A Simplified Macro-Economic Model of the US Economy

and it's Use to Analyze the Effect of Offshoring and Rehiring

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Abstract. In this paper, we first describe a simplified macro-economic model of the US economy. The national economy is represented with four sectors: Goods Production, Services, Government and Persons, plus the pseudo-sector of Foreign Transactions. The model relies on real data, as published by the Bureau of Economic Analysis, US Department of Commerce, in lumped and somewhat modified form. A semi-graphic representation of the system shows the links between the various sectors. This is followed by an analytical model describing the same, with the sector balances in the focus of the analysis. Finally, we investigate the effect on the US economy of moving US manufacturing jobs overseas ("offshoring") and subsequent rehiring in the domestic service industry, in various scenarios. This is done by extending the analytical model, with offshoring and rehiring represented as linear perturbations.

Keywords. Macro-economic model; Leontieff model; Macro-economic data; Budget deficit; Offshoring; Rehiring; Perturbation analysis

1. Introduction

Economic conditions affect the everyday life of modern humans at least as much as the natural or built-up environment. The economy is perhaps the most important element of personal and institutional interrelations. Modern society is built on the division of labor; individuals produce only a small fraction of their needs, obtaining the rest from the market. Modern economy is governed by the laws of the market: the relation of supply and demand, as well as the superimposed political and social distortions (and speculation). The so called socialist economy tried to eliminate the market but these attempts have not been successful.

Macro-economy deals with the analysis of economic systems at the national level. Macro-economy is an extremely complex multi-variable system, where even to decide which variables are the inputs and which ones the outputs may be difficult (actually, the classification depends on the situation investigated). The system is basically self-controlling via the market mechanisms. The system is subject to a number of disturbance effects: external disturbances are e.g. extraordinary whether conditions, natural disasters or wars, while internal disturbances are irresponsible financial manipulations, labor actions, panic reactions at the stock-market, etc.

The market economy offers very limited possibilities for deliberate intervention; the central bank may manipulate the interest rates and the money supply, the legislature may change taxes and custom duties. Such interventions may be aimed at affecting the inflation, stimulating or damping the economy, or slowing down or fending off arising crisis processes. The American approach to the economy is mainly characterized by the “laissez faire” principle (do not intervene), though some limited interventions do take place. In Europe, governments usually tend to intervene more actively. At the far end of the scale one finds the totally planned economies, characteristic of the “communist” countries of the past century.

One of the central problems of the science of macro-economy is the mathematical modeling of economic systems. The most important elements of the models are their underlying assumptions and the effects and circumstances considered and investigated. The purpose of modeling is the better understanding of the processes which, beyond satisfying one’s scientific curiosity, may help to predict future trends and events and may serve as a somewhat solid basis for decisions on intervention.

A significant class of economic models is static; these are mostly based on Leontieff’s input-output system (Leontieff, W.W., 1986). Leontieff’s model describes the flow of goods and services between the various sectors of the economy, expressing those flows with their money value, in matrix form. On the basis of the input-output model, supplementing it with non-material items, did the UN define an accounting system used for computing and comparing the gross national product (GNP) of the various countries (Carson, C.S. and Honsa, J., 1990; McCulla, S.H. and Smith, S., 2007). A great number of extensions to the Leontieff model have been developed, to investigate the effect of various economic and non-economic factors, such as prices, taxes, social and psychological customs (Ayres, R.U. and Warr, B., 2009).

Another large class of models is dynamic, in continuous or discrete time. With these, processes that take place in time are described, such as the evolution of the gross national product or national consumption (Ferguson, B.S. and Lim, G.C., 1998; Agenor, P.R., 2004). Though the processes usually happen in continuous time, the data is mostly available in discrete time, as quarter-year averages or quarter-end samples. Crucial factors in the evolution process are the ratio of accumulation, the dynamics of the population and the rate of amortization of the fixed assets (production tools) (Solow, R.M., 1956; Swan, T.W., 1956). Newer models take into account such non-economic factors as the level of technical

development and the technical and cultural education of the population (Breton, T.R., 2013). Dynamic model analysis is usually focused on seeking the equilibrium states of the economy and investigating the stability of those states.

For people with background in engineering or physical sciences, it is an attractive idea to seek parallels between the economic and the physical-technical systems. Perhaps the best known example of this idea is the Phillips model. William Phillips originally studied electrical engineering in New Zeeland. Moving to London after World War II, he turned his attention to economic systems and eventually became a well-recognized economist. Phillips created a model for the economy using the analogy of a hydro-dynamic system. Based on this model, a hydro-dynamic analog simulator was constructed (the "Phillips Machine") in 1949 (Figure 1) (Bissell, C., 2007). 11 or 12 copies of the machine were built, some of which can still be seen exhibited at various universities.

