Título: Análise econômica da reforma fiscal do PIS e da COFINS: integrando um modelo de micro-simulação com um modelo de equilíbrio geral computável[♦]

Title: Economic analysis of PIS-COFINS tax reform: integrating a micro simulation model with a computable general equilibrium model.

Resumo: *Neste texto é apresentado o relatório final do projeto 561/06, "Análise Econômica da Reforma Fiscal do PIS-COFINS: Integrando um modelo de micro-simulação com um Modelo de Equilíbrio Geral Computável". Essencialmente trata-se de uma extensão metodológica do projeto 461/04, visando um aprimoramento da quantificação dos impactos sobre indicadores de bem estar, particularmente pobreza e desigualdade. Além do modelo de Equilíbrio Geral, busca-se uma integração com um modelo de micro-simulação, baseado nas pesquisas domiciliares com o intuito de aprofundar e identificar o impacto que a reforma fiscal teve sobre indivíduos e famílias brasileiras, fazendo com estes sejam identificados com uma precisão muito maior, na medida em que a pesquisa anterior permitia apenas a identificação de um agrupamento representativo da população brasileira, enquanto esta permite a integração no modelo das amostras individuais presentes na PNAD. Os resultados apresentados são sensíveis a nova metodologia utilizada.*

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Apresentação

Este texto tem como objetivo a apresentação do relatório final do projeto 561/06, "Análise Econômica da Reforma Fiscal do PIS-COFINS: Integrando um modelo de micro-simulação com um Modelo de Equilíbrio Geral Computável". O referido projeto foi submetido inicialmente ao GV Pesquisa em abril de 2006 e foi aprovado em junho de 2007, com sua execução inicialmente prevista para o período entre 20 de junho e 20 de dezembro do mesmo ano. No início deste ano apresentamos um relatório intermediário que descrevia a situação do projeto até aquela data.

O conteúdo deste projeto é praticamente uma extensão do projeto do GV Pesquisa 461/04, "Impactos Econômicos das Mudanças do PIS-COFINS utilizando um Modelo de Equilíbrio Geral Computável", onde além do modelo de Equilíbrio Geral utilizado naquela primeira pesquisa, busca-se uma integração com um modelo de micro-simulação, com o intuito de aprofundar e identificar o impacto que a reforma fiscal teve sobre indivíduos e famílias brasileiras. Desta forma, o relatório atual é um aprofundamento da análise anterior, na medida em que esta permitia apenas a identificação de um agrupamento representativo da população brasileira.

Como foi ressaltado na proposição deste projeto, a integração entre o modelo de Equilíbrio Geral (CGE Model) e o modelo de Micro-simulação (MS model) pode ser implementada adotando-se metodologias diferentes, dependendo, principalmente, da abrangência que esta integração visa alcançar. No caso específico deste projeto, foi proposta uma meta ambiciosa, que seria perseguida, para a integração dos modelos, de tal forma, que as simulações de políticas seriam solucionadas simultaneamente em ambos. Desta forma, neste estágio final do trabalho, podemos afirmar que as atividades realizadas após o relatório parcial proporcionaram a realização do objetivo final desta pesquisa.

Assim, este relatório final apresenta a descrição de todo arcabouço analítico alcançado na presente pesquisa, identificando os avanços que foram alcançados com a concessão do prazo adicional de aproximadamente 6 meses para a conclusão do projeto. Também, tentaremos demonstrar a eficácia e aplicabilidade desta nova metodologia, que proporciona a geração de resultados significativos para a análise da reforma fiscal focalizada neste projeto.

Neste documento, a análise de uma política econômica é realizada partindo das restrições macroeconômicas, passando pelo comportamento de cada função de produção setorial, que interage primeiramente com instituições e agentes representativos, e que por sua vez conectam-se a indivíduos reais desagregados, que estão presentes nas pesquisas domiciliares. Desta forma, a análise se estende do PIB ao indivíduo particular, que possui endereço, têm idade, sexo, escolaridade e todas as outras características utilizadas pessoais utilizadas na pesquisa, o que permite a "individualização" dos efeitos da política econômica, que é o objetivo fim de uma ação pública através do estado.

Com o intuito de apresentar o que foi discutido acima, organizamos este relatório parcial em 5 seções principais, além da referência e de um anexo. A estrutura destas seções está dividida da seguinte forma: A primeira, Introdução, apresenta um resumo da reforma fiscal do PIS-COFINS e uma descrição das principias mudanças ocorridas desde a finalização do projeto anterior (461/04). A segunda seção, Metodologia, está subdividida em 3 partes principais. Na primeira parte, apresentamos uma descrição sumarizada do estágio atual do modelo de equilíbrio geral. Na segunda parte são apresentados os limites deste modelo para análise de políticas focalizadas no bem estar da população. Ainda nesta seção, são discutidas as principais metodologias de integração entre o "CGE Model" e o modelo de micro-simulação. Na terceira parte, é apresentada a metodologia final de integração adotada nesta pesquisa.

Na terceira seção são discutidas as simulações de mudanças tributárias em 2 cenários básicos, diferenciados pela utilização do CGE isoladamente e pela integração deste com o modelo de micro-simulação. Na quarta seção, os resultados são apresentados para estes dois cenários básicos, dando-se ênfase na discussão dos resultados relacionados com o bem estar dos indivíduos. A seção 5 traz os comentários finais. O relatório termina com a apresentação sumarizada da base de dados utilizada nos dois modelos.

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1. Introduction[1]

In this project our main focus of analysis still is the so called "PIS–COFINS tax reform" which took place during 2003 and 2004.[2]

Prior to this reform, PIS and COFINS were cumulative taxes that charged firms' gross revenue and did not levy imports. The initial proposal of the reform was the complete conversion of these cumulative (on gross revenue) taxes in non-cumulative (on value-added) ones in order to induce economic efficiency gains by reducing the incentives to excessive vertical integration of firms. Also, the reform intended to improve the national firms' competitiveness by applying them on imports of goods and services and maintaining the exports exemptions. By means of this reform, in 2003 the incidence of PIS on firms' gross revenue was partially changed to firms' value-added, that is, this cumulative tax was partially converted to a non-cumulative one. In 2004, the COFINS was subject to a similar change and both taxes started levying imports of goods and services.

Despite this analysis focuses on economic aspects, below we summarize the 3 main federal laws that had accomplished these changes. The Law 10637/2002 (December 2002) introduced the non-cumulative regime for PIS. The main modification was the change of its rate and incidence base from 0.65% on firm's gross revenue to 1.65% on firm's value added, following a credit and debit system similar to the one adopted by the ICMS.[3] Despite the Federal Government would intend generalize these changes, exceptions and exemptions were established for: firms that have chosen the income tax bill estimation form based on "Lucro Presumido" (a type of profit estimation based on a fixed percentage of revenues), firms that were under the "SIMPLES" taxation system, firms located in the "Zona Franca de Manaus", Financial Institutions and the sectors whose collection system is called "antecipação monofásica"(a single-phase anticipation process). Finally, the exports exemptions from PIS were maintained.[4]

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[1] The full description of PIS-COFINS tax reform can be found in Cury and Coelho (2006) which was based in the final report of project 461/04, "GV-Pesquisa", *"Impactos Econômicos das Mudanças do PIS-COFINS, utilizando um Modelo de Equilíbrio Geral Computável"*.

[2] The completed names of these taxes are: (1) "Contribuição do Programa de Integração Social e de Formação do Patrimônio do Servidor Público (PIS/PASEP)" and (2) "Contribuição para a Seguridade Social (COFINS).

[3] ICMS stands for Imposto Sobre Circulação de Mercadorias and it is a value-added tax.

[4] The exports were exempted from PIS/PASEP and COFINS by Provisional Remedy 2158-35/2001.

By means of the Law 10833/2003 (December 2003), one year after the beginning of the non-cumulative regime for PIS, a similar regime was also established for COFINS with tax rate of 7.6% on value-added to do not change the COFINS collection level (SE–MFAZ, 2004, p.2). Beyond allowing the exceptions and exemptions mentioned in the previous paragraph, the option to stay in the old cumulative regime was given to many kinds of activities,[5] among them: health insurance firms, values monitoring and transport services, cooperative societies, telecommunications services and media companies, public multi-modal transportation services, health services provided by hospital or similar units and all kinds of educational services. Finally, the exports exemptions from COFINS were maintained.

The taxation reform was completed by means of the Law 10865/2004 (March 2004) by which PIS and COFINS started levying imports of goods and services. The basic percentage tax rates were the same for domestic flows, 1.65% and 7.60%, summing up to 9.25%, but levying a different base from that one that is considered for Import Tariff (CIF value) collection. In the PIS-COFINS case, beyond the imports CIF value, must be added the Import Tariff (IT), the "Imposto sobre Produtos Industrializados (IPI)" (a tax on manufactured products), the ICMS (mentioned before), and the own PIS-COFINS. Thus, the final effect of this extended base is a multiplier that magnifies the original (nominal) legally established tax rates.

Considering all the previous information, we can say that the PIS-COFINS complete reform presented two parts: (1) the "domestic" and (2) the "external". The first part of the PIS-COFINS reform was basically characterized by the introduction of their: (1) incidence on firms' value-added (non-cumulative regime) and (2) new rates (1.65% for PIS and 7.60% for COFINS) on value-added. The "external" side of the PIS-COFINS reform presented the introduction of their: (1) incidence on imports of goods and services and (2) new rates (1.65% for PIS and 7.60% for COFINS) on imports. Also, after the PIS-COFINS taxation reform these taxes started being collected by two regimes: (1) the (previous) cumulative and (2) the (new) non-cumulative.

Given these characteristics, the implementation of PIS-COFINS reform basically induced relative prices changes in the Brazilian economy and, consequently, the economic agents rethought their resource allocation decisions, which characterize a

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[5] Exemptions were established by means of 17 paragraphs in the law.

general equilibrium phenomenon. From the individuals' and families' point of view, modifications in the relative prices structure can significantly alter their welfare, by means of the changes in the structure of the real incomes and the expenditure of these agents. Besides, the taxation system together with the social public expenditure has been considered very ineffective in changing our income distribution.

Therefore, it seems very appropriate to assess the economic impacts from the PIS-COFINS taxation reform by means of "fiscal reform simulations" with the utilization of an integrated modeling approach between the computable general equilibrium (CGE) model and the microsimulation (MS) model. The following section presents the methodology to achieve this purpose.

2. Methodology

2.1. The CGE Model

The aiming of this session is to present the CGE side of the integrated approach. The CGE model version used in this report was updated from the version used in the last project (461/04) which also was an extension from the one presented by Cury *et al.* (2005)[6] where further details can be found.

2.1.1. The Product Market

2.1.1.1. Product Supply

Foreign product supply is modeled as being totally elastic,[7] while sectoral domestic supply is represented by a three steps nested production function with three types of inputs: labor, capital and intermediate inputs.[8]

First, amounts of types of labor (F_l), given by the first order firm's profit maximization conditions, are combined in a composite labor (Ld_i) for each sector i, by a Cobb-Douglas function with constant returns to scale:[9]

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[6] This model results from a series of developments made in the model proposed by Devarajan *et al.* (1991), as can be seen in Cury (1998), Barros *et al.* (2000a) and Coelho *et al.* (2003).

[7] Thus, Brazilian demands for imported goods are fully satisfied without facing external supply constraints.

[8] The model represents the 42 sectors of activities listed in the 2003 Brazilian National Accounts.

[9] This means that an identical increase of every type of worker results in an identical increase of the aggregate worker.

$$Ld_i = \prod_l F_{il}^{\beta_{il}} \qquad (1)$$

where β_{il} is the share of each type of labor: unskilled informal (L1), skilled informal (L2), formal with low skill (L3), formal with average skill (L4), formal with high skill (L5), public servant with low skill (L6) and public servant with high skill (L7).[10]

Second, in each sector *i*, aggregated labor (Ld_i) and capital (K_i)[11] are associated by a constant elasticity of substitution (CES) function to obtain the production level (X_i):

$$X_i = a_i^D \left[\alpha_i Ld_i^{\rho_{it}} + (1-\alpha_i) K_i^{\rho_{it}}\right]^{1/\rho_{it}} \qquad (2)$$

where a_i^D is the CES shift parameter, α_i is the sector's i labor share in the production value and ρ_{ip} is the elasticity of substitution between capital and labor.

Finally, in the third step the various intermediate inputs levels (INT_i) are obtained by a Leontief production function (e.g., fixed proportion to sector *j* total product, X_j):[12]

$$INT_i = \sum_j a_{ij} * X_j \qquad (3)$$

where α_{ij} is the technical coefficient of input *j* in sector *i*.

Domestic producers react to the relative prices in domestic and international markets and the domestic output is divided by a constant elasticity of transformation (CET) function with imperfect substitution in products sold to these markets:

$$X_i = a_i^T * \left[\gamma_i * E_i^{(\rho_{it}+1)/\rho_{it}} + (1-\gamma_i) * D_i^{(\rho_{it}+1)/\rho_{it}}\right]^{(\rho_{it}+1)/\rho_{it}} \qquad (4)$$

where X_i, E_i and D_i are, respectively, the domestic sector *i*'s total output, exported volume and sales to internal market. a_i^T and γ_i are model's parameters and ρ_{it} is the elasticity of transformation.[13]

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[10] Also, there are more 2 types of employers that are treated as labor and enter in the Cobb-Douglas aggregation.

[11] The model closure adopted in the simulations determines that the sectoral levels of capital are fixed.

[12] It is worth mentioning that Devarajan *et al.* (1991) makes use only the first and third steps, by combining capital with labor and value added with intermediate inputs, in this order.

[13] There are no empirical estimates of Brazilian export elasticities using a CET structure for a highly disaggregated sectoral specification. Therefore, it was adopted the same procedure used in Cury (1998,

2.1.2. Demand for products

2.1.2.1. Families

Families are classified according to per head household income, level of urbanization and household head characteristics: poor urban families headed by active individual (F1), poor urban families headed by non-active individual (F2), poor rural families (F3), urban families with low average income (F4), urban families with average income (F5), rural families with average income (F6), families with high average income (F7), and families with high income (F8).

They choose commodities' consumption levels to maximize utility subject to a budget constraint,[14] according to a Cobb-Douglas functional form (similar to the production function presented earlier).

Families and firms demand domestic and imported goods as imperfect substitutes that differ according to their source (domestic or external), as proposed by Armington (1969), and their utility levels are measured (in product quantity) by a CES function:

$$Q_i = a_i * c\left[\delta_i * M_i^{(\rho_{ic}-1)/\rho_{ic}} + (1-\delta_i) * D_i^{(\rho_{ic}-1)/\rho_{ic}}\right]^{1/\rho_{ic}} \quad (5)$$

where M_i is the imported volume of good i and D_i is the consumption of the domestic good i. $a_i * c$ and δ_i are parameters, while ρ_{ic} is the Armington elasticity of substitution between D_i and M_i.[15] Finally, Q_i indicates the utility derived from the consumption of good i.[16].

The external agents demand domestic goods, reacting to changes in relative prices as well. Similarly to the import demand function, the exports demand arises from a CES utility function that represents the imperfect substitution between products from the external regions and Brazil.

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pp. 112-113), which departed from the elasticities estimated by Holand-Holst *et al.* (1994) to the American economy.

[14] Actually, this utility maximization can happen along the consumers' lifetime. From the point of view of most practical applications, the maximization is on the goods and services available in a given period.

[15] These elasticities values were estimated by Tourinho *et al.* (2002) for the same sectors considered in the model.

[16] It can be interpreted as the quantity of a hypothetical composite good that would be demanded by consumers.

2.1.2.2. Firms

Firms demand commodities to satisfy their production requirements of intermediate inputs according to the technical coefficients from the input-output matrix.

Due to the static nature of accumulation in the capital market, investments are important for product demand. Similarly to consumption, the investment is characterized as the purchases of certain goods and can be considered as a final consumption undertaken by firms. The savings represent this amount of resources and it is assumed that a share of it corresponds to investment in stocks of finished goods, while the remaining parcel represents the net investment required to expand production. The first share is defined based on a fixed proportion to the sectoral output, while the second is distributed exogenously among the sectors, reflecting information from the input-output tables (goods by sector of origin) and the matrix of sectoral composition of capital (goods by sector of destination and origin).

It is considered that investment goods are being produced but not used as increments of capital stocks. Thus, the model closure is closer to a medium-run type: constant capital stock, price flexibility and existence of involuntary unemployment in equilibrium.

2.1.2.3. Government

The Government consumption (GC) is derived from maximization of a Cobb-Douglas utility function subject to the budgetary constraint corresponding to the total expenditure that is fixed according to the total amount registered for the base year.

2.1.3. The Labor Market

Labor is a production factor used by firms and is classified into 7 types, according to contract status and schooling.[17] It is admitted that firms aim at maximizing

[17] The labor treatment that follows is applied for the 5 types of private workers. The 2 types of public servants follow the traditional labor market closure of CGE models with either wage or employment being fixed. Therefore, there is no substitution between public servants and the private kinds of workers, in the sectors where there is no public companies. In the sectors where public and private firms coexist, the changes in the public-private composition of labor are related to the changes in the public-private composition of the sectoral representative firm.

profits under technological constraints conditions imposed by production function, in an environment where prices of inputs, production factors (labor and capital) and output are beyond their control. Therefore, as a result of this maximization, for each type of workers, a specific demand curve is defined by the condition that their marginal productivities equalize their wages:[18]

$$P_i * \partial X_{il} / \partial F_{il} = W_{il} \tag{6}$$

In order to incorporate involuntary unemployment in the labor market equilibrium, a wage curve was introduced in the CGE model specification. Therefore, the equilibrium in this market is achieved by the interaction between labor demand and the wage curve.

The wage curve is an empirical 'law' of economics firstly reported by Blanchflower and Oswald (1990, 1994), describing a negative causality that runs from the unemployment rate to employees' wages.

The wage curves adopted here represent the negative relation between the unemployment rate (U_l) and the wage level (W_l) for private worker l in Brazil:

$$\ln W_l = \alpha_i - \beta_l * \ln U_l \tag{7}$$

where β_l reflects the firm's bargaining power in offering lower wages according to unemployment rate.[19]

According to Blanchflower and Oswald (1994), the theoretical foundations for the existence of wage rigidity are efficiency wages or union bargaining. Concerning the first theory, the firm tends to motivate an efficient behavior by means of attractive wages. However, when the unemployment rate is high, the worker feels threatened of losing his job and tends to be naturally efficient and the firm does not need to offer an attractive wage. In an alternative way, firms may feel pressured to raise wages when unemployment is low, as the bargaining power of workers increases under this situation.

In this sense, the wage curve can be interpreted as a firm's wage determination policy that considers the competition among workers for a job vacancy. Once the

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[18] The derivative of the profit function with relation to the factor demand must be equal to the factors' price (first order condition).

[19] These parameter values were taken from Reis (2002), who estimated then for the Brazilian case.

competition level increases with the unemployment rate, the firm can offer a relatively lower wage.

Due to this specification, the labor market equilibrium (employment and wage) is determined by $E^{/}$, the intersection point between the demand curve (L^d) and the wage curve (S). The wage level defined by $E^{/}$ does not correspond to the labor supply (L^o), and the difference $L^o – L$ is the excess of labor supply that corresponds to the involuntary unemployment level (U) in the economy.[20]

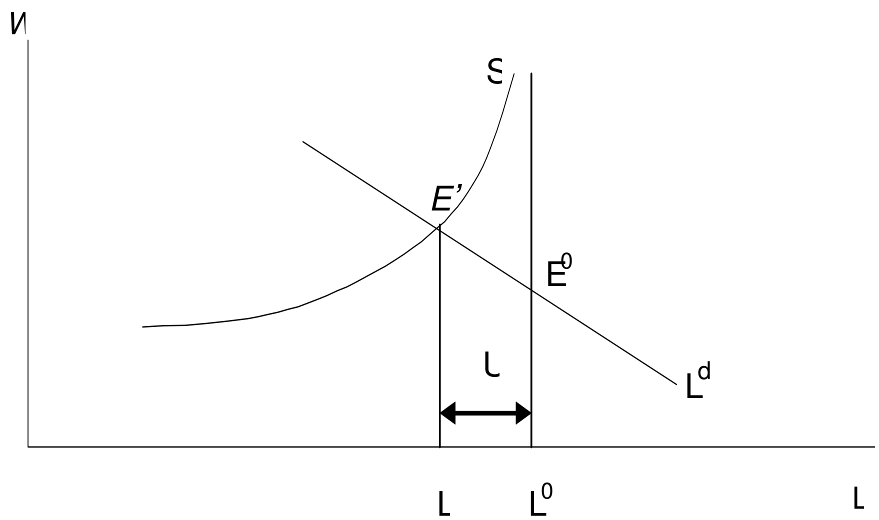

Figure 2.1 - Equilibrium in the labor market for a given type of labor

It deserves to be mentioned that the CGE model takes the assumption that this market equilibrium mechanism does not describe the adjustments for the two types of public servants considered in the model. In Brazil, in general, public servants are hired by mean of official examination for a governmental post and their working contract includes a job stability clause in Brazil. Therefore, it is assumed that the employment levels of public servants are fixed and that the disequilibria in their labor markets are adjusted by means of changes in wages.

The labor market closure is not formulated by sector, but rather by type of labor. In this sense, the adjustment mechanism is from the aggregate to the sectoral level. After an economic shock, first, we have the definition of the aggregate levels of employment, wages and unemployment for each type of labor by the interaction of their aggregate demand, aggregate supply and wage curves, as explained earlier.

[20] E^o would be the full employment level given by the interaction between labor supply and labor demand.

To define the employment and wage levels in each sector, it is assumed that the wages of the given types of workers are differentiated by sector in the model, which implies, in sectoral imperfect segmentation in the labor market. In this sense, for example, a formal worker with average qualification employed in the mechanic/automobile sector receives a larger wage than a worker with similar schooling degree and contract status would receive in the clothing sector.

The hypothesis implicit in the adopted mechanism is that workers with similar observed productive characteristics (schooling and contract status) are paid in a different way according to their sector of employment or occupation. The idea is to capture the fact that, although the abovementioned similarities, the workers have another characteristics such as profession type and sector specific training or qualifications that do not permit their free mobility between all sectors but also do not completely constrain their mobility to some other sectors. Therefore, the wage differentials among sectors would remain due to the imperfect mobility of workers between the economic sectors. Pinheiro and Ramos (1995) have not only proven this fact but have also demonstrated that the wage differentials among sectors are stable along the time.

In this sense, there is imperfect mobility of workers among sectors and, thus, the sectoral wage differentials will not be eliminated, that is, the wage equalization among sectors cannot be achieved by the migration of workers from sector(s) paying lower wages to sector(s) paying higher wages.

The wage of each kind of worker in each sector (W_{li}) is obtained by the interaction between the average wage for each type of labor (W_l) and an exogenous variable for the relative wage differentials among the sectors. With this information, by means of a sector and labor type specific demand curve (equation 2.6), we can also determine the sectoral employment level of each type of labor (F_{il}), which are aggregated by a Cobb-Douglas function (equation 2.1) to define the sector *i*'s composite labor.

2.1.4. The Income Transfer Mechanisms

Here it will be presented the formation process of income flows received by families and firms. The remuneration of capital is paid to firms[21] and the labor earnings to workers. In each sector, the payments to capital are distributed to the firms according to their initial share in the total earnings of capital.

The eight types (*h*) of families receive earnings from the seven types (*l*) of labor according to the initial shares (ε_{hl}) of these workers in these families, which also receive the remuneration of capital transferred by firms (*YK*) according to the family *h*'s share in these income flows (ε_{hk}). Finally, the families also receive net remittances from abroad (RE_h), adjusted by the exchange rate (*R*), and transfers from the Government (*TG*), in the form of payment of benefits (direct income transfers)[22] and as other transfers (essentially domestic debt interest)that are allocated to the families according to the initial shares (θ_{ht}). Therefore, the family *h's* income is:

$$Y_h = \varepsilon_{hl} * W_l + \varepsilon_{hk} * YK + (pindex) * \theta_{hk} * TG + R * RE_h \qquad (8)$$

2.1.5. The Government

The Government spends by consuming ($\sum_i CG_i$) and transferring resources to the economic agents. It plays a very important role in the process of determination of secondary income, once it directs a share of its transfers to firms as interests on the domestic debt and also demands products. Similar to families, the sharing of government transfers to the types of firms follows the proportions observed in the base year (θ_k). Finally, it also transfers resources to abroad (*GE*) and its total expenditure is:

$$GG = \sum_i CG_i + pindex * \left(\theta_{ht} + \theta_k\right) * TG + R * GE \qquad (9)$$

To face all expenditures, the Government relies on three types of collections: (1) direct taxes levied on firms' and families' income (ϕ_h and ϕ_k, respectively), and (2) indirect taxes on domestic and imported goods (proportional to production (*X*), domestic sales (D), imports (*M*) and value added (*VA*) amounts). Besides these sources, it also

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[21] Small (self-employed people) and large (other firms).

[22] These transfers include the social security benefits as well as other programs such as unemployment benefits, income transfer social programs and other cash benefits.

receives transfers from abroad (gfbor) and, finally, there is the balance of the social security system (*SOCBAL*).[23] Thus, the Government total revenue is:

$$RG=\sum_h \phi_h * Y_h + \sum \phi_k * YK + \sum_i (\eta_i * X_i) + \sum_i (\xi_i * D_i) + \sum_i (\pi_i + \sigma_i) * VA_i \\ + \sum_i (\mu_i + \kappa_i + \gamma_i) * M_i + R * gfbor + SOCBAL \tag{10}$$

where η_i are the tax rates on production, ξ_i and π_i are, respectively, the sector *i*'s PIS-COFINS rates on domestic sales value (cumulative regime) and on value-added (non-cumulative regime), σ_i and κ_i are, respectively, the ICMS-IPI tax rates on value-added and imports, μ_i is the tariff on imports, while γ_i are the PIS-COFINS rates on imports of commodity type *i*.

An eventual lack of government resources is defined as a government deficit that, together with domestic private (firms and families) and foreign savings, defines the amount of resources spent as investments.

The implementation of the PIS-COFINS reform changed the way by which the Government collects indirect taxes that levy domestic and imported commodities. Thus, the indirect tax revenue (INDTAX) from domestically produced goods is given by:

$$INDTAX = \sum_i (\eta_i * (PX_i * X_i)) + \sum_i (\xi_i * (PD_i * D_i)) + \sum_i ((\pi_i + \sigma_i) * (VA_i)) \tag{11}$$

where PX_i*X_i is the production value, PD_i*D_i is the gross revenue value from domestic sales and VA_i , η_j , ξ_i , σ_i and π_i were presented in equation 10.

This equation is very important to understand the way the implementation of the fiscal reform will be simulated. According to PIS-COFINS tax revenue data from "Receita Federal", all sectors are being levied in both cumulative and non-cumulative regimes. Then, the domestic part of the simulation will consist in applying the ξ_i and π_i tax rates that were verified in 2004 at sectoral level.

The other equation that contributes to the Government revenue and deserves mention is the indirect taxes on imports revenue, which is given by:

$$TARIFF = \sum_i (pwm_i * R).(\mu_i + \kappa_i + \gamma_i) * M_i \tag{12}$$

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[23] In fact, social security is treated as an agent apart from the Government in the model, not only because of the considerable amount of resources that it handles in Brazil, but also because of the contributions

where pwm_i is the external price of imports (in US$), μ_i is the tariff on imports, κ_i is ICMS-IPI rates on Imports and γ_i are the PIS-COFINS rates on imports.

Again, this equation is important to understand the way that the fiscal reform will be simulated, once another feature of this reform was that the imports started being levied by PIS and COFINS taxes. Thus, the implementation of this part of the reform will consist in applying γ_i tax rates that were collected from import flows of commodity type *i* in 2004.

2.2. From the CGE-RH model to the CGE-MS integration.

The pioneering studies on the assessment of the impacts of economic policies on income distribution and poverty using CGE models were presented by Dervis *et al.* (1982) and Gunning (1983). After them, some other papers have introduced other approaches to the issue concerning the evaluation of policy impacts on income distribution and poverty, which can be classified into three main categories: models with single representative household (RH), models with multiple households (MH), and the micro-simulation approach that links a CGE model to an econometric household micro-simulation model (Savard, 2003). This section aims to present these approaches highlighting theirs main advantages and drawbacks.

The first and traditional method is characterized by a CGE model with representative households (RH) used to perform distributional analysis by comparing income variation between the different groups of RH. Poverty analysis is made by applying the change of income of the RH generated by the CGE model on household survey data to perform ex ante poverty comparison. Dervis *et al.* (1982), de Janvry *et al.* (1991), Chia *et al.* (1994), Decaluwé *et al.* (1999a), Colatei and Round (2001) and Agenor *et al.* (2001) present evaluations based on this approach.

The main drawback to this approach is that it either supposes no intra-group income distribution change, or that this intra-group distribution change follows a defined statistical relationship between mean and variance of the income distribution. Therefore, there is not economic behavior behind this change in the intra-group distribution.

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that it applies on either the company's income (here again in a different form), or on the installments of the added value of labor.

This disadvantage is more serious when the analysis is performed with CGE model with just one RH. In this case the impacts on poverty are evaluated by applying the change of income of the RH on all households in the survey data. In this case, the consequence is that, besides not capturing intra-group effects, this approach also does not capture between group effects, that is, by imputing the resulting income variation from the CGE model on survey data, it just changes the average mean but not the variance of the distribution.

The main advantage of this approach is that it is easier to implement than other approaches, as it does not require specific modeling effort outside the CGE modeling analysis, once the researcher can simply use a CGE model and apply the simulation outputs to perform poverty analysis. In the previous research, as stated before, we followed this methodology.

The second approach is the integrated multi-households CGE (CGE-IMH) modeling, which consists of multiplying the number of representative households in relation to the CGE-RH approach. This kind of CGE model can present as many households as could be found in an income and expenditure household surveys. Decaluwé *et al.* (1999b), Cockburn (2001), and Boccanfuso *et al.* (2003) applied this approach to perform poverty and income distribution analysis. The analysis conducted in the scope of the project 561/06 was based in results generated by a CGE model with multiple households.

The main advantages of this approach, compared to the CGE-RH, are that they allow for intra-group income distributional changes as well as does not require pre-definition of household groups or aggregates. By avoiding this constraint, this approach permits any decomposition of poverty and income distribution analysis since all, or a large sample, of the survey households are directly included in the model.

The main disadvantages of this approach are the limits it imposes in terms of modeling possibilities of the household behavior. First, this happens because the large size of the model can become a constraint by making difficult its numerical solution. Second, its size can turn the data reconciliation between household income or expenditure and the national accounts' data relatively difficult. This reconciliation is need due to some under or over reported variables in the household survey.

According to Bonnet and Mahieu (2000, *apud* Savard, 2003), the above limitations can be overcome with the utilization of micro-simulation which is required to analyze income distribution (dispersion) effects.

2.3. The integrated methodology.

This research project seeks to assess the impacts of the PIS-COFINS reform on poverty and inequality using a Computable General Equilibrium (CGE) model integrated to a Microsimulation (MS) model in an effort to identify these impacts in a more realistic way.

Considering the importance of taking in account the effects of economic policies not only on the mean but also on the variance of the income distribution to perform distributional and poverty analyzes, this research adopts an approach based on the idea raised by Savard (2003) and Müller (2004), which is basically a sequential CGE-MS resolution with feedback between them.

This integrated methodology aims to overcome the difficulties posed by traditional CGE models for poverty analysis and consists in the use of a CGE model linked to a MS model with a bi-directional linkage between them to guarantee convergence of solutions for both models.

After presenting the microsimulation model in the next subsection, we will present more details about the models' integration.

2.3.1. The Micro Simulation (MS) Model.

This section describes the second part of the integrated approach. It contains the specification of the household income model used for the micro simulation and the consistency procedure between the results of the CGE model and the MS model.

The initial hypothesis for the utilization of a micro simulation model comes from the fact that an alteration in the tax system provokes behavioral changes in the individuals, both in terms of their participations in the job market and also for the expenditure level. The utilization of a micro simulation model in this work will be useful, in first place, to evaluate the PIS/COFINS reform impact in the individual's labor supply, considering a nationally representative sample of the population.[24] In a second moment, after the shocks, we will be able to evaluate properly the redistributive impacts of the reform, by the rearrangement of the individual incomes.

The micro simulation model adopted in this work is a simplification of the model proposed by Savard (2003). In this case, we will assume a fully segmented labor market, in which the workers receive a flexible wage that adjusts with labor supply and demand in each segment. The potential wage of each worker determines its choice between offering (or not) his workforce in this market. Thus, a worker decides to leave the labor market if the observed wage in his sector is bellow his potential wage.[25]

The potential wage is obtained through the observable and non-observable individuals' characteristics, as well as the family *h*'s characteristics, of which this individual belongs to. Therefore, the worker *i*'s potential wage, w_i^j, is estimated by the equation:

$$\log w_i^j = \alpha_i + \beta_i (Z_i H_{i \in h}) + u_i, \qquad i = 1,...,n \;\; e \;\; j = 0,1 \tag{2.3.1}$$

where α_i and β_i are the parameters to be estimated; Z_i and $H_{i \in h}$ represent, respectively the characteristics vectors of individuals' observable characteristics and the worker *i* family's characteristics; u_i is the random error term, which captures the non-observable characteristics that affect the earnings of individual *i*; and *j* is the individual's state, being 0 if the individual is unoccupied and 1 if the individual is occupied.

The Z_i vector of individual characteristics was composed, in this work, by the following variables:

$$Z_i = educ, exper, exper^2$$

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[24] As the database used in this work, the National Research of Sample by Domicile (PNAD), doesn't possess information about the domicile's expenditures, the micro simulation model will be reduced to the analyzes of the individual's labor supply.

[25] In Savard (2003), the labor market is segmented in two types: one with a fixed wage and another one with a flexible wage. Therefore, an individual could alter between three states (observing the implicit costs of choosing each one of them): offering her workforce in each one of the two markets or getting unemployed by choice.

where *educ* denotes the number of years of study and *exper* is a *proxy* to the level of experience, represented by the difference between the age and the individual's years of study.

The worker *i* family's characteristics, by their turn, were resumed by the sum of the earnings of all members of family h, which the worker *i* belongs to, that is:

$$H_{i\in h} = \log \sum_{i,h=1}^{n} w_{ih}$$

To the individuals that are employed, $j = 1$, we calculate the observed wage as the sum of the wages of all the works that individual *i* might have, denoted by w_i. Due to the identification impossibility of the observed wage to the sample's individuals that are unemployed, we need to estimate a *probit* model that determines the probability of the individual to take part in the labor market. This probability, $S_i = 1$, is estimated by the function:

$$\Pr(S_i = 1 \mid \mathbf{z}) = \Phi\{\gamma_i (X_i G_{i\in h})\} \qquad (2.3.2)$$

where: Φ is a function of accumulated distribution; γ_i is a vector of estimated parameters that determine the probability of the individual to take part in the labor market; as before, X_i and $G_{i\in h}$ are the individual and familiar characteristics that determine the probability of participating in the labor market, represented, by the variables:

$$\begin{cases} X_i = educ, age, age^2, D_g \\ G_{i\in h} = tamfam, D_a \end{cases}$$

in which *educ* possess the same meaning exposed above; *age* is the individual's age; D_g is a *dummy* for gender (0 for woman and 1 for man); *tamfam* represents the number of individuals that compose the family (excluding pensioners, domestic servants and their parents); and D_a is a dummy for the area where the family's domicile is located (0 for urban and 1 for rural).

Finally, the equations (2.3.2) and (2.3.1) are estimated by the two stages method proposed by Heckman (1979). In this model, equation (2.3.2) is also known as the equation of correction of sample selection's bias by non-observable. From this equation is extracted the inverse of Mills' ratio, $\lambda(\mathbf{z}\gamma)$, which will be applied in (2.3.1), in a way that the parameters of this equations are going to be consistently estimated.

Possessing the estimated coefficients in (2.3.2) and (2.3.1) and the inverse of Mills' ratio, it will be possible to calculate the expected wage of each individual, $\overline{w}_i^j$, based on her observable and non-observable characteristics. If the individual belongs to state $j = 1$, the potential wage of worker i is obtained. If he is part of the state $j = 0$, the reserve wage of this individual is obtained. This potential wage (or reserve wage) will be used in comparison with the observed wage, w_i, which suffers the shock from the tax political change.

2.3.2. The Integration of the CGE and the MS models

The impacts of the PIS-COFINS reform on welfare indicators will be evaluated with an integrated CGE-MS modeling framework with bi-directional linkage between them to guarantee convergence of solutions for both models. The communication between CGE and MS models will occur by means of wages and occupational level of labor. This sub-section describes the way these are integrated to generate a convergent for them.

Running the integrated model involves the following procedure: we first compute the CGE simulation and sequentially run the MS model.

The basic issue is using a CGE model to simulate the implementation of the PIS-COFINS fiscal reform and calculate the induced changes in the general average real wage and the general price index. These changes are fed into the MS model, in which they are exogenous variables, to define the labor occupational level for each kind of worker, that are feed backed to the CGE model, in which they become exogenous variables after the first simulation, producing new values for general average real wage, and general price index that are retransmitted to the MS model, in order to define labor occupational levels compatible with the new value for the general wage. This iterative process continues until the difference between the values of occupational levels for the labor types in the CGE model between two consecutive iterative steps are very close to zero. The following description illustrates the way that we intend the bidirectional procedure works in the case of simulating the implementation the PIS-COFINS fiscal reform:

- *Step 1*

The simulation of the fiscal reform implementation induces the economic system to achieve new equilibrium values for each variable in the CGE model, including the general average real wage $\left(W^{*}_{CGE}\right)$ and the occupational level by labor type $\left(L^{*}_{CGE}\right)$.

- *Step 2*

The MS model contains data about thousands of individuals and estimates the potential wage ($\overline{w}_i^{\,j}$) for each person i in the database and defines occupational levels for each category of labor by means of the system equation (2.3.2) and (2.3.1) estimated by the Heckman procedure.

For each employed person, this procedure apply the following criterion: if the estimated potential wage $\left(\overline{w}_i^{\,j}\right)$ is higher than the earned wage $\left(w_i\right)$ observed in the database, then this person is indicated as potentially unemployed; otherwise, he remains employed, i.e:

$$\begin{cases} \text{if } \; w_i < \overline{w}_i^{\,j} \,, & \text{individual } i \text{ is a potentially unemployed} \\ \text{otherwise} \;, & \text{he is a potentially employed} \end{cases}$$

After making this comparison for each employed person, the model determines the Heckman pre-simulation occupational level by labor type $\left(HLsl\right)$ by summing up the number of people originally unemployed with the number of people that would unemployed according to the Heckman criterion.

- *Step 3*

The percentage change in the general average real wage $\left(\Delta W^{*}_{CGE}\right)$ obtained from the simulation with the CGE model is applied on the wages earned by each person i in the MS model's database $\left(w_i\right)$, defining after-shock values for earned wages $\left(w_i^{*}\right)$. For example, if the post-simulation general average real wage in the CGE model is 5%

higher than its initial value, then all wages earned by each one in the MS model's database are raised by 5%.

After that, we compare the values of these new individual wages $\left(w_i^*\right)$ with their respective potential wage amounts $\left(\overline{w}_i^j\right)$ by means of a Heckman procedure. Using the same previously mentioned criterion for this procedure, we have that:

$$\begin{cases} \text{if } \ w_i^* < \overline{w}_i^j \ , & \text{individual } i \text{ is unemployed,} \\ \text{otherwise} \ , & \text{he is employed.} \end{cases}$$

Summing up the number of people originally unemployed with the number of people that would unemployed according to the Heckman criterion, we define the Heckman post-simulation occupational level for each labor type (*HLsl**).

- *Step 4*

The step 3 shows the number of individuals who lose jobs in the microsimulation process. The selection of individuals who are unemployed follows the method proposed by Savard (2003). Firstly, we classify the workers by the reservation wages. The workers with the highest reservation wage will be the first to become unemployed if the real wage decreases. If there is positive change in real wages, the first to be employed will be those with lower reservation wage.

- *Step 5*

It deserves to mention that Heckman pre-simulation occupational level by labor type $(HLsl)$ is different from the original occupational level in the database (Lsl), once there are people in the database that work and earn wages lower than their estimated reservation wages. This happens because these reservation wages are actually estimates of the wages that these people could earn in the market according to characteristics of themselves and of their families. Therefore, just the application of the Heckman procedure to the database changes the occupational level for each labor type.

In order to capture the change in the occupational level by labor type that is due only to the variation of wages and not to the application of the Heckman procedure to the database, we calculate the difference between the Heckman post-simulation

$(HLsl*)$ and pre-simulation $(HLsl)$ occupational level by labor type defined by the MS model. Then we take this difference and sum it to the original occupational level in the database (Lsl) to have an occupational level that is compatible with the new values of wages, that is, a post-simulation occupational level calculated by the MS model $(Lsl*)$ for each labor type.

These new levels of occupational levels are then transmitted to the CGE model, as shown in the figure below that illustrates the iterative procedure described in Figure 2.2. below:

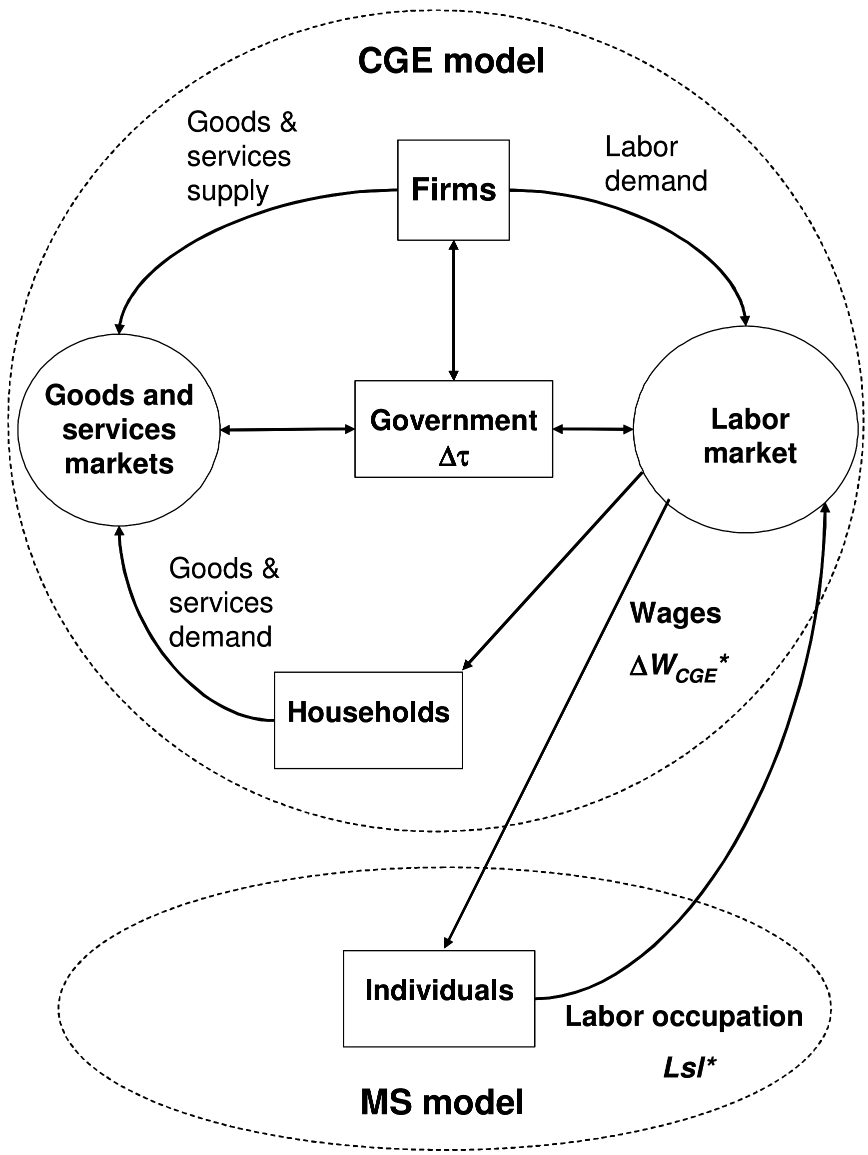

Figure 2.2 – MS-CGE Integration

If the occupational levels calculated by the MS model are different from those in the CGE model, they change the equilibrium of the labor markets, which will present new values for wages and induce changes in the economic environment as a whole until the CGE model reaches a new equilibrium situation. In this sense, the step 1 restarts and this integrated solution procedure loops until the difference between the post-simulation occupational level calculated by the MS model $(Lsl*)$ in one round is reasonably close to the one obtained in the previous round.

This association is done in a consistent way with the equilibrium of aggregate markets in the CGE model, which requires that: (1) relative changes in average earnings in the micro simulation must be equal to changes in wage rates obtained in the CGE model for each wage group in the labor market; (2) relative changes in the number of waged workers by labor-market segment in the micro simulation model must match those same changes in the CGE model, and (3) changes in the consumption price vector, p, must be consistent with the CGE equivalent price indicator.

2.3.3. Non-labor income procedures

The non-labor income variables have a mixed treatment in the calculation of poverty and inequality indicators. Basically they follow the CGE variations or they held the same value of the household survey, as described in the table bellow.

Table 2.1 – Integration CGE-MS Model for non labor Income (base 2003)

Household Income Source	Procedure in the Microsimulation (PNAD 2003)
Governmental Transfers	The same vector value of the microsimulation base year model
Self Employed Income	Changes from the CGE model are applied to the microsimulation model vectors
House Rent	The same vector value of the microsimulation base year model
Interest, Dividends and Others	Changes from the CGE model are applied to the correspondent variable by family type
Retiree and Pension Public Benefits	The same vector value of the microsimulation base year model
Retiree and Pension Private Benefits	The same vector value of the microsimulation base year model
Donation received	The same vector value of the microsimulation base year model
The above sources are deflated by the CGE model price index (after simulation) for each family type (weighted by the consumption model vector)	

3. Simulations description

This report aims at assessing the effects of the "PIS-COFINS Tax reform" on welfare indicators using an integrated modeling approach. The simulation was carried out in two basic parts: (i) the standard simulation with only the CGE model and (ii) the simulation using the integrated CGE-MS models.

At the CGE level, the impacts of the PIS-COFINS taxation reform were simulated by implementing a mixed taxation regime, which consists of the following steps: (1) the taxes levy sector's revenue from domestic sales and value added, (2) application of the new tax rates on domestic flows verified in 2004, (3) the taxes start levying imports, and (4) application of the new tax rates on import flows verified in 2004. These 4 items were simulated in two steps. First it was implemented the mixed taxation regime (features (1) and (2)). Then, the PIS-COFINS rates on imports was also implemented (features (3) and (4)), taking as database the resulting scenario from the first step. Thus, the results from the second step capture all the impacts of the taxation reform.[26]

The second part of the simulation is related to the method adopted to make the consistency between the two models. We decided to use two approaches, from which we derived two sets of results from the same CGE simulation. Therefore, from the CGE simulation, we are going to have two simulations results, that we call **SIMU 1** and **SIMU 2**.

Basically, SIMU 1 has a specific role as the reference simulation, used for comparison, where we don't adopt any type of integration. In this case, we are using the family income results of the CGE model without any new estimation from the MS Model. The usage of PNAD household survey was restricted to the weighting of family types in the calculation of welfare indicators.

On the other hand, SIMU 2 is totally different. Their income results are derived from the integration procedure and establish the linkage between the CGE and the MS models, as described in section 2.3.2. In this way, we are allowing the intra group effect that the CGE does not take in account.

[26] A completed description of the simulations at the CGE level can be found in Cury and Coelho (2006).

4. Results

4.1. Macroeconomic impacts

Once one of the main purposes of the simulation is to evaluate the potential distributive impacts of the PIS-COFINS fiscal reform, the analysis will focus on the impacts on employment, wages and household income. However, the impacts on selected aggregated variables will be presented in order to show the magnitude of the macroeconomic effects.

The simulated macroeconomic impacts of the PIS-COFINS reform, without MS, are reported in the first column (SIMU 1) in Table 4.1. The effects of the reform with the integrated MS model are also reported in the second column (SIMU2).

Table 4.1: Macroeconomic Indicators (percentage change) [a]

	SIMU 1 without MS	SIMU 2 with MS
GDP	– 0.71	– 0.49
Consumption	– 1.15	– 1.15
Investment	0.71	1.29
Public sector revenue	0.51	1.17
Public sector deficit	– 9.51	– 21.86
Exports	– 2.35	– 2.22
Imports	– 3.02	– 2.84
Employment	– 2.77	– 0.43
Price Index	2.51	2.37

Note**:** (a) real percentage change from base year.

The overall impacts from fiscal reform were adverse since it induced a real GDP fall of 0.71% (SIMU1) and 0.49% (SIMU2), an aggregate employment decrease of 2.77% (SIMU1) and 0.43 % (SIMU2) and, generated inflation with price index increases from 2.51% (SIMU1) to 2.37 % (SIMU2). The effect on real GDP reflects the fact that the reduction of the cumulativeness of these taxes had significantly divergent effects on output at sectoral level.

The taxation of value-added (VA) induced an increase in its price, which was equivalent to a rise in the marginal costs. To achieve the equilibrium, in perfect competition, the representative firm need earn higher marginal revenue or reduce marginal costs, which could be done by reducing the VA components usage. Considering the way that the labor market operates and the model's closure features, this implies in a lower labor demand, inducing a decrease in wages, and so, reducing the available income and, consequently, consumption expenditure.

Also, by taxing imports, that is, increasing their prices in domestic market (+6.80%), the reform induced another adverse effect on aggregate consumption. Once domestically produced and imported commodities are not perfect substitutes, even changing the relative prices in favor of the domestic ones,[27] this price increase raised the composite commodities prices in internal market (+2.51 or 2.37%), which induced the households to consume less, but substituting imported commodities by larger amounts of domestic ones. In a similar way, the firms should have substituted import inputs by domestic ones in some extent. However, this positive effect was not strong enough to offset the negative effect on consumption induced by the taxation of imports, and so, there was a second adverse impact on consumption demand.

The macroeconomic closure considers that the investment is determined by the savings behavior and that the Government consumption is fixed. This implies that the changes in the tax revenue affected the Government savings and, therefore, the public deficit and investment. Thus, the investment increased by 1.29% (SIMU1) or 0.71% (SIMU 2) due to the rise in the public sector revenue, which decreases the public sector deficit.

Exports fell due to the price-responsiveness behavior of external agents and the model external closure characteristics. First, the reform induced an increase in domestically produced commodities prices, which, by turn, caused a decrease in external demand by Brazilian commodities. Second, the rise of import prices and the reduction of internal absorption (activity) induced a fall in demands for imported commodities, and in order to not affect the trade balance equilibrium (fixed in the model closure), exports decreased.

The fall in aggregate consumption and exports more than offset the increase in investment and the fall of imports.

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[27] The prices of the domestically produced commodities sold in the internal market increased by 2.20%.

The macro results changes brought by the CGE - MS Integration.

Although the macro results present the same direction at both simulations, they differ significantly in their size. The main difference was found in the employment level where the new methodology reduces the variable change from -2.77 % to -0.43 %. This new level of employment allows a higher production level resulting in a higher level of GDP. Consequently, the government revenue increases from 0.51 % (SIMU1) to 1.17 % (SIMU2) allowing higher levels of Savings and Investments. Since the others components of the demand don't change significantly, this higher level of capital production today will open the possibility for a recovery of the product losses in the near future.

To better understand the relationship between public sector fiscal revenue and PIS-COFINS taxes according to their three different sources, the taxes amounts for the model base year (2003) and the two simulations scenarios are shown in table 4.2, below.

Table 4.2: PIS-COFINS values, before and after taxation reform (2003 R$ millions)$^{\alpha}$

	Base (2003)[28]	SIMU 1 without MS	SIMU 2 with MS
PIS-COFINS other than value added	62,868	32,450	32,457
PIS-COFINS on value added	11,157	45,910	45,889
PIS-COFINS on Imports	----	13,955	13,990
Total PIS-COFINS	74,025	92,315	92,336

Note**:** (**α**) real values deflated by model price index.

The total amount collected after the reform confirms the results reporting in the former project. The total value collected in the partial reform (the first 2 lines of the table) was just 5.85 % higher than the base value. These results confirm the hypothesis that only changing the taxation regime would not significantly alter the total PIS-COFINS collection. However, when the taxation on imports are also simulated, the total revenue significantly increases by R$ 18,300 millions (+24.7%) with PIS-COFINS

[28] The base year total value of this table has a small difference from the data reported in table 1 and 2 above because the later has some deductions due to total taxes GDP participation methodology adopted by "Receita Federal".

collection on imports (R$ 13.9 billions) representing almost 80% of that growth.[29] Also the adoption of the integrated approach don't change the amounts of PIS-COFINS collected as shown in the last line of the tables.

4.2. Impacts on employment and wages

At this section, we can see the main differences between the two methodologies adopted in the simulations. While the taxation reform reduced the aggregate employment by 2.77 % in the case of SIMU 1 (see table 4.1), the same figure will be only 0.43 % in the case of the integrated approach. The introduction of the integrated approach described at sections 2.3.1 and 2.3.2 modify the economic adjustment of the fiscal reform. Instead of the five wage curves presenting in the CGE model, the labor supply model adopted at MS model allowed the individualized treatment of all private workers included in the PNAD household survey.

The main economic effect of this new procedure can be seen at the behavior of the private employees. The MS model shows that a great employee portion accepts the real wage reduction in exchange to maintain their present employment.

Table 4.3: change in employment from the base-year (%)

	L1	L2	L3	L4	L5	6	L7
SIMU 1 without MS	– 3.46	– 1.17	– 2.19	– 0.88	– 0.74	0.00	0.00
SIMU 2 with MS	– 0.82	– 0.45	– 0.19	– 0.31	– 0.13	0.00	0.00

Note: **L1**-unskilled informal; **L2**-skilled informal; **L3**-formal with low skill; **L4**-formal with average skill; **L5**- formal with high skill; **L6**- low skilled public servant; **L7**- highly skilled public servant.

By labor type the results show that employment would fall for all categories of workers in the private sector. The public servants employment does not change because public sector does not follow the behavior of private sector concerning hiring/firing people and so, by assumption, their employment levels are fixed and their labor market adjust only by means of wages.

[29] Despite not being a good method for comparison, the total value showed in table 4 agree with the amount verified in 2004, when it is deflated, R$ 91,140 (see Receita Federal, 2006), since it is just 0.96% higher than this value.

In the case of SIMU 1, the effects were more pronounced among the less skilled ones, regardless their labor contract status (L1 and L3) and the less affected category would be the formal with the highest qualification (L5). Although with much less impact, the most affected at the SIMU 2 were the two informal labor types (L1, L2). We think that this difference was also due to the MS model which can capture a higher level of protection for the formal private workers.

The table 4.4 bellow shows the effects on wages by labor type. In this case, the results are the opposite of the employment in the previous table. Now, the impact is higher in the case of the integrated approach (SIMU2). The trade off between the simulations is clear with employees losing their job (SIMU 1) or allowing a real wage decrease (SIMU2). In the end, as explained before, the firms must reduce their labor cost to cope with the higher taxation on value added and/or a demand decrease.

Table 4.4: change in the average real wage from the base-year (%)

	L1	L2	L3	L4	L5	L6	L7
SIMU 1 without MS	– 1.05	– 0.74	– 0.85	– 0.99	– 1.74	– 1.81	– 1.77
SIMU 2 with MS	– 2.55	– 1.40	– 2.29	– 1.64	– 2.41	– 2.36	– 2.36

Note: **L1**-unskilled informal; **L2**-skilled informal; **L3**-formal with low skill; **L4**-formal with average skill; **L5**- formal with high skill; **L6**- low skilled public servant; **L7**- highly skilled public servant.

Note that the general effect was a real wage fall at both experiments. Among private sector workers, the decreases in wages were higher among the least skilled worker (L1) and the most qualified (L5). The higher reductions of public servants' earnings were due to the assumption that the equilibrium in their labor market is almost exclusively achieved by means of adjustments in wages.

Despite the trade off described above, it is important to emphasize that the adjustment in the employment level is different from the wage level in macroeconomic terms. The simulations demonstrate that in the last case the economy is better off with a higher level of investment with the possibility of recovering in the near future.

4.3. Welfare results: income, inequality and poverty impacts

4.3.1. Income and Inequality

The effects of the fiscal reform on household income are presented in the table 4.5 below. For the family per capita income variation, the results look quite different between the simulations. Without the integrated approach, the family per capita income falls on average -1.24 %. On the other hand, the SIMU 2 shows a sharp decrease of -2.13 %. One first explanation can be found in the differences of data between the household survey (MS database) and the National Accounts (CGE database). Considering the family income composition by income source and specifically the case of labor income (employees and self employed), it has a higher participation in the MS model (PNAD data base) and therefore a higher influence in the overall family income.

The same could be said about the social security income. But this source of difference has an additional component due to the treatment of all govern direct transfers, including all types of public retirement benefits. In the CGE, by construction, this source still neutral to the movements of price index while in the integration approach (SIMU2) they received the full impact of the inflationary process find in the simulations through the deflation of that benefits. Thus, the total family income of SIMU 2 will be necessarily lower than SIMU 1.[30]

The difference in the results can also be explained by the integrated approach itself. After the convergence solution at SIMU2, described at section 2.3.2 (steps 1 to 4) some individuals in the MS model must be choosing to become new unemployed into each labor segment. Following the Savard (2003) approach these former employees, now unemployed based in their labor supply decisions, will be the ones with the highest reservation wage, thus affecting with more intensity the average family income by type. At SIMU 1, in contrast, this phenomenon is not the same because the reduction of labor income is based in the fall of average wage.

[30] The treatment of government transfers relative to the price movements is a controversial subject in the CGE models. On the one hand you can not correct the transfer at all meaning to fix its nominal values. On the other hand it is possible the indexation of these values through some price index, which is the case of our CGE model. Between them it is possible the behavior modeling of this process if would be available a representative function of this conflict among the agents.

Table 4.5: change in household income from the base-year (%)

	F1	F2	F3	F4	F5	F6	F7	F8
SIMU 1 without MS	– 1.31	– 0.18	– 1.23	– 1.27	– 1.21	– 0.98	– 1.23	– 1.29
SIMU 2 with MS	– 3.82	– 3.18	– 6.29	– 1.32	– 0.91	– 1.87	– 1.34	– 3.62

Note: F1 – poor urban families headed by active individuals, **F2** – poor urban families headed by non-active individuals, **F3** – poor rural families, **F4** – urban families with low average income, **F5** – urban families with average income, **F6** – rural families with average income, **F7** – families with high average income, **F8** – families with high income.

The same differences between the simulations are noted when we analyze the income for each family type. In the case of SIMU 1, the most affected are F1 and F8, which are the poorest and richest family, respectively. Also, all CGE families have an income fall of more than 1%, except the F2 (non-active individuals) with decrease of only (–0.18%). This happens because the above explanation of transfers treatment in the CGE.

But in SIMU 2 the pattern of the effects is different. The poor rural families (F3) are most affected and this can be related to the highest job loss of the informal unqualified worker (L1). After that come F1 and F8, repeating the same pattern of SIMU1, but with more intensity because the above explanations.

Table 4.6: Income inequality indicators

Inequality Indicators	Base year	SIMU 1- without MS		SIMU 2 - with MS	
	Results*	Results**	Change	Results**	Change
Gini Index	0,5948	0,5947	-0,02%	0,5939	-0,15%
Theil-T Index	0,7266	0,7263	-0,05%	0,7211	-0,77%

(*) original values from Pnad , (**) after the application of simulation shocks.

As we can see in the table 4.6, the income inequality presents a small distinction between the simulations. In the case SIMU 1, the two indicators (Gini, Theil-T) are practically stable, reflecting the pattern of family income reported at table 4.5. On the other hand, SIMU 2 shows a slight decrease in GINI and a more significant for Theil-T. If you looked just in the above family income information seems that the income fall of the poor rural family (F3) and the urban poorest (F1) were offset by the income fall of the richest family (F8). In terms of income amounts, the reduction in F8 is more than the doble of the poorest families together and the four richest families the reduction is 3.9 times the four poorest.

4.3.2. Poverty Indicator

The effects of the fiscal reform on poverty are presented in the table 4.7 below.

Table 4.7 Poverty Indicators - PNAD 2003

Poverty Indicators	**Base year**	**SIMU 1 - without MS**		**SIMU 2 - with MS**	
	Results*	Results	Change	Results	Change
Poverty Line (Line = R$ 143,70)					
P0	0,3319	0,3353	1,02%	0,3367	1,45%
P1	0,1615	0,1636	1,30%	0,1672	3,51%
P2	0,1081	0,1095	1,22%	0,1133	4,74%
Extreme Poverty Lines (Line = R$ 71,84)					
P0	0,1482	0,1502	1,37%	0,1554	4,85%
P1	0,0798	0,0807	1,09%	0,0848	6,21%
P2	0,0609	0,0614	0,79%	0,0648	6,39%

Despite the differences in the inequality results, both SIMU 1 and SIMU 2 showed a substantial deterioration in the poverty indicators. The poor proportions (P1) increased at both simulations. The increase is higher at SIMU 2 than at SIMU 1. Also the extreme poverty indicators demonstrate the same behavior and are more intense than in the poverty situation. These facts point out that the CGE-MS integration captures additional income effects inside the population poor groups and the lowest income portion of this group is the most affected

This situation is firstly explained by the income shocks of the 3 poorest families type (F1, F2, F3) presented at table 4.5 previously. In the first simulation (SIMU 1), the 3 poorest families suffer mainly an income decrease due to the fall in labor income represented by the job losses. On the other hand, as pointed out before, at SIMU 2 we have the fall in the labor income but we also have deterioration of the government transfers such the social security benefits. The price effect increase (see section 4.1) appears with more intensity in the SIMU2 affecting the non-labor income which is very important for the poorest groups too. These last comments illustrates the importance of the adoption of the integrated approach (CGE-MS) but also raised other questions of the political economy such as the many possibilities of individual reactions when the macroeconomic environment is changing as a consequence of the fiscal reform.

5. Final Remarks

This research project has developed and implemented an integrated CGE-MS model to evaluate the distributive impacts of the PIS-COFINS taxation reform. Once this integrated methodology permits better identification of individuals and families, it can generate more realistic results about poverty and inequality than those obtained with models with representative agents.

The impacts of the fiscal reform implementation were evaluated with two methodologies: (1) CGE model, and (2) CGE-MS integrated model, in order to evaluate the differences in simulation results generated by both methodologies and, in this sense, assess the gains of using the integrated approach.

The overall macroeconomic impacts from fiscal reform were adverse since it generated inflation and reduced the macroeconomic aggregates, except investment that increased due to the rise in the public sector revenue, which decreased the public sector deficit.

Although macroeconomic effects have presented the same direction at both simulations, they have differed significantly in size, especially the employment level. The introduction of the integrated approach modified adjustment mechanism in the labor market that captured the fact that a significant number of employees accepts a real wage reduction in exchange to maintain their jobs, which is reinforced by the simulated effects on wages. Despite this trade off, once the adjustment in aggregate employment level is different from the wage level, the economy is better off in the last case that presents a higher level of investment with the possibility of recovering in the near future.

The effects on the family per capita income were much stronger in the simulations with the integrated model. One first explanation for these results is related to the participation of labor income (employees and self employed) that is higher in the MS model (PNAD data base) and, therefore, has higher influence on the overall family income. Another explanation is related to the criterion used in the MS model to choose people that would become unemployed first: those with the highest reservation wage, thus affecting with more intensity the average family income by type.

The income inequality would not be affected by the fiscal reform in a significant way. The income fall was generalized, although some families seemed to be more affected than others. The results showed that the fall of income of the poor families were offset by the income fall of the richest family.

Despite the slight effects on income distribution, both simulations showed substantial deterioration of poverty indicators that were higher at SIMU 2 than at SIMU 1. The extreme poverty indicators showed the same pattern but have worsened more than the poverty ones.

These evidences point out that the CGE-MS integration captures additional income effects inside the population groups than are not considered in representative agents models. Therefore, we consider that this research project was well succeed in developing an integrated CGE-MS model to better capture the effects of economic policies on poverty and income distribution.

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APPENDIX A - The Models' Data Bases and Econometrics Estimates

A.1. CGE data base.

Almost all data used in the CGE model and simulations were derived from a Social Account Matrix (MSC–2003), which contains all the quantities and prices information in 2003 (the model's base year). Besides, all the model's coefficients and parameters obtained by the model calibration process are calculated from this data matrix, whose description can be found at Cury *et al.* (2006). It deserves mention that it was not made based on new Brazilian National Accounts 2000 series released just in March 2007 by the Instituto Brasileiro de Geografia e Estatística (IBGE). Another set of data used to calculate the economic shocks that will be simulated and evaluated will be presented in the next section.

A.2. Micro Simulation database.

The database for the micro simulation consists of the sample of almost 384,834 individuals distributed in 117,010 households in the PNAD 2003. Each of the individuals in active age (over 10 years old) was classified according to the 11 types of factors derived from the CGE model. However, only individuals in active age belonging to the factors L1 to L5 were considered in the CGE-MS integration, that is, those individuals who have as the main income source the wages paid in the private sector. Thus, the sample had 106,590 observations that represent 48,742,853 individuals that were classified as occupied and unoccupied as shown in the table below.

Table A.1 – Employed and unemployed reweighing for L1 to L5 work factors

Factor	Description of the worker	PNAD occupational condition (in 1.000 persons)			Unem-ployed ratio	CGE model data (in 1.000 persons)			Unem-ployed ratio	Reweighing	
		Emplo-yed	Unem-ployed	Total		Emplo-yed	Unem-ployed	Total		Emplo-yed	Unem-ployed
L1	Unskilled informal	12.890	1.567	14.457	10,8%	11.714	1.418	13.132	10,8%	0,9088	0,9052
L2	Skilled informal	5.694	952	6.646	14,3%	5.264	878	6.143	14,3%	0,9245	0,9226
L3	Formal with low skill	13.923	1.349	15.272	8,8%	12.274	1.184	13.458	8,8%	0,8815	0,8782
L4	Formal with average skill	9.208	854	10.062	8,5%	8.331	774	9.105	8,5%	0,9048	0,9062
L5	Formal with high skill	2.211	95	2.306	4,1%	2.063	88	2.152	4,1%	0,9334	0,9238
Totals		**43.926**	**4.817**	**48.743**	**9,9%**	**39.647**	**8.537**	**87.788**	**9,7%**		

Source: PNAD 2003, CGE model data base

One of the main difficulties in order to make the CGE-MS integration is the convergence. For this convergence be successful it was appropriate to make the two databases had the same values. Thus, the weights of individuals were multiplied by a factor (reweighting), so as the PNAD data base reflected the CGE model data. Table A.1 presents the results of this reweighting for employed and unemployed people.

A.3. Econometric Estimates.

The first part of the micro simulation process is the computation of the potential wages and the new occupation ratio. For this phase, it was considered only the factors L1 to L5. From the reweighed data base, it was estimated the equations (2.3.2) and (2.3.1) by the two stages method proposed by Heckman (1979), that has the following specification:

$$\begin{cases} \Pr(S_i = 1 \mid \mathbf{z}) = \Phi\mathbf{z} = \Phi\{\gamma_i(Z_i H_{i\in h})\} \\ \log w_i^j = \alpha_i + \beta_i(X_i G_{i\in h}) + u_i \end{cases} \qquad i = 1,\ldots,n \;\; and \;\; j = 0,1 \qquad \text{(A.1)}$$

where

$$\begin{cases} Z_i = educ, exper, exper^2 \\ H_{i\in h} = \log \sum_{i,h=1}^{n} w_{ih} = \log\_wd \\ X_i = educ, age, age^2, D_g \\ G_{i\in h} = tamfam, D_a \end{cases}$$

Table A.2 contains the econometric estimates by the system equation (A.1), including the coefficients and their standard errors to 5% of significance, as well as the inverse of the Mills's ratio, $\hat{\lambda}(\mathbf{z})$.

From these estimates were computed the potential wages necessary for the completion of the steps 3 and 4 of the microsimulation process. The final convergence process has generated a final shock in wages for L1 to L5 factors, which provided a new unemployment rate, as shown in Table A.3. It is important to note that the unemployment rates of L1 to L5 factors, before and after the microsimulation, considered the new weights, according to Table A.1.

Table A.2 – Results of econometric estimates - Heckman selection model

	Coefficient	SE	z	p-value
Wage regression equation: $\log w_i^j$				
educ	0,0496	0,0006	81,05	0,0000
exper	0,0475	0,0005	101,16	0,0000
exper^2	-0,0007	0,0000	-74,94	0,0000
log_wd	0,5394	0,0025	211,79	0,0000
constant	1,4633	0,0159	91,97	0,0000
Selection equation: $\Pr(S_i = 1 \mid \mathbf{z})$				
educ	0,0113	0,0011	10,26	0,0000
age	0,0225	0,0019	12,05	0,0000
age2	-0,0002	0,0000	-6,94	0,0000
D_g	-0,4747	0,0083	-57,41	0,0000
tamfam	-0,0924	0,0024	-39,06	0,0000
D_a	0,1385	0,0180	7,70	0,0000
constant	1,0620	0,0354	29,99	0,0000
$\hat{\lambda}(\mathbf{z})$	-0,6210	0,0025		
Number of obs. = 106.590				
Censored obs. = 12.016				
Log likelihood = -117.439,8				

Source: Authors' estimates.

So the difference between the number of unemployed before and after the microsimulation, in Table A.3, represents the individuals who lose their jobs because of the final shock, according to the step 4 in microsimulation process.

Table A.3 – Occupational characteristics before and after the shock

Factor	Baseline model				After microsimulation		
	Total work force	Employed	Unemployed	Unemployed ratio	Employed	Unemployed	Unemployed ratio
L1	13.132.377	11.714.080	1.418.297	10,8000%	11.618.126	1.514.251	11,5307%
L2	6.142.532	5.264.150	878.382	14,3000%	5.237.838	904.694	14,7284%
L3	13.457.807	12.273.520	1.184.287	8,8000%	12.249.912	1.207.895	8,9754%
L4	9.105.290	8.331.340	773.950	8,5000%	8.305.359	799.931	8,7853%
L5	2.151.658	2.063.440	88.218	4,1000%	2.060.857	90.801	4,2200%
Total	43.989.664	39.646.530	4.343.133	9,8731%	39.472.093	4.517.571	10,2696%

Source: Authors' estimates.