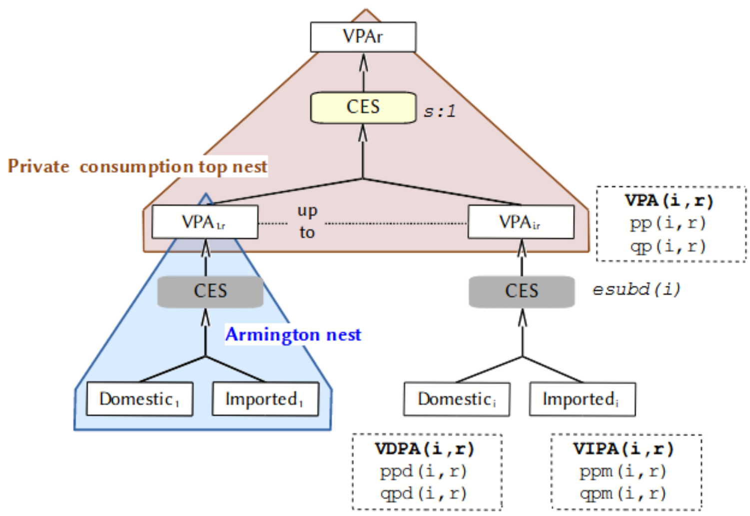

Figure 8: Private Agent Technological Tree

VDPA(i,r) – private consumption expenditure on domestic good *i* in region *r* - valued at agent's prices; **VIPA(i,r)** – private consumption expenditure on imported good *i* in region *r* - valued at agent's prices; **VPA(i,r)** – private consumption expenditure on good *i* in region *r* valued at agent's prices; **VPA(r)** – private expenditure in region *r*;
ppd(i,r) – price of domestic *i* in private consumption in *r*; **ppm(i,r)** – price of imports of *i* in government consumption in region *r*; **pp(i,r)** – private consumption price for commodity *i* in region *r*
qpd(i,r) – private demand for domestic *i* in region *r*; **qpm(i,r)** – private demand for imported *i* in region *r*; **qp(i,r)** – private demand for commodity *i* in region *r*;
esubd(i) – region-generic elasticity of substitution domestic/imported for all agents.

the quantity consumed varies proportionally to the change in price.

The private consumption price index $\mathtt{ppriv}_r$ is just a weighted average of prices of the composite goods:

$$\mathtt{ppriv}_r = \sum_i [\mathtt{CONSHR}_{i,r} . \mathtt{pp}_{i,r}] \tag{60}$$

where $\mathtt{CONSHR}_{i,r}$ is the share of household consumption devoted to good i in r.

Private expenditures on composite goods are decomposed into demand for domestic and imported commodities using a CES preference function. Equations (61), (62), and (63) determine the private demand for domestic goods ($\mathtt{qpdi,r}$), the demand for imported goods ($\mathtt{qpmi,r}$), and the consumer price of the composite ($\mathtt{pp}_{i,r}$).

$$\mathtt{qpm}_{i,r} = \mathtt{qp}_{i,r} - \mathtt{ESUBD}_i . [\mathtt{ppm}_{i,r} - \mathtt{pp}_{i,r}] \tag{61}$$

$$\mathtt{qpd}_{i,r} = \mathtt{qp}_{i,r} - \mathtt{ESUBD}_i . [\mathtt{ppd}_{i,r} - \mathtt{pp}_{i,r}] \tag{62}$$

$$\mathtt{PP}_{i,r} . \mathtt{QP}_{i,r} = \mathtt{PPD}_{i,r} . \mathtt{QPD}_{i,r} + \mathtt{PPM}_{i,r} . \mathtt{QPM}_{i,r} \tag{63}$$

$$\mathtt{pp}_{i,j,r} = [\mathtt{PMSHR}_{i,r} . \mathtt{ppm}_{i,r}] + [(1 - \mathtt{PMSHR}_{i,r} . \mathtt{ppd}_{i,r})] \tag{63'}$$

The aggregated private consumption expenditure in region r, is, therefore:

$$\mathtt{yp}_r = \mathtt{qp}_{i,r} + \mathtt{pp}_{i,r} \tag{64}$$

In the case of Brazilian households in different regions, their private consumption ($\mathtt{VPAi,r}$) is allocated to each income class based on their share of total consumption in the region. The approach taken is to first retrieve the consumption of each household in the region from the database ($\mathtt{FVPAi,r,f}$)[9] and then use a set of equations to link household consumption

[9] $\sum_f \mathtt{FVPAi,r,f} = \mathtt{VPAi,r}$

with private consumption (prices and quantities), taking into account the proportion of each household's consumption in the total consumption of the region (FCSHR).

$$\mathtt{pfam}_{r,f} = \sum_{i} \mathtt{FCSHR}_{i,r,f} \cdot \mathtt{pp}_{i,r} \tag{65}$$

$$\mathtt{FVPA\_F}_{i,r} \cdot \mathtt{qp}_{i,r} = \sum_{f} \mathtt{FVPA}_{i,r,f} \cdot \mathtt{qfp}_{i,r,f} \tag{66}$$

$$\mathtt{ypf}_{r,f} = \mathtt{qfp}_{i,r,f} + \mathtt{pp}_{r,f} \tag{67}$$

where $\mathtt{qfp}_{i,r,f}$ is the family f demand for commodity i in region r; $\mathtt{pfam}_{r,f}$ is the price index for family expenditure in region r; and, $\mathtt{ypf}_{r,f}$.

2.5.3 Model's Assumptions

In contrast to the standard GTAP approach, the DAYANE model does not utilize the "Global Bank" approach, as it considers investment volume as exogenous and fixed. Specifically, after a shock, the amount of investments in the database remains constant, but their prices become endogenous, leading to changes in their value. In the DAYANE model, total investment is equal to household savings, and investment demand is simplified and kept fixed, along with international capital flows and the time path of adjustment. The model does not incorporate changes in international (interregional) financial capital flows resulting from trade policy changes. Instead, the capital market closure used involves fixed net capital inflows and outflows.

The economy is kept in a full-employment condition, meaning that all available factors of production are used, and there is no frictional unemployment. The factor markets are competitive, and labour and capital are mobile between sectors, but not between regions. However, the model is limited in its ability to work with multiple households and capital and labour mobility because part of household income also depends on factors. Therefore, the rate of unemployment in the long run is determined by mechanisms outside of the model.

Labour is assumed to be able to move between different types of skills. Employment is determined by demand, which is driven by industry outputs, technologies, and pre-tax wage rates relative to the costs of using other primary factors in the production process. However, the model allows for a policy shock to generate movements in labor supply between skills. For example, if a policy shock induces an increase in the wage rate of skilled labor relative to the unskilled, the model allows for an increase in skilled labor supply with a corresponding reduction in unskilled supply. The model assumes that wages are free to adjust in response to a labor supply shock, following the approach of Dixon et al. (2019) and Soliman et al. (2015).

The model assumes trade in goods differentiated by country of origin, which are combined using a CES aggregator into a composite good for intermediates or final consumption. The long-run macro-closure fixes the balance of trade as a proportion to GDP, as the rest of the world may be unwilling to fund an increased trade deficit, implying that exchange rates must adjust to accommodate changes in the trade balance.

The families total expenditure follows increases on total income[10]:

[10] $VFACINC(i,r) * wfacinc(i,r) = sum\{j, COM, VFM(i,j,r) * [pmfac(i,r) + qfe(i,j,r)]\}$

$$\mathrm{VFAMINC}_{f,r}.\mathrm{wfaminc}_{f,r} = \mathrm{VFACTINC}_{f,r}.\mathrm{wfactinc}_{f,} + \sum_{t}\mathrm{TRANSF}_{f,r,t}.\mathrm{wtransf}_{f,r,t} - \mathrm{ITAX}_{f,r}.\mathrm{witax}_{f,r};$$

$$\mathrm{VFACTINC}_{f,r} = \mathrm{FCAP}_{f,r} + \mathrm{FLND}_{f,r} + \mathrm{FWAGE}_{f,r};$$

$$\mathrm{VFACTINC}_{f,r}.\mathrm{wfactinc}_{f,r} = \mathrm{FCAP}_{f,r}.\mathrm{wfamcap}_{f,r} + \mathrm{FLND}_{f,r}.\mathrm{wfamland}_{f,r} + \mathrm{FWAGE}_{f,r}.\mathrm{wlabinc\_s}_{f,r};$$

$$\mathrm{ypf}_{r,f} = \mathrm{wfaminc}_{f,r};$$

The value of factors income is determined by factor prices and quantities. Transfers and direct income tax are, on default mode, endogenous and follow the percentage changes in GDP and in families total income, respectively:

$$\mathrm{VFACTINC}_{i,r}.\mathrm{wfactinc}_{i,r} = \sum_{c}\mathrm{VFM}_{i,c,r}.[\mathrm{pmfac}_{i,r} + \mathrm{qofac}_{i,r}];$$

$$\mathrm{wtransf}_{f,r,t} = \mathrm{ftransf}_{f,r,t} + \mathrm{wgdpbra};$$

$$\mathrm{witax}_{f,r} = \mathrm{wfactinc}_{f,r} + \mathrm{fitax}_{f,r}$$

In the model, the variables `ftransf` and `fitax` act as shifters that enable the exogenous shock of transfers and income tax. This is done by replacing the previously endogenous variables `wtransf` and `witax`. If transfers and income tax were endogenous, they would follow changes in Brazilian GDP (`wgdpbra`) and income gains (`wfactinc`), respectively.

The GDP calculated on the income side, represented by the sum of endowments and indirect taxes (`ENDW + IndTax`), must be equal to the GDP calculated on the expenditure side, represented by the sum of private consumption, investment, government spending, and net exports (`C + I + G + (X-M)`). Therefore, in the Dayane Model's standard closure, government spending on commodities is treated as a residual, since investment and the trade balance are fixed, and private consumption follows household income in Brazil and regional income in other regions (as previously mentioned). Some scholars, such as Adams (2003), argue that the "slack" assumption of government on GDP simply implies that the loss of tariff revenue does not lead to reduced government spending or increases in other taxes. Many published GTAP applications adopt this assumption.

It is reasonable to assume that the government will absorb all possible distorting effects on the economy, both direct and indirect. However, changes in public policies must also be measured in terms of their costs. Therefore, it is important to track the government's accounts to determine the costs of the new policy. Government income includes all taxes, including income tax from families in Brazil, while government expenses include VGA and transfers to families in different Brazilian regions.

In order to prevent isolation of different governments within Brazil, it is assumed that regional governments receive all commodity taxes and pay for all final demands. They also receive/send transfers to the Federal Government to cover any differences. The Federal Government receives all income taxes, pays for transfers to families, and transfers to Regional Governments. This ensures that real government consumption in each Brazilian region follows the national value, as given by the equation `qg`. However, `pgov` and `wgov` differ between regions.

$$\mathrm{qg}_{i,r} = \mathrm{fqg\_i}_{r} + \mathrm{fqg}_{i,r} + \mathrm{ISBRA}_{r}.\mathrm{govslack}$$

where ISBRA is a key for Brazilian regions and govslack is a slack variable to align Government spending in Brazil.

2.5.4 The applied shocks

Two standard scenarios will be analyzed in this study. The first scenario aims to increase the number of workers from Basic Education (S3) to Technical Skill (S5), while the second scenario aims to increase the number of workers from Incomplete Fundamental (S4) to Technical Skill (S5). It is worth noting that the initial skill levels chosen for the analysis are the primary skills achieved by heads of households benefiting from Bolsa Família, which represent 56.37% of the total qualifications of these families. It is also important to mention that all income families receive transfers from the Bolsa Família Program, which is the reason why all families are considered in this study, not just the poor ones.

By replacing the variable ffskl with workrs_c, it is possible to decrease the number of workers in skill levels S3/S4 while increasing the number of workers in S5. However, the variable used for this shock does not differentiate between families that receive the Bolsa Família Program and those that do not. Therefore, the shock is applied uniformly to all families in each region based on the percentage of the population that receives the program from the government.

There is a substitution between the new labour income and transfers. To calculate the decrease in transfers from government to families, it is possible to write wtransf equation as:

$$\mathtt{TRANSF}_{f,r,t}.\mathtt{wtransf}_{f,r,t} = \mathtt{TRANSF}_{f,r,t}.\mathtt{ftransf}_{f,r,t} + \mathtt{TRANSF}_{f,r,t}.\mathtt{wgdpbra};$$

Now each term is (100 times) the ordinary change. We want to ensure that:

$$\mathtt{TRANSF}_{f,r,\text{"BolsaFam"}}.\mathtt{ftransf}_{f,r,\text{"BolsaFam"}} = -\,\mathtt{FWAGE}_{f,r}.\mathtt{wlabinc\_s}_{f,r};$$

$$\mathtt{ftransf}_{f,r,\text{"BolsaFam"}} = -\left[\frac{\mathtt{FWAGE}_{f,r}}{\mathtt{TRANSF}_{f,r,\text{"BolsaFam"}}}\right].\mathtt{wlabinc\_s}_{f,r}$$

We can work out the Right Hand Side of equation above and use that to shock $\mathtt{ftransf}_{f,r,\text{"BolsaFam"}}$ to reduce government transfers via Bolsa Família Program in the same proportion as families wages increase. The shocks can be observed in Appendix 4.

There are two assumptions on Government educational expends:

- The first is to simply accept that these expends already exist on base data, and now the families are just absorbing this service;

- The second is to consider that the expends will, in fact, increase the government expenses.

The variable $\mathtt{fqg}_{i,r}$ is used to model changes in government spending on specific sectors in different regions. This shock variable is essential if we want to simulate increases in particular industries or sectors.

The GTAP database aggregates the original 65 sectors into 19 sectors according to the PAEG methodology. Among these sectors, the educational sector accounts for 16.90% of the Brazilian Government's expenditure on services. According to data from INEP/MEC (2021), the Brazilian Government spent US$2,379.99 per student in professional courses in 2014. Therefore, to calculate the government's expenses on education in Brazil, we will run the simulation without any shock on the `fqg` variable, determine the number of workers moving across different skill levels, and estimate the value of the services sectors corresponding to the educational sector.

In this paper, we assume that the government is already spending on the education sector, and that the people are benefiting from this "service". We have two reasons for this assumption: first, expenses on technical courses are included in the input-output tables as part of the services sector, and second, such expenses have already been approved by law (approximately R$ 6.8 billion annually). We also assume that the policy we are analyzing would increase government expenses in sectors, particularly in the service (education) sector, enough to cover any additional spending.

Disregarding the expenses with family qualification means assuming that the cost of educating each additional student through Pronatec is zero. However, it is reasonable to believe that the unit cost of educating additional students would actually decrease in t+1 time, as many costs would have already been incurred. Moreover, the social returns of investing in such education are likely to be greater than the costs incurred, so the decision was made to ignore these expenses.

Increases in income would result in an increase in the Government's income, mainly due to the rise in income tax revenue. The model used in this study assumes that in Brazil, the regional governments receive all commodity taxes, make payments for all final demands, and transfer funds to the Federal Government to cover any discrepancies. In contrast, the Federal Government receives all income taxes, provides transfers to families and regional governments based on Regional Governments Savings, and keeps investments and capital flows fixed. Any changes in goods prices may lead to changes in the representative agent aggregate consumption, and fluctuations in activity levels and consumption may affect tax revenues. Additionally, changes in the real exchange rate may be necessary to adjust to alterations in export and import flows after any shocks.

3 Results and Discussion

When there is a shock that increases the number of workers in a specific skill class, it is expected that the wage for that skill class will decrease. This will lead to the labour factor market price being cheaper compared to capital. It is also important to analyze the impact on wage costs, which will depend on the elasticity of demand substitution by firms for different types of skills. The elasticity determines how many firms can choose to reduce the demand for a skill that has become more scarce (low qualification) and shift to the one that has become more abundant (higher qualification).

It is expected that improving skills will increase labour expenses for industries. This will have two critical effects: impacts on family income and, as a result, consumption and welfare, as well as impacts on output, leading to impacts on relative prices. Therefore, the applied policy will also change intermediate consumption and international flows in addition to government and family consumption. The impacts will depend on the sector's skill level intensity - the higher the reliance on the shocked skill level, the higher the impact, and also on the sector's consumption share of total family consumption (in terms of welfare).

The welfare of families is affected by changes in transfers and income tax payments. It is assumed that higher wages will result in lower Bolsa Família transfers and higher income tax payments. Therefore, the increase in earnings from the labour market should be enough to offset the reduction in transfers and the increase in income tax. To assess the success of improving the labour market outcomes for Bolsa Família beneficiaries, we will examine the impact on families' income and consumption as well as the balance of the government's accounts (assuming that the government already spends enough on education).

The labour qualification policy will only impact employed individuals, regardless of whether they work in formal or informal jobs (the model does not account for unemployment). Skilled workers will be absorbed by various sectors, and the values used are fixed at a specific point in time. The analysis assumes a long-term perspective and a macroeconomic closure. However, Brazilian training courses for low-skilled individuals typically last between two months and one year. Therefore, it should be considered that policies implemented here will take effect after a year of qualification, and all changes in values are interpreted annually. Additionally, the effects of labour qualification will persist as long as the qualified workers remain employed in the labour market.

The model used in this analysis is valuable for examining the effects of labour qualification policy on different regions in Brazil, as it considers ten income classes and twelve skill levels. However, it does not account for movements between different income classes or model the poverty line. Therefore, it cannot be used to investigate the impact of the policy in terms of reducing poverty or helping individuals cross the poverty line. To analyze such issues, a different model that accounts for poverty line modelling, such as GTAP_POV developed by Hertel et al. (2011), would be required.

3.1 Impacts of skill improvement of Bolsa Família Program beneficiaries

This section will discuss the impacts of workforce qualification on beneficiaries of the Bolsa Família Program. First, we analyze the impacts on factor market values. Both policies increase labor in higher skill levels. Due to the low elasticity of substitution between different skill levels, it is reasonable to expect that the market labor price falls relative to other factor prices, primarily due to a significant decrease in labor prices of S5. However, it is important to note that the negative impact on labor prices related to other factors is driven by the shock effect on S5 prices and does not necessarily mean undesirable impacts on family wages. To analyze the percentage change in factor income in Brazilian regions, we refer to Table 2.

Table 2: Impacts of Bolsa Família beneficiaries skill improvement in factor income changes

	BRA	NOR	NDE	MDE	SDE	STH
Basic Educated[1]						
Labour (%△)	0.885	0.898	1.047	0.707	0.872	0.897
Capital (%△)	0.529	0.962	0.071	0.671	0.551	0.622
Land (%△)	0.972	1.100	0.738	0.974	0.767	1.945
NatRes (%△)	1.461	2.100	3.453	-0.518	1.502	-0.253
GDP (%△)	0.734	0.968	0.567	0.695	0.753	0.754
Incomplete Fundamental[2]						
	BRA	**NOR**	**NDE**	**MDE**	**SDE**	**STH**
Labour (%△)	0.521	0.570	0.636	0.399	0.530	0.458
Capital (%△)	0.300	0.622	-0.051	0.373	0.332	0.348
Land (%△)	0.545	0.559	0.509	0.352	0.380	1.272
NatRes (%△)	0.870	1.391	2.350	-0.424	0.869	-0.267
GDP (%△)	0.734	0.968	0.567	0.695	0.753	0.754

Where: NOR – North region; NDE – Northeast region; MDE – Midwest region; SDE – Southeast region; STH – South region;
[1] – Improving labour qualification of workers from skill S3 (Complete Basic) to S5 (Qualified Basics) – first shock;
[2] – Improving labour qualification of workers from skill S4 (Incomplete Fundamental) to S5 (Qualified Basics) – second shock;

The movement of workers causes large wage increases for S3 and S4 and very large decreases for S5. On the other hand, the increase in effective skilled labour supply also causes real GDP on income side to rise in aggregated Brazil and all regions. The higher the worker quantity moving among different skills, the higher the impact on labour income concerning other factors. The number of families on Complete Basic educated (S3) skill level is higher than Incomplete Fundamental (S4) one. Thus, on the second shock (moving workers from S4 to S5) the impact on labour income is smaller than the first shock since the amount of effective skilled labour increases less. The changes on factor income is different among regions due to the different skill enhancement in each one.

Regarding the first simulation, the Northeast region increases effective labour by 3.38% and 1.047% on labour income. On the other hand, the Midwest region increases the effective labour by 1.40%, and 0.707% in labour value. In the second scenario, the pattern of the regions is the same. The effective labour increases 2.60% in Northeast, 2.20% on North, 1.43% on Southeast, 0.84% on Midwest and 0.81% on South. The percentage change in families factor income value[11] from factors emphasize that labour value are higher then other factors.

It is expected that the movement of workers from S3 (basic educated) and S4 (incomplete fundamental) to S5 (professionalizing course) leads to an increase in wages. The ESKL elasticity is set in a way to leads to large wages differences between low-skilled and high-skilled workers. The higher the salary "gap" between skills the higher the price of labour increase. Table 3 shows the impacts on equilibrium labour prices.

It is important to emphasize that the worker's mobility between the different skills is exogenous (it occurs via shock). In this way, an increase in lower skills wage is an analogy for the transition of workers from these classes to the upper class. Since the model considers full employment, the necessary adjustment is a reduction in the wages of the upper class (this makes a higher salary possible for the lower levels of education. Furthermore, the magnitude of the wage reduction of the upper classes depends on the elasticity of substitution between different skills It is expected, due to the inelasticity of substitution between the different skills in the model, that the impact on the upper-income class (S5) will be significant.

Table 3: Impacts of Skill improvement in market wage prices

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
First Scneario												
NOR	4.68	4.79	27.32	4.65	-84.03	4.39	3.80	4.47	3.39	4.30	4.50	3.78
NDE	5.56	5.10	34.83	5.44	-93.74	5.20	5.27	4.88	4.78	4.78	5.03	4.55
COE	2.32	2.16	12.88	2.15	-45.69	2.12	2.20	2.00	2.01	2.10	2.12	2.02
SDE	3.64	3.38	12.19	3.36	-62.57	3.29	3.25	3.72	3.20	3.12	3.16	3.14
SUL	2.88	3.05	9.83	2.56	-48.24	2.44	2.77	2.60	2.43	2.46	2.57	2.48
Second Scneario												
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**
NOR	3.03	3.11	2.83	25.74	-64.28	2.82	2.42	2.90	2.13	2.77	2.91	2.4
NDE	3.69	3.35	2.84	34.38	-80.06	3.44	3.48	3.22	3.21	3.21	3.34	3.08
COE	1.38	1.26	1.28	11.94	-33.5	1.23	1.30	1.13	1.18	1.23	1.22	1.19
SDE	2.18	2.02	1.97	10.78	-43.12	1.95	1.92	2.23	1.90	1.84	1.87	1.86
SUL	1.44	1.50	1.29	8.36	-28.47	1.21	1.36	1.28	1.20	1.22	1.25	1.21

Where: NOR – North region; NDE – Northeast region; MDE – Midwest region; SDE – Southeast region; STH – South region;
[1] – Improving labour qualification of workers from skill S3 (Complete Basic) to S5 (Qualified Basics) – first shock;
[2] – Improving labour qualification of workers from skill S4 (Incomplete Fundamental) to S5 (Qualified Basics) – second shock;

It can be observed in Table 3 that the increase in basic educated wage prices due to a decrease in professionalizing training courses are higher than the increase in incomplete fundamental workers wage prices, as expected. The results corroborate with Diaz and Rosas (2016); Psacharopoulos and Patrinos (2018) also showing that families from most impoverished regions present higher impacts. As stated previously, both simulations increase the all effective

[11] `VFACTINC(f,r)*wfactinc(f,r) = FCAP(f,r)*wfamcap(f,r) + FLND(f,r)*wfamland(f,r) + FWAGE(f,r)*wlabinc_s(f,r)`

labour on the economy. Thus, all other skills also present an increase in wage prices, but less than the focussed population (S3 and S4). The impact on sectors output depends on its skill-intensity once factors are inputs for production.

The database indicates that agriculture is a low-skilled-intensive sector, i.e. is most reliant on S3 and S4, that are now receiving higher wages due to the qualification. Thus, there will be a greater increase in expenses in agricultural sectors than manufacturing or services. In a "losers and winner" interpretation it is possible to argue that wage changes tend to be favourable to manufacturing and services at the expense of agriculture.

Thus winning sectors will increase the output, and the loser sectors must decrease it. On the other hand, government consumption is service-intensive (which is a labour-intensive sector) and greater enough to change the path, increasing output in that sector. Families would maintain consumption even with an increase in output prices due to the satisfactory impacts on total income.

The wage earned by families in each income class (summed over sectors and skills) can be observed in Table 4. The impacts of labour qualification are positive in almost all families in Brazilian regions even not being uniformly distributed. In all regions, families until Income Class 3 have positive impacts, mainly in the Northeast and North. This is relevant because these families present greater importance of labour on total income formation. So, it will be helpful to guarantee consumption gains (that must be greater than transfers losses). As expected workers moving from skill class S3 will present higher impacts on labour prices. There is not a specific pattern for other income classes.

Table 4: Impacts on families labour income in Brazilian regions

	First Scenario[1]					*Second Scenario*[2]				
	NOR	**NDE**	**MDE**	**SDE**	**STH**	**NOR**	**NDE**	**MDE**	**SDE**	**STH**
	% ch	**% ch**	**% ch**	**% ch**	**% ch**	**% ch**	**% ch**	**% ch**	**% ch**	**% ch**
	US$bi	**US$bi**	**US$bi**	**US$bi**	**US$bi**	**US$bi**	**US$bi**	**US$bi**	**US$bi**	**US$bi**
F1	2.340	1.500	5.250	0.75	1.860	1.400	1.230	1.880	0.180	0.560
	0.009	0.013	0.008	0.008	0.006	0.005	0.011	0.003	0.002	0.002
F2	0.710	0.570	1.450	0.950	0.960	0.480	0.380	0.930	0.570	0.570
	0.014	0.0250	0.014	0.059	0.014	0.009	0.018	0.009	0.035	0.008
F3	0.840	0.290	1.150	0.500	0.700	0.930	0.260	0.680	0.430	0.390
	0.027	0.020	0.028	0.083	0.028	0.030	0.023	0.016	0.069	0.016
F4	-1.350	-0.510	0.310	0.500	0.380	-0.600	-0.230	0.220	0.230	0.220
	-0.070	-0.340	0.480	6.290	0.390	-0.060	-0.290	0.470	0.250	0.380
F5	1.450	-0.100	0.310	0.220	0.080	1.020	0.340	0.020	0.100	-0.07
	0.052	-0.017	0.013	0.071	0.007	0.036	0.034	0.001	0.033	-0.005
F6	0.420	-0.28	0.570	0.720	0.420	0.360	0.510	-0.480	0.490	0.210
	0.014	-0.031	0.031	0.227	0.046	0.012	0.044	-0.025	0.150	0.023
F7	3.350	0.990	1.040	-0.440	0.250	2.200	0.580	0.540	0.330	0.010
	0.078	0.073	0.043	-0.125	0.025	0.051	0.046	0.022	0.100	0.001
F8	4.200	4.54	0.890	-0.340	1.030	3.130	3.370	0.520	-0.20	1.060
	0.148	0.510	0.063	-0.195	0.208	0.110	0.386	0.037	-0.115	0.215
F9	-2.140	-2.02	2.840	3.230	2.010	-1.640	-2.470	1.060	2.050	0.960
	-0.061	-0.160	0.163	1.259	0.328	-0.047	-0.189	0.061	0.797	0.156
F10	-2.980	0.200	0.970	0.840	1.080	-1.300	-0.500	0.380	0.620	0.480
	-0.391	0.058	0.501	2.600	0.841	-0.171	-0.237	0.188	1.867	0.370

Where: NOR – North region; NDE – Northeast region; MDE – Midwest region; SDE – Southeast region; STH – South region;
[1] – Improving labour qualification of workers from skill S3 (Complete Basic) to S5 (Qualified Basics) – first shock;
[2] – Improving labour qualification of workers from skill S4 (Incomplete Fundamental) to S5 (Qualified Basics) – second shock;
The left column shows families income classes (F1 - F10); Each family has results presented in two rows: the top one is the percentage change on labour income summed over skill and commodities, the bottom one is the change in nominal US$bi

Families from richer income classes from Professionalized Skill (S5) are employed mainly in manufacturing, industry, and services. Those sectors are the "winners", less dependent on low-skill labour. Considering that these sectors pay less for workers on S3 and S4, compared to S5, there are no gains for workers. Thus, the wealthy families (but not just) will present negative impacts. However, those families total incomes are not mainly labour-dependent, thus, impacts on consumption would not be expressive.

It is important to note that the gains in percentage terms are relative to each income class. Therefore, a smaller percentage variation does not imply smaller gains in nominal prices. It is also important to note that the wage gain described here is summed over sectors and skills. So it is completed understandable for some isolated wages to be higher or lower. Nevertheless, the presented is sufficient to understand the importance of professional qualification for each income class, once the aggregated salary is what will matter for family total income (considering the labour factor).

The impact on families total income still depends on variations in the price of capital and land, and the relative importance of wages in total income formation. Furthermore, for the policies applied, gains on wages will reduce the transfers from Bolsa Família Program as well as increase income taxes. The total income changes in each family income due to improvement in labour skill class can be observed in Table 5.

Table 5: Impacts of skill improvement combined with Bolsa Família withdraw on families total income (%)

	First Scneario						*Second Scneario*				
	NOR	**NDE**	**MDE**	**SDE**	**STH**		**NOR**	**NDE**	**MDE**	**SDE**	**STH**
F1	1.515	0.865	3.668	0.723	1.349	**F1**	0.421	0.173	0.931	0.121	0.303
F2	0.811	0.556	1.048	0.818	0.832	**F2**	0.346	0.083	0.488	0.318	0.349
F3	0.869	0.432	0.921	0.588	0.699	**F3**	0.530	0.065	0.381	0.266	0.236
F4	0.286	0.145	0.505	0.583	0.549	**F4**	0.188	-0.075	0.185	0.177	0.175
F5	1.123	0.256	0.469	0.433	0.434	**F5**	0.663	0.094	0.093	0.126	0.062
F6	0.790	0.154	0.633	0.693	0.545	**F6**	0.470	-0.168	0.351	0.334	0.202
F7	1.789	0.592	0.853	0.063	0.463	**F7**	1.070	0.198	0.378	0.266	0.123
F8	2.107	1.734	0.772	0.120	0.845	**F8**	1.420	1.112	0.387	-0.009	0.652
F9	0.332	-0.459	1.700	1.867	1.292	**F9**	0.114	-0.821	0.660	1.091	0.578
F10	0.136	0.218	0.766	0.687	0.780	**F10**	0.196	-0.149	0.338	0.402	0.340

Where: NOR – North region; NDE – Northeast region; MDE – Midwest region; SDE – Southeast region; STH – South region;
[1] – Improving labour qualification of workers from skill S3 (Complete Basic) to S5 (Qualified Basics) – first shock;
[2] – Improving labour qualification of workers from skill S4 (Incomplete Fundamental) to S5 (Qualified Basics) – second shock;

It is expected that gains on families total income would be lower than the gains on labour income. This occurs because the families are not receiving transfers from Bolsa Família anymore besides increases on income tax. The opposite is true, i.e. families that are receiving less income from labour will receive more income from Government. However, the impacts on richer income classes, in response to increasing on Bolsa Família transfers tend to be mild and also depend on other factors income.

Although the losses on transfers balance, the favourable impacts presented in Table 4 should be sustained considering the importance of labour on families total income. Another important highlight is to observe the income-change between labour and Bolsa Família Transfers. The reduction in families Bolsa Família transfer income in response to higher labour income can be observed in Appendix 4, on shock design section.

Smaller percentage changes in labour income of the first income classes in almost all regions of the Basil, lead to greater impacts on factor income, in monetary terms. While the percentage variations of the Bolsa Família reduction are high, they result in lower monetary values. Labour has greater relative importance (compared to the factor itself) for the income of the poorest families. This result emphasizes that in fact policies on labour market will be an opportunity for the families to find an "exit door" from Social Programs.

For example, families from 1^{st} income class on North regions increase labour income by 2.34% (US$ 0.009bi) and transfers reductions by 3.60% (US$0.005bi); on Midwest regions the labour increase is 5.30% (US$0.008bi), and in Bolsa Família Program reduction is 24.2% (US$ 0.0101bi); in Southeast the relation is 0.78% (US$ 0.008bi) – labour and 4.04% (US$ 0.109bi); and, in South region is 1.88% (US$ 0.006bi) increase on labour and 24.10% (US$0.0106bi) on transfer reduction. The exeption is Northeast region with increases on labour income by 1.44% (US$0.013bi) and decreasing on Bolsa Família by 13.20% (US$0.073bi).

Even with the reduction in Government transfers to the families, the family's gains on labour market are sufficient to increase total income. Thus, even if the Program withdrawal is not gradual (i.e. a fully-reduction once), since these families are better skilled, would not negatively impact the beneficiary families. This is important to ensure the "income replacement" time. The desirable results on families income will be reflected in consumption, as the model considers the total families expenditures guided by families total income. The impact of skill improvement on total consumption can be observed in Table 6.

Table 6: Impacts on families welfare in Brazilian regions

	First Scenario[1]					*Second Scenario*[2]				
	NOR	**NDE**	**MDE**	**SDE**	**STH**	**NOR**	**NDE**	**MDE**	**SDE**	**STH**
	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi	% ch US$bi
F1	1.515%	0.865%	3.668%	0.723%	1.349%	0.421%	0.173%	0.931%	0.121%	0.303%
	0.083	0.182	0.191	0.032	0.082	0.023	0.018	0.013	0.009	0.007
F2	0.811%	0.556%	1.048%	0.818%	0.832%	0.346%	0.083%	0.488%	0.318%	0.349%
	0.182	0.344	0.144	0.715	0.183	0.077	0.051	0.067	0.277	0.077
F3	0.869%	0.432%	0.921%	0.588%	0.699%	0.530%	0.065%	0.381%	0.266%	0.236%
	0.191	0.261	0.199	0.903	0.311	0.117	0.039	0.082	0.409	0.105
F4	0.286%	0.145%	0.505%	0.583%	0.549%	0.188%	-0.075%	0.185%	0.177%	0.175%
	0.03	0.04	0.08	0.54	0.17	0.021	-0.022	0.028	0.165	0.053
F5	1.123%	0.256%	0.469%	0.433%	0.434%	0.663%	0.094%	0.093%	0.126%	0.062%
	0.011	0.003	0.005	0.004	0.004	0.048	0.020	0.011	0.108	0.016
F6	0.790%	0.154%	0.633%	0.693%	0.545%	0.470%	-0.168%	0.351%	0.334%	0.202%
	0.082	0.054	0.055	0.373	0.115	0.026	-0.030	0.047	0.298	0.054
F7	1.789%	0.592%	0.853%	0.063%	0.463%	1.070%	0.198%	0.378%	0.266%	0.123%
	0.124	0.065	0.080	0.037	0.106	0.074	0.022	0.035	0.157	0.028
F8	2.107%	1.734%	0.772%	0.120%	0.845%	1.420%	1.112%	0.387%	-0.009%	0.652%
	0.115	0.321	0.136	0.107	0.260	0.078	0.206	0.068	-0.008	0.201
F9	0.332%	-0.459%	1.700%	1.867%	1.292%	0.114%	-0.821%	0.660%	1.091%	0.578%
	0.019	-0.057	0.152	1.563	0.299	0.007	-0.101	0.059	0.913	0.134
F10	0.136%	0.218%	0.766%	0.687%	0.780%	0.196%	-0.149%	0.338%	0.402%	0.340%
	0.026	0.134	0.627	2.838	0.800	0.037	-0.091	0.277	1.660	0.349
Total	0.808%	0.421%	0.825%	0.667%	0.729%	0.457%	0.036%	0.353%	0.343%	0.309%
	0.898	1.281	1.604	7.747	2.418	0.508	0.110	0.687	3.987	1.024

Where: NOR – North region; NDE – Northeast region; MDE – Midwest region; SDE – Southeast region; STH – South region;
[1] – Improving labour qualification of workers from skill S3 (Complete Basic) to S5 (Qualified Basics) – first shock;
[2] – Improving labour qualification of workers from skill S4 (Incomplete Fundamental) to S5 (Qualified Basics) – second shock;
The left column shows families income classes (F1 - F10); Each family has results presented in two rows: the top one is the percentage change on labour income summed over skill and commodities, the bottom one is the change in nominal US$bi

It can be observed that, following the increase in income, families present important results on aggregated consumption as well. The magnitude, however, is low in percentage change terms, reaching a maximum of 3.688% for 1^{st} income class on Northeast. The results for all regions are showing that even with the reduction in total income due to reduction in transfer and increase in direct tax payment. Thus, the impact on consumption on beneficiary's families is favourable. The first scenario results are also greater than the second scenario, due to higher wages between Trained workers and Basic Educated ones.

The aggregated consumption represents the private consumption on Gross Domestic Consumption. Both scenarios increase the aggregated consumption (in GDP) in all regions. Regarding the first scenarios (skill improvement for S3 workers) the impacts are: 0.808% (US$0.898bi) for North; 0,421% (US$1.281bi) for Northeast; 0.825% (US$1.604bi) for Midwest; 0.667% (US$7.747bi) for Southeast; and, 0.729% (US$2.418bi). Regarding the second scenario (skill improvement for S4 workers) the impacts on aggregate private consumption on GDP are: 0.457% (US$0.508bi) for North; 0.036% (US$0.1101bi) for Northeast; 0.353% (US$0.687bi) for Midwest; 0.343% (US$3.987bi) for Southeast; and, 0.309% (US$1.024bi).

The government behavior assumption on applied policies is important to understand the impact on its accounts. There is no "extra increase" in consumption, but the government consumption also increases in response to new prices – thus, consumption in educational sectors. On the other hand, ceasing transfers to the families would represent positive impacts on consumption (however, the government consumption is residual on GDP). Moreover, families will pay more tax on consumption and direct taxes to the government due to higher wages received in the labour market.

The public service increases consumption in all regions. In the second scenario, the Government increased consumption of goods by 2.93% in the North region; 2.15% in the Northeast region; 3.14 % in the Midwest region; 2.69% in the Southeast region; and, 2.88% in the South region. The government also increase the collects on indirect taxes by 0.58% in North; 0.53% in Northeast; 0.37% on Midwest; 0.51 % on Southeast; and, 0.39% on South region. Income taxes increase in all regions as well, the exception is Northeast (-0.04%). The transfers to families through Bolsa Família decrease in all regions: -0.073% on North; -0.016% on Northeast; -0.013% on Midwest; -0.005% on Midwest; and, -0.005% on South.

Regarding the first scenario, the Government increased consumption of goods by 2.27% in the North region; 1.66% in the Northeast region; 2.39 % in the Midwest region; 2.15% in the Southeast region; and, 2.29% in the South region. The increase on indirect taxes collection are: 0.94% in North; 0.93% in Northeast; 0.72% on Midwest; 0.86 % on Southeast; and, 0.76% on South region. Income taxes increase in all regions as well. The transfers to families through Bolsa Família decrease in all regions: -0.089% on North; -0.017% on Northeast; -0.028% on Midwest; -0.009% on Midwest; and, -0.010% on South.

The skill enhancement will also increase the regional GDP in both scenarios. However, since the first scenario presents higher income gains, it will present better impacts on GDP. On first simulation, the percentage change on GDP is: 0.95% on North region; 0.50% on Northeast region; 0.72% on Midwest region; 0.75% on Southeast region; and, 0.74% on South region. While the GDP impacts on second scenario are: 0.61% on North region; 0.29% on Northeast region; 0.37% on Midwest region; 0.45% on Southeast; and, 0.39% on South region.

4 Final Remarks

The general objective of this study was to assess the economic impacts of a skill improvement policy via professionalizing courses for Bolsa Família beneficiary families in Brazilian regions. To achieve the objective was applied a general equilibrium model (DAYANE model), which presents several skill levels and families income classes for Brazilian regions. In general, it is shown how the increase in human capital positively impacts society as a whole and the beneficiaries of a cash transfer program, allowing them to exit the program.

The hypothesis of improvement in Bolsa Família families beneficiaries consumption and income are accepted. Also, the effects tend to be lasting, as the value of labour factor increases in all regions, and it is the main income source for the poorest families. The results suggest that skill improvement increases families income. The impacts are higher in a scenario where the salary "gap" is larger. That is, the workers qualification from lower skill levels have higher wage gains, as expected, and heavily state in literature. However, sectors that are low-skill-intensive (like agriculture) will decrease the output due to an increase in the price of the main productive factor.

There is also clear evidence that skill improvement reduces families dependence on Bolsa Família Program in the long term. More than that, it is clear that the better wages on labour market are enough to ensure the withdrawal of transfers, proportionally to increase on labour income, once even with transfers reduction, the higher wages ensure better economic conditions to the families . Regarding families consumption and welfare, it was observed desirable impacts. Albeit the results in the poorest families could be better since the industries in the sectors that these families consume relatively more are precisely the ones that most reduce their supply.

Future researches would investigate alternatives to alleviate the impacts on industries production. Furthermore, another suggestion relies on upon introduce mechanisms to allow families to move among classes and model poverty line as well, once the model is not prepared to apply such kind of simulation. The model is capable of simulating various social policies, including emergency aid due to COVID-19 in Brazil. However, by assuming that this program is not intended only for beneficiaries of the Bolsa Família Program (the object of research in the paper), it was decided not to simulate it. Thus, it would be also relevant studies in this sense.

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Appendix

Table A.1: First Simulation

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
					S5					
NOR	9856	21138	16245	7793	4834	1934	1399	1347	476	1308
NDE	46963	95596	63032	27260	12956	6496	3612	3100	1492	4204
MDE	1627	6507	8633	5548	3716	2441	1330	1410	655	902
SDE	8426	30667	34476	27401	16664	10078	6487	6286	2300	5488
STH	2046	8197	10925	9587	7211	4577	2954	2937	1087	2350
					S3					
NOR	-9856	-21138	-16245	-7793	-4834	-1934	-1399	-1347	-476	-1308
NDE	-46963	-95596	-63032	-27260	-12956	-6496	-3612	-3100	-1492	-4204
MDE	-1627	-6507	-8633	-5548	-3716	-2441	-1330	-1410	-655	-902
SDE	-8426	-30667	-34476	-27401	-16664	-10078	-6487	-6286	-2300	-5488
STH	-2046	-8197	-10925	-9587	-7211	-4577	-2954	-2937	-1087	-2350
					Bolsa Família Program Withdraw					
NOR	-5.2%	-1.6%	-1.9%	1.1%	-5.2%	-3.3%	-9.8%	-15.5%	2.5%	8.4%
NDE	-2.0%	-0.9%	-0.8%	-0.2%	-0.7%	-0.8%	-3.1%	-9.2%	1.7%	-1.6%
MDE	-30.0%	-4.1%	-3.0%	-2.0%	-3.0%	-4.1%	-5.6%	-6.2%	-17.8%	-6.6%
SDE	-9.1%	-2.9%	-2.1%	-2.0%	-2.1%	-3.2%	-1.0%	-1.3%	-11.2%	-5.2%
STH	-37.4%	-6.5%	-2.0%	-1.4%	-0.9%	-3.0%	-2.4%	-5.6%	-7.7%	-3.9%
					Skill Movement					
					Workers					
			NOR	**NDE**	**MDE**	**SDE**	**STH**			
			66329 (9.76%)	264712 (12.64%)	32769 (4.96%)	148272 (4.10%)	51871 (3.38%)			
					% of total families					
NOR	1,42%	0,65%	0,50%	0,51%	0,53%	0,35%	0,22%	0,20%	0,12%	0,11%
NDE	1,90%	0,72%	0,47%	0,44%	0,30%	0,20%	0,17%	0,11%	0,09%	0,08%
COE	0,80%	0,31%	0,24%	0,22%	0,20%	0,17%	0,13%	0,09%	0,07%	0,02%
SDE	0,92%	0,29%	0,18%	0,24%	0,16%	0,10%	0,11%	0,07%	0,04%	0,03%
SUL	0,82%	0,28%	0,19%	0,21%	0,20%	0,13%	0,11%	0,08%	0,05%	0,04%
					% of total workers					
NOR	2,06%	1,76%	1,48%	1,17%	1,17%	0,89%	0,84%	0,83%	0,45%	0,51%
NDE	2,24%	2,13%	1,82%	1,45%	1,21%	1,06%	0,95%	0,73%	0,65%	0,60%
COE	0,99%	0,86%	0,81%	0,66%	0,57%	0,53%	0,45%	0,39%	0,38%	0,18%
SDE	1,01%	0,76%	0,64%	0,58%	0,45%	0,40%	0,34%	0,31%	0,21%	0,16%
SUL	0,90%	0,68%	0,62%	0,53%	0,46%	0,44%	0,40%	0,34%	0,25%	0,22%

where:
S3 and **S5** presents number of workers moving across skills S3 and S5;
Skill movement totals shows the total number of employed people being trained by Government – this is the `workrs_c(FAM,"BRA","SKL")` shock value;
Bolsa Familía Program Withdraw are the reduction on Transfers from Government to Families via Bolsa Família Withdraw according to increasing on labour income – this is the `shock wtransf("FAM","BRA","BolsaFam")`

Table A.2: Second Simulation

					S5					
	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**
NOR	4359	9982	9407	5121	2439	975	676	757	328	1124
NDE	26211	49926	35902	17684	8338	3369	1746	2032	544	2004
MDE	651	4197	5312	4417	2349	1880	805	963	231	481
SDE	3293	16015	20146	14160	9296	5975	4549	3790	1155	3116
STH	659	4245	5426	4906	3334	2330	1319	1722	346	1044
					S4					
NOR	-4359	-9982	-9407	-5121	-2439	-975	-676	-757	-328	-1124
NDE	-26211	-49926	-35902	-17684	-8338	-3369	-1746	-2032	-544	-2004
MDE	-651	-4197	-5312	-4417	-2349	-1880	-805	-963	-231	-481
SDE	-3293	-16015	-20146	-14160	-9296	-5975	-4549	-3790	-1155	-3116
STH	-659	-4245	-5426	-4906	-3334	-2330	-1319	-1722	-346	-1044
					Bolsa Família Program Withdraw					
NOR	-3.6%	-1.3%	-2.0%	0.1%	-4.0%	-2.9%	-6.8%	-11.7%	1.7%	2.3%
NDE	-1.7%	-0.7%	-0.7%	-0.4%	-1.0%	-0.3%	-2.3%	-6.9%	2.6%	-0.1%
MDE	-13.3%	-3.2%	-2.2%	-1.9%	-2.4%	-3.8%	-4.2%	-4.9%	-9.3%	-4.5%
SDE	-5.9%	-2.3%	-1.9%	-1.6%	-1.9%	-2.7%	-3.1%	-1.7%	-8.0%	-4.5%
STH	-19.5%	-4.9%	-1.5%	-1.2%	-0.7%	-2.5%	-1.7%	-5.7%	-4.6%	-2.5%
					Skill Movement					
					Workers					
			NOR	**NDE**	**MDE**	**SDE**	**STH**			
			35168 (9.76%)	147756 (12.64%)	21286 (4.96%)	81497 (4.10%)	25333 (3.38%)			
					% of total families					
NOR	0,63%	0,31%	0,29%	0,33%	0,27%	0,18%	0,11%	0,11%	0,08%	0,10%
NDE	1,06%	0,38%	0,27%	0,29%	0,19%	0,10%	0,08%	0,07%	0,03%	0,04%
COE	0,32%	0,20%	0,15%	0,17%	0,12%	0,13%	0,08%	0,06%	0,02%	0,01%
SDE	0,36%	0,15%	0,11%	0,12%	0,09%	0,06%	0,07%	0,04%	0,02%	0,02%
SUL	0,26%	0,14%	0,09%	0,11%	0,09%	0,06%	0,05%	0,05%	0,02%	0,02%
					% of total workers					
NOR	0,91%	0,83%	0,86%	0,77%	0,59%	0,45%	0,41%	0,47%	0,31%	0,44%
NDE	1,25%	1,11%	1,03%	0,94%	0,78%	0,55%	0,46%	0,48%	0,24%	0,28%
COE	0,40%	0,56%	0,50%	0,53%	0,36%	0,41%	0,27%	0,27%	0,14%	0,10%
SDE	0,40%	0,40%	0,38%	0,30%	0,25%	0,23%	0,24%	0,19%	0,10%	0,09%
SUL	0,29%	0,35%	0,31%	0,27%	0,21%	0,22%	0,18%	0,20%	0,08%	0,10%

where:

S4 and **S5** presents number of workers moving across skills S4 and S5;

Skill movement totals shows the total number of employed people being trained by Government – this is the `workrs_c(FAM,“BRA”,“SKL”)` shock value;

Bolsa Familía Program Withdraw are the reduction on Transfers from Government to Families via Bolsa Família Withdraw according to increasing on labour income – this is the `shock wtransf("FAM","BRA","BolsaFam")`

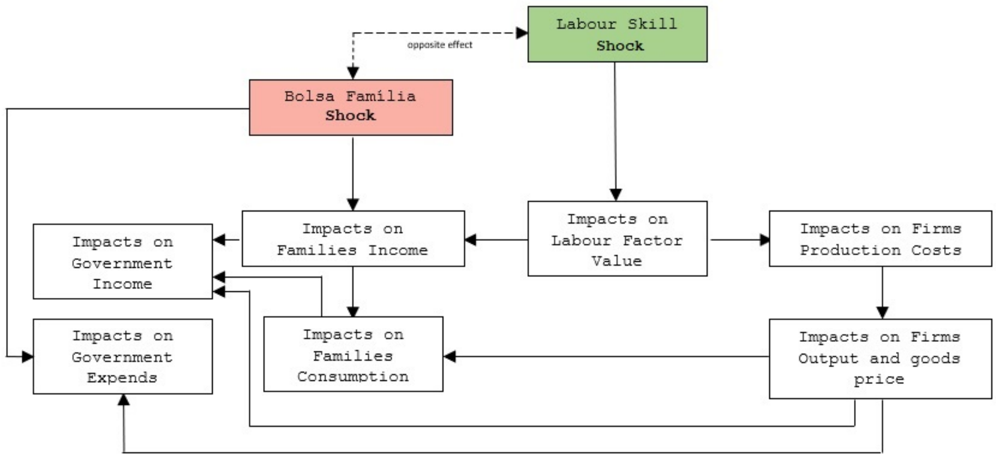

Figure A.1: Shocks causal effects