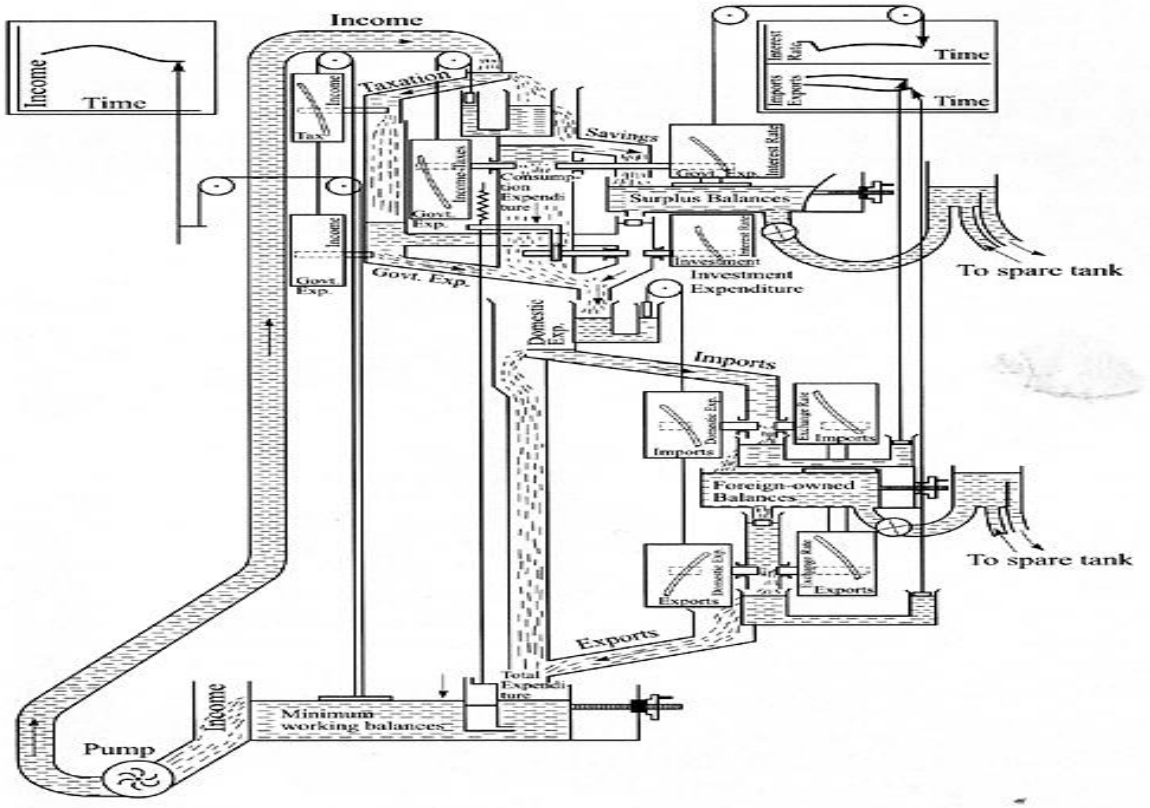

Figure 1. The Phillips Machine

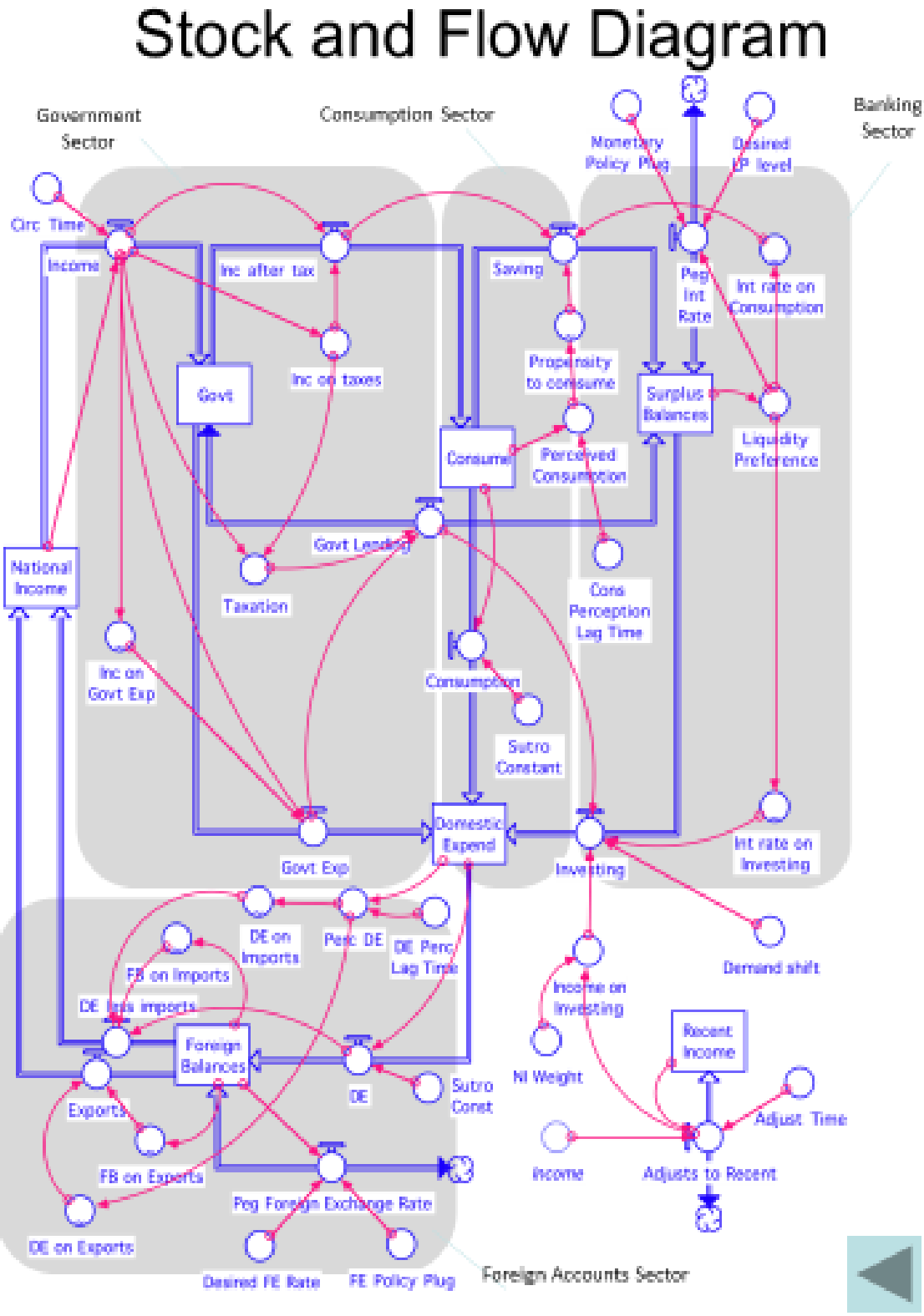

Figure 2. The stock and flow diagram of the Phillips Machine (William H. Ryder, 2014). The “blue” layer in the figure shows the flows and stocks (water in the machine, dollars in the economy) while the “red” layer presents information links.

Figure 2 presents the system diagram of the Phillips machine (William H. Ryder, 2014). The base layer is a stock and flow diagram, where the “material” is water in the machine and money in the economy. Superimposed is a signal-flow graph indicating the information links in the system.

The Phillips model described the British economy after World War II; it has limited validity under the present macro-economic circumstances. We included it here because of its historical significance and because it emphasizes the parallels between the economic and the physical material processes.

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In this paper, we first describe a simplified macro-economic model of the US economy. The model relies on real data (for the year 2005), in lumped and somewhat modified form, and shows the links between the various sectors. This is followed by an analytical model describing the same, with the sector balances in the focus of the analysis. Finally, the analytical model, with several extensions not described here, is used to analyse the effect of offshoring and subsequent rehiring on the US economy.

2. A Macro-Economic Model of the US Economy

In the following description, we rely on the present economic and government structures of the United States of America.

The economy of a country can be described with four fundamental sectors: Goods Production, Services, Government and Persons (individuals, families) (Fig. 3).

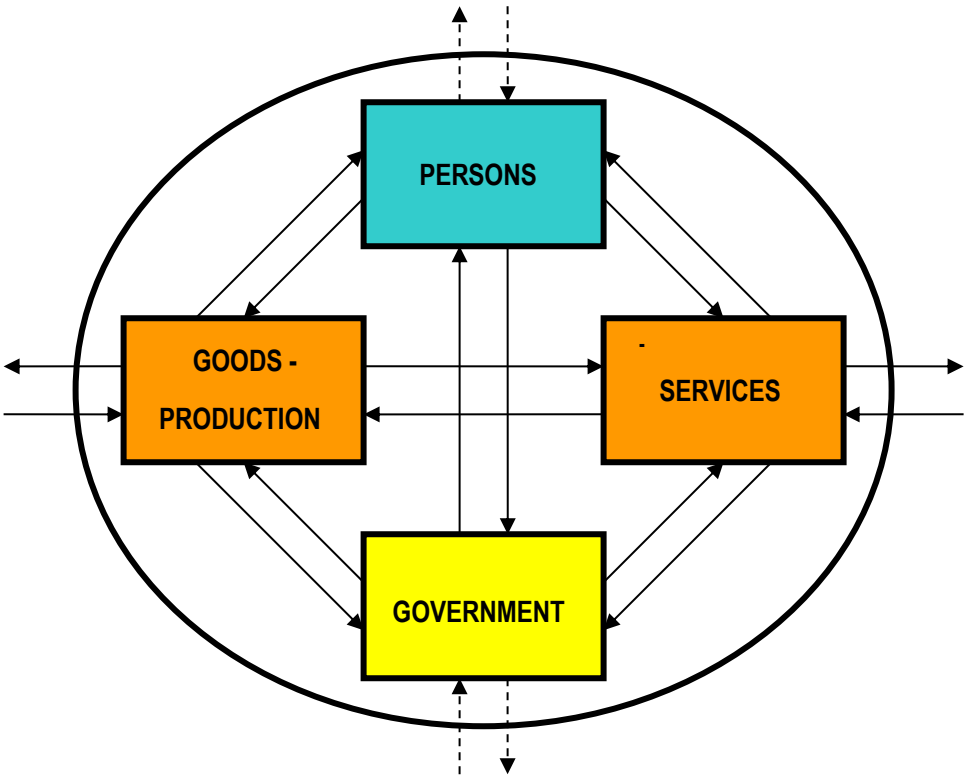

Figure 3. Four-sector macro-economic model. Outside the large ellipse is the “rest of the world”; solid lines across the border represent export-import while dashed lines indicate financial transactions.

- The Goods Production sector includes agriculture and food production, mining, construction industry and manufacturing.
- The Service sector is quite broad, it includes public utilities, transportation (of goods and persons), gross and retail trade, financial services, health services, education, information services, catering services and public entertainment. The role of the financial sub-sector is especially important in the highly developed capitalist economy; it includes the banks, insurance and pension corporations, and investment houses.

Industrial activity takes place primarily in the form of corporations but, especially in the Service Sector, the contribution of small enterprises is also significant. There are several legal and taxation differences between the two forms.

The economy of a country, especially under increasing globalization, is not isolated from the global economy; the USA imports and exports goods and services from/to various other countries and conducts significant financial transactions with the rest of the world.

The government structure in the United States has three levels: the federal government, the governments of each of the 50 states, and the local (city, county) governments. The federal government controls national defense, internal security services, foreign affairs, main transportation infrastructure and some social services. The states are responsible for the mid-level transportation infrastructure, higher education, and the remainder of social services. The elementary and high-school education is under the control of the local governments, as are the local transportation infrastructure, police, fire- and ambulance services and other community services.

The model to be introduced below is a static balance model, conceptionally the combination of the Leontieff and Phillips models. The model represents the flow and accumulation of money, for one calendar year. This approach shows a close similarity to the material and energy balance models used to describe chemical and other complex process systems.

The data used for illustration are the real economic data of the United States in the year 2005. These have been computed on the basis of tables published by the Bureau of Economic Analysis (BEA), of the US Department of Commerce (BEA NIPA Tables, 2005; BEA IEA Tables, 2005; McCulla S.H. and Mead, C.I., 2007). These tables are publicly available on the internet but understanding them requires some specific knowledge. Note that the BEA tables are rather detailed while they lack some data in the structure ideal for this analysis. Therefore we have used numbers obtained by combining several entries in the BEA tables, while at other occasions introduced estimates or minor corrections (Gertler, J., 2009).

2.1. Goods Production Sector

The goods production sector, of course, produces goods, such as food, raw materials, machines, and various equipment, as well as buildings, roads, etc. To do so, it utilizes the labor of its employees, for which it pays wages. In addition to the direct wages, the company contributes to the health-insurance and retirement costs of its employees (“fringe benefits”). The sector purchases services from the Service Sector, and utilizes imported goods. The goods produced by the Goods Producing Sector are primarily utilized by the Personal Sector (persons) but goods are purchased also by the Service Sector and the Government. The majority of the produced goods is directly consumed while a smaller part gets accumulated as new “fixed assets”. Also a part of the goods produced is exported. There is a significant

movement of goods within the sector, between the various companies and small enterprises, the boundaries however are hard to establish. In our lumped model, the intra-sector transactions are ignored (with the exception of new fixed assests produced and used by the same sector).

In addition to wages and the cost of services and imports purchased, the sector's operation is also subject to various expenses of financial nature. Some of these are taxes and duties in connection with the production and selling of goods. Other expenses include interests paid after loans taken and bonds issued by the sector. As for the handling of the net income, there is a difference depending on the legal form of the enterprise:

- In the case of corporations, the amount remaining from the income after paying the expenses is the profit. For the profit, the corporation is to pay taxes to the government and dividends to the shareholders. The remainder is used for investment (buying new "fixed assets", such as buildings, machines, software) and for financial reserve ("liquid assets").
- In the case of small enterprises, the amount remaining from the income after paying the expenses is the profit of the proprietor; a part of this may be invested into new fixed assets while the rest is the proprietor's personal income.

TABLE 1. GOODS PRODUCTION SECTOR (billion dollars)

Income		Expenditures		
Personal consumption	1652	Wages		1416
Consumption of Service Sector	1330	Purchase from Service Sector		1402
Consumption of Government	458	Import		1472
Fixed assets for persons	416	Proprietors' profit		286
Fixed assets for own sector	40	of this fixed assets	16	
Fixed assets for Service Sector	93	Taxes and duties		21
Fixed assets for Government	128	Interest expense		72
Export	908			------
	------			4669
	5025	Profit		356
		of this tax	132	
		dividend	97	
		fixed assest	49	
		liquid assets	78	

The incomes and expenditures of the Goods Production Sector for the year 2005 are shown in Table 1. The amounts are billion dollars. Figure 4 shows the links of the sector with the other sectors and with the rest of the world.

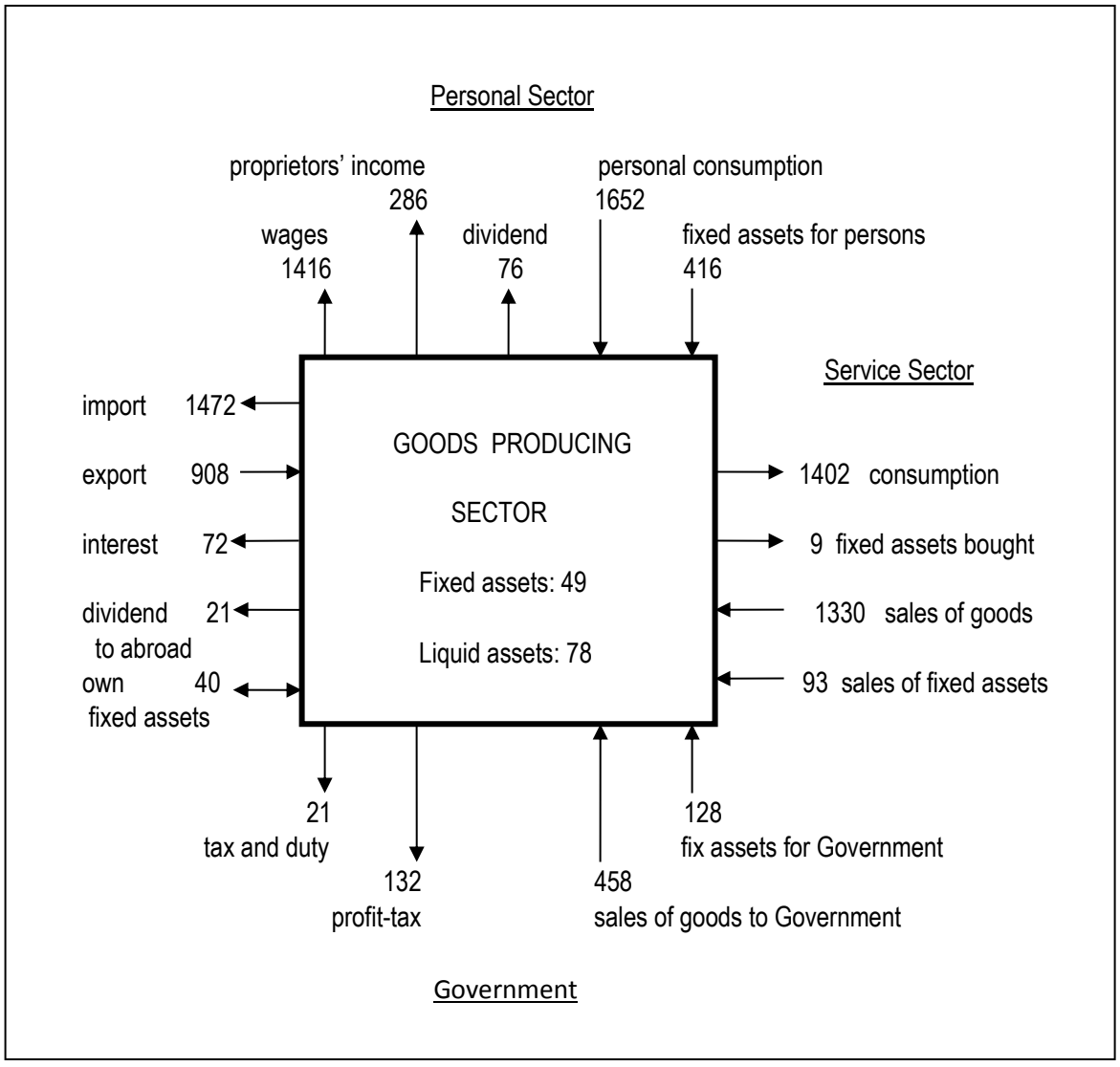

Figure 4. The links of the Goods Production Sector with the other sectors and with the rest of the world. The arrows indicate the direction of money movement. The numbers are in billion dollars. In the rectangle, "Fixed assets" is the value of the sector's new investment and "Liquid assets" is its new accumulation. The double arrow indicates the new fixed assets procured within the sector.

2.2. Service Sector

The operation of the Service Sector is not very different from that of the Goods Producing Sector, with obvious differences. The main customer of services is the Personal Sector. Services are also purchased by the Production Sector and by the Government, and some of the services are exported. The Service Sector

participates in the production of new fixed assets, for itself and for the other sectors, as the major software systems (produced by the Service Sector) are considered as fixed assets. The Service Sector purchases goods and fixed assets from the Production Sector and by direct import.

The income and expenditures of the Service Sector are shown in Table 2. The links of this sector to the other sectors and to the rest of the world are shown in Figure 5.

TABLE 2. SERVICE SECTOR (billion dollars)

Income		Expenditures		
Personal consumption	6147	Wages		4405
Consumption of Production Sector	1402	Purchase from Production Sector		1330
Consumption of Government	301	Import		590
Fixed assets for persons	102	Proprietors' profit		758
Fixed assets for own sector	23	of this fixed assets	85	
Fixed assets for Production Sector	9	Taxes and duties		362
Fixed assets for Government	17	Interest expense		159
Export	396			------
	------			7604
	8397	Profit		793
		of this tax	268	
		dividend	282	
		fixed assest	116	
		liquid assets	127	

2.3. *Government Sector*

As mentioned before, the government structure of the US has three levels: federal government, governments of each of the 50 states, and local (city, county) governments. The income of the sector comes primarily from taxes. The federal government levies taxes on the production, sales and import activities of the enterprises. Beyond this, corporate profits are subject to a 35% profit tax, though there are several ways (loop-holes) to avoid or reduce this. Persons, including proprietors of small enterprises, are subject to federal income tax. Income tax is collected by the states as well, at tax rates varying from state to state (in some states the state income tax is zero). States also collect sales (value added) taxes; the rate again is different from state to state (in Virginia, for example, the sales tax is 6%). Citizens pay real estate tax to the local governments, the rate of this is about 1% of the assessed value of the property. Beyond these, the federal government collects social security taxes (for future federal retirement and health-insurance benefits); this is 15.2% of the individual's income (for those employed, half of this is carried by the employer).

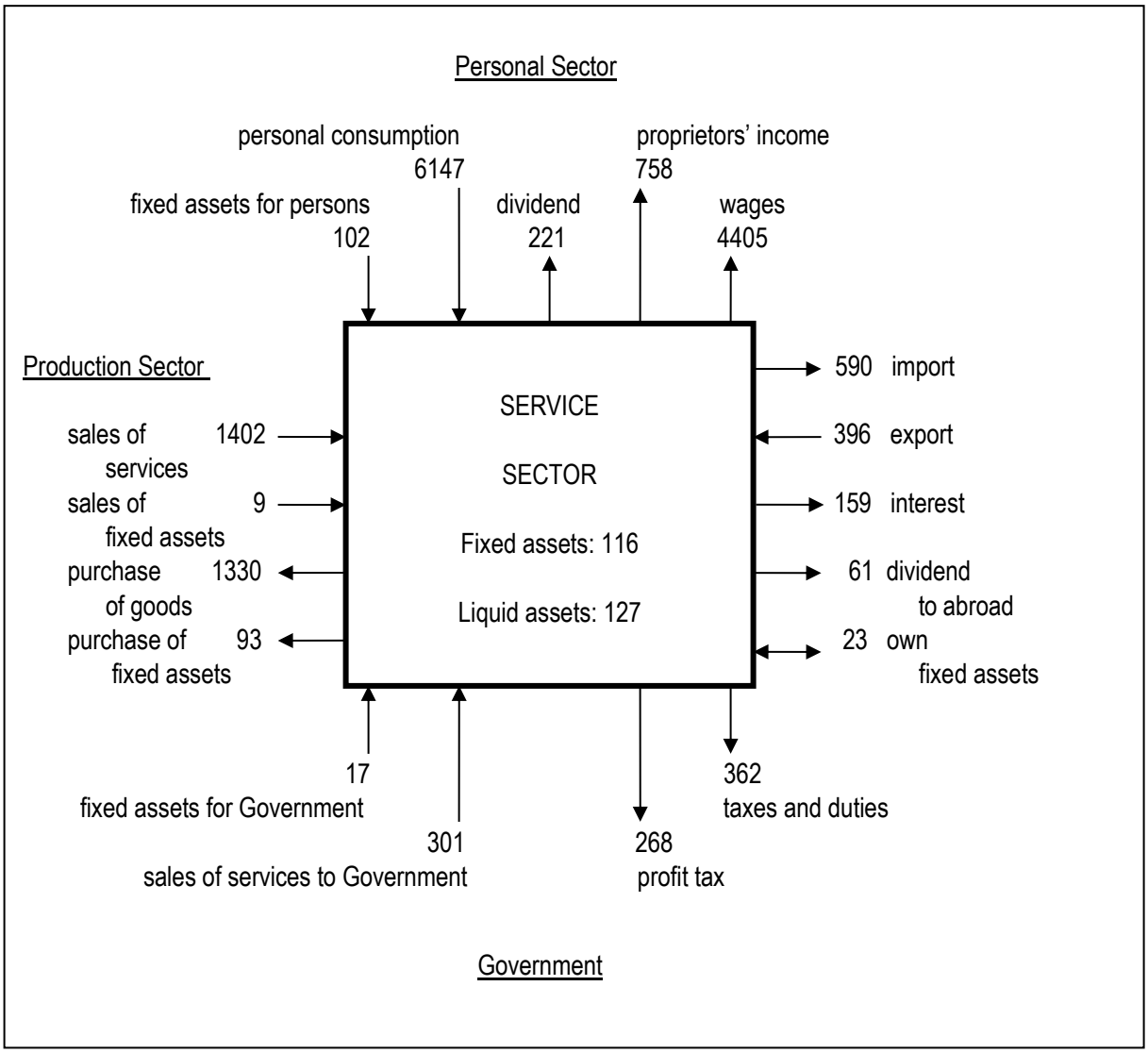

Figure 5. The links of the Service Sector with the other sectors and with the rest of the world. The arrows indicate the direction of money movement. The numbers are in billion dollars. In the rectangle, "Fixed assets" is the value of the sector's new investment and "Liquid assets" is its new accumulation. The double arrow indicates the new fixed assets procured within the sector.

The most important part of the expenses of the federal government are the social expenses. These include old-age pension ("social security"), and health insurance for the aged and the poor (Medicare and Medicaide). Also significant is the wages and fringe benefits paid to the many people employed by the government bureaucracy and services. The expenses of national defense also contain a significant amount of wages, plus an also significant amount spent on equipment procurement. Another important item is the maintenance and development of the federal level infrastructure. Finally, a major item is the interest the government has to pay to holders of federal bonds, issued to cover the rather significant deficit accumulated over the recent years.

State governments also spend on welfare, as well as higher education and the maintenance of state-level infrastructure. Local governments spend much of their budget on the operation of the local school-system. Other expenses include the local infrastructure, police, and other services to the populace.

Table 3 shows the incomes and expenditures of the Government Sector, lumped for the three government levels. In wages and the various procurement expenses, the cost of defense is not shown separately, but the total defense expenditure is indicated. Remarkable is the significant deficit of the budget; without the purchase of fixed assets this is 3830 – 3502 = 328 billion dollars while including fixed assets it is 3975 – 3502 = 473 billion dollars. This latter is 12% of the expense side of the budget (3.6% of the GDP).

The links of the Government Sector to the other sectors are illustrated in Figure 6.

TABLE 3. GOVERNMENT SECTOR (billion dollars)

Income		Expenditures	
Production taxes and duty	383	Wages	1216
Profit tax	400	Social expenses	1481
Personal income tax	1203	Purchases from production sector	458
Social tax	881	Purchases from service sector	301
Real estate tax	137	Interest	348
Sales tax	402	Transfers to abroad	26
Interest	96		---
	---		3830
	3502	Procurement of fixed assets	145

			3975
		Of this defense 517	

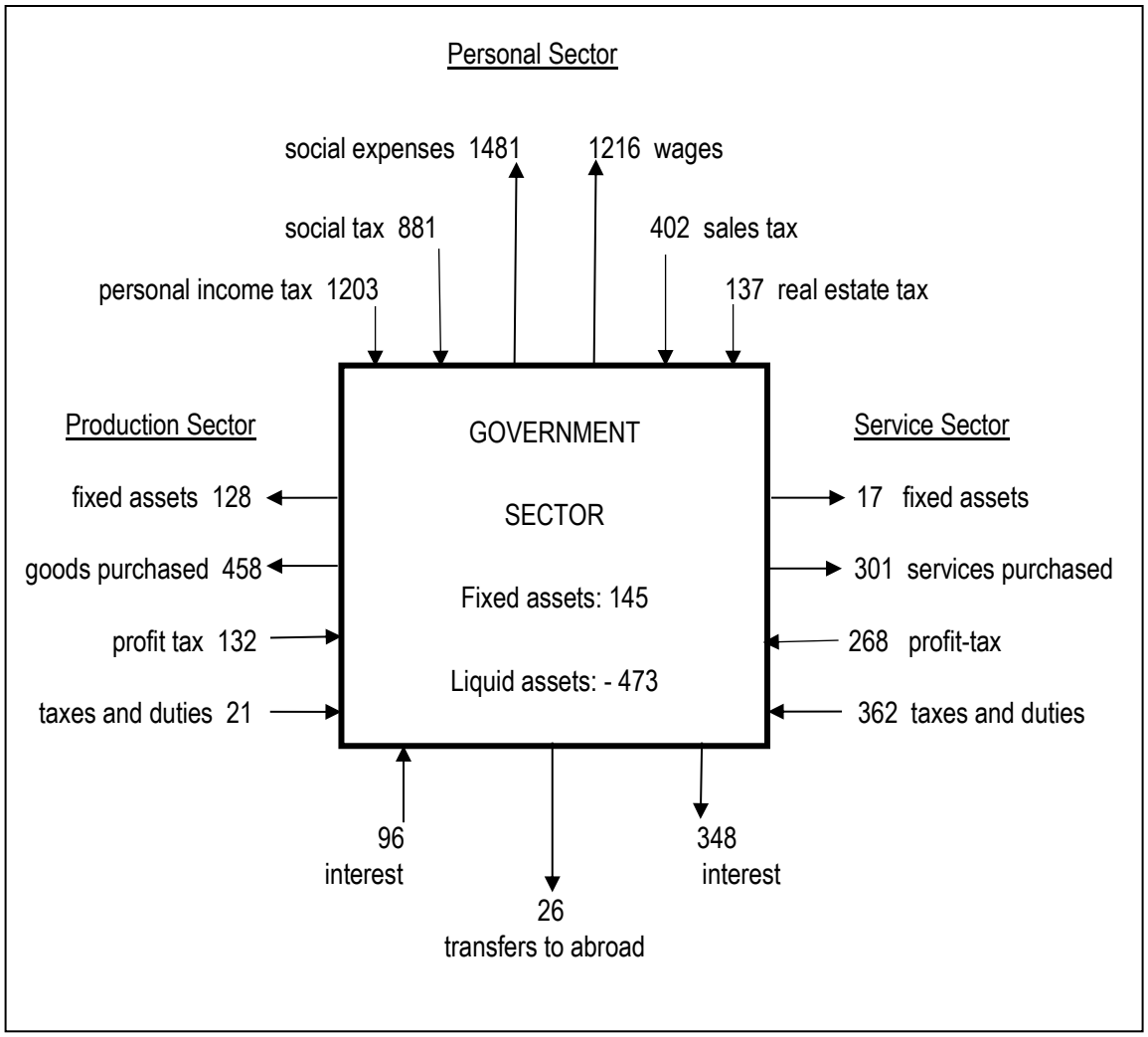

Figure 6. The links of the Government Sector with the other sectors and with the rest of the world. The arrows indicate the direction of money movement. The numbers are in billion dollars. In the rectangle, "Fixed assets" is the value of the sector's new investment and "Liquid assets" (with negative sign) is the budget deficit.

2.4. Personal sector

The Personal Sector includes the persons (families) residing in the United States. The main sources of personal income are the wages of employees, the income of proprietors of small enterprises and the pension and other social support provided by the government. This is supplemented by interest and dividend income generated by bank deposits and investments (including investment in private pension funds). The main component of expenses is the personal consumption of goods and services. The populace is subject to various taxes, such as personal income tax, social tax, real-estate tax and sales tax. Additional expenses are interests arising from the purchase of homes (mortgage) and of various goods, some in the form of credit-card debt. Significant is the money transfer to abroad, especially on the part of foreigners living in the US.

As mentioned before, half of the social tax of employees is paid by their employer, directly to the federal government. In our tables, this amount is shown as part of the wages (income for persons/expenditure for companies), while the full amount of social taxes is shown among the expenses of persons. Beyond this, employers contribute to the private pension deposits and health insurance premiums of their employees ("fringe benefits"); these are shown as a part of wages (income/expenditure).

The money movements related to private retirement funds are not shown in the federal statistical tables so they are hidden in our lumped data as well. The employers' contribution becomes part of the employees' personal wealth as soon as it is payed into the pension fund. The employees may make additional contributions from their income. Proprietors of small enterprises pay the entire contribution (premium) themselves. Personal distributions from one's private pension account do not appear in the inter-sector balances since the entire account is already considered the property of the person. Monies paid into retirement accounts are exempt from personal income tax; the tax has to be paid when the money is taken out of the account. The retirement accounts usually exist in some income generating form (long-term deposit, stock-mix accounts, bond accounts, real-estate accounts).

The various credits and loans play an important role in the life of American families and persons. The family home (that is usually a single-family house or a townhouse, in big cities a condominium) is bought almost exclusively with a bank loan; in general, mortgage credit can be obtained with a 10% down payment, for 30 or 15 years. The monthly payment of the home mortgage is a fundamental part of the family budget. Many people take out additional loans for the improvement or extension of their home. It is quite usual to buy cars on credit, also major appliances, and many people accumulate a significant credit card debt. All these generate additional interest obligations.

The incomes and expenditures of the Personal Sector are summarized in Table 4. Remarkable is the huge (417 billion dollar) new, non-productive fixed asset procurement; most of this is new housing. (In 2005, the great real estate boom was already under way – that lead then, in 2008, to a serious global financial crisis.) The Personal Sector (the populace) has a sizable, 11608-417–11124 = 67 billion dollar deficit, even without the money spent on new fixed assets. Taking the 417 billion into account, the deficit (new debt) comes to 11608-11124 = 484 billion dollars; this is about the same as the government deficit. (It is remarkable that while the government deficit was widely known and discussed, the personal deficit was largely ignored.)

The links of the Personal Sector to the other sectors are shown if Figure 7.

TABLE 4. PERSONAL SECTOR (billion dollars)

Income		Expenditures		
Wages and fringe benefits	7037	Personal income tax	1203	
Proprietors' income	1044	Social tax	881	
Social income	1481	Sal;es tax	402	
Dividend	617	Real estate tax	137	
Interest income	945		------→	
	--------	Tax total		2623
	11124			
		Mortgage interest	409	
		Interest on other loans	212	
			------→	
		Interest total		621
		Consumption of goods	1652	
		Consumption of services	6147	
			------→	
		Consumptions total		7799
		Transfers to abroad		47

				11090
		New fixed assets, enterprises	101	
		New fixed assets, persons	417	
			-----→	
		New fixed assets, total		518

				11608

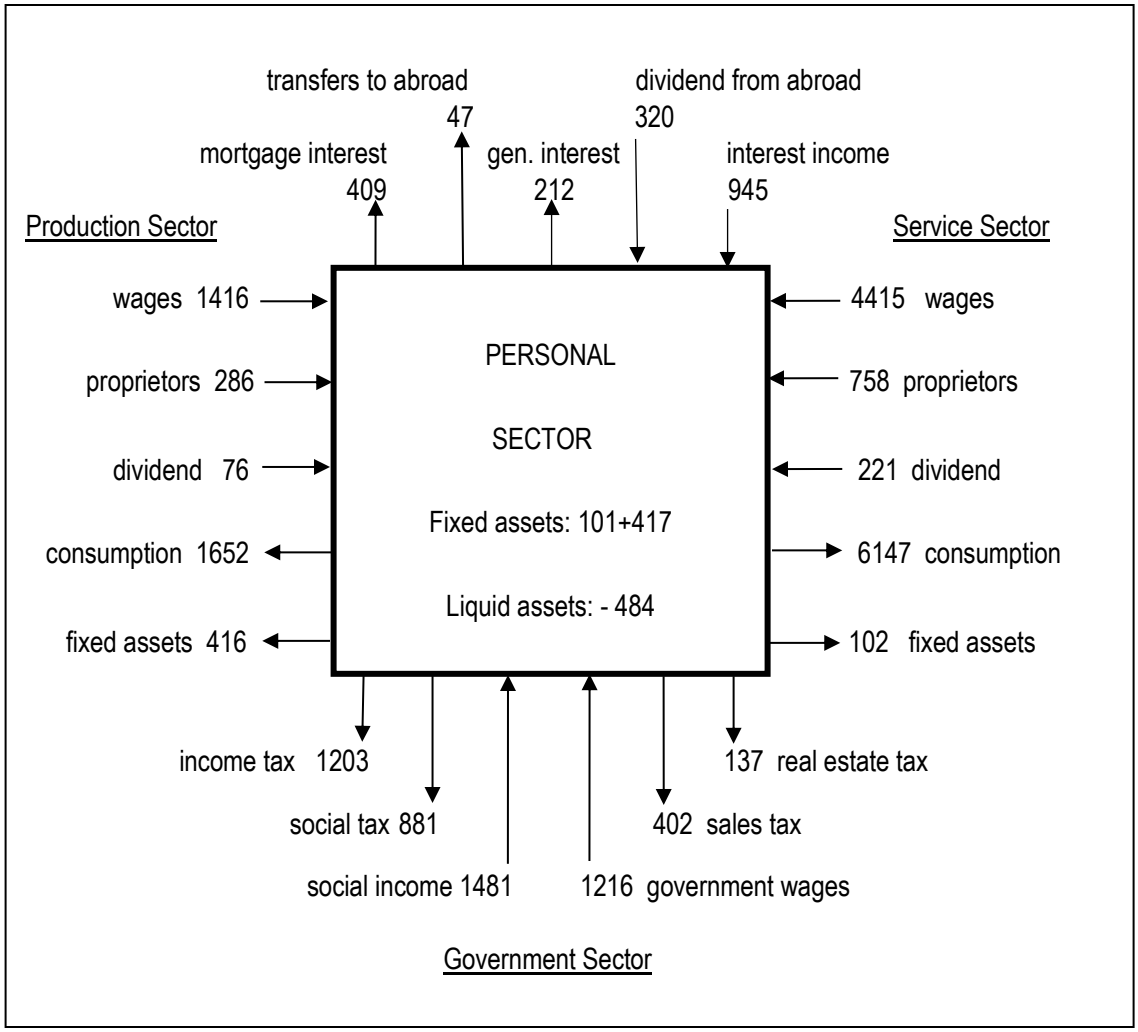

Figure 7. The links of the Personal Sector with the other sectors and with the rest of the world. The arrows indicate the direction of money movement. The numbers are in billion dollars. In the rectangle, the first number of "Fixed assets" is the new investments of small enterprises and the second number is the non-productive investment of the populace. "Liquid assets" (with negative sign) is the budget deficit (new debt) of the sector.

2.5. Foreign Transactions

In addition to foreing trade (exports and imports), foreign transactions include financial activities such as interest and dividend received from and paid to abroad, as well as international money transfers. The values of these for the year 2005 are summarized in Table 5. As it can be seen, the foreign balance of the US economy in that year was

1796 – 2548 = - 752 billion dollars.

The links of the national sectors to the rest of the world are shown in Figure 8.

TABLE 5. FOREIGN TRANSACTIONS (billion dollar)			
Income		Expenditures	
Export	1304	Import	2062
Dividend received	320	Dividend paid	82
Interest received	172	Interest paid	331
	-------	Trasfers	73
	1796		-------
			2548

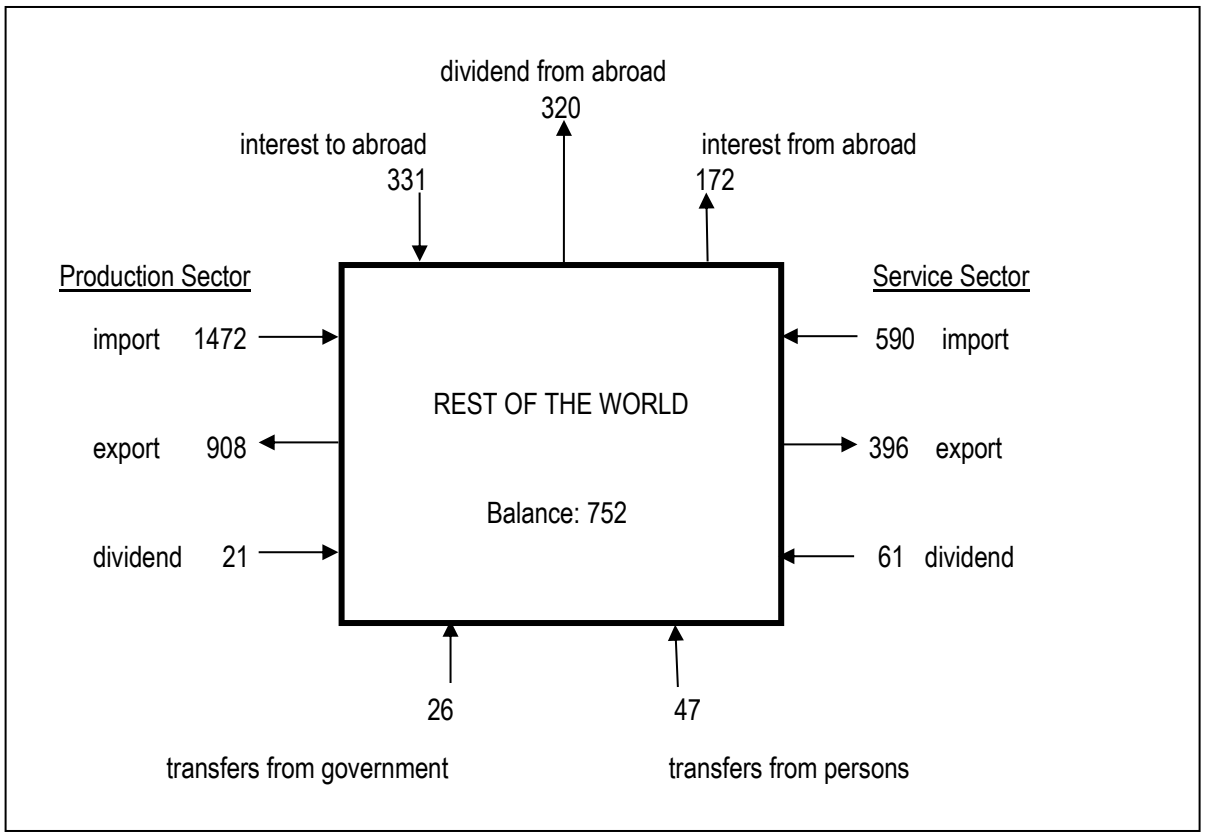

Figure 8. Links of the US economy to the Rest of the World. The arrows show the direction of money movement. Amounts are in billion dollars. The positive number in the rectangle is the balance of the Rest of the World with respect to the US economy (the deficit of the latter).

Note that the foreign balance is the composite balance of the total economy (with respect to the Rest of the World) so it is to agree with the sum of the sector balances. In the case of the Production and Service Sectors, this balance is the change of liquid assests, while for the Government and Personal Sectors, it is the difference between income and expenditures. Table 6 demonstrates the validity of this statement.

TABLE 6. BALANCES OF THE INTERNAL SECTORS (billion dollars)

Goods Production Sector	+ 78
Service Sector	+ 127
Government Sector	- 473
Personal Sector	- 484

	- 752

As can be seen, the US economy in 2005 had a total deficit of 752 billion dollars; this is the deficit of foreign transactions relative to the Rest of the World, and also the total of the internal sector deficits. By one interpretation, the international financial transactions could not compensate for the gross foreign trade deficit (the imports far exceeded the exports), partly due to the high foreign interest burden. By another interpretation, the modest liquid assets generated by the Production and Service Sectors were no match for the huge deficits created by the government and the individuals. Thus while the Production and Service Sectors could pay for their share of the foreign trade deficit, they did this using money they collected from the govenment and from persons, and this money was lacking sufficient backing.

The foreign transaction deficit (that is, the deficit of the entire internal economy) was covered by foreign investors. To pay for their budget shortfall, the various levels of the government issued bonds, and a part of these were bought by foreigners (including foreign governments, mainly China). The Personal Sector (people) covered their shortfall from bank loans (including mortgage loans), and these loans were also partly backed by foreigners (banks, institutions and individuals) who bought for investment the bonds and investment packages issued by US banks. Among these investments, there were packages containing mixes of the mortgage loans issued to US individuals and bussineses. When the real estate bubble burst in 2008, a great number of loanees proved insolvent and the value of the real estate securing the loans dropped below the loan value. Thus the investment packages „poisoned" with such loans became worthless; this triggered then the financial crisis of 2008.

3. Analytical Model

Tables 1 through 5 show the fundamental data of the US economy for the year 2005. As mentioned earlier, these data were derived from the tables published by the Bureau of Economic Analysis (BEA) of the US Department of Commerce (BEA NIPA Tables, 2005; BEA IEA Tables, 2005). BEA publishes huge amounts of data. Our tables resulted from significant simplifications; related items have been lumped, minor items ignored, while maintaining the consistency of the entire data system. In particular, the following simplifications or modifications have been made:

1. We represented the national economy by four (lumped) sectors, Goods Production, Services, Government and Persons, supplemented by the "sector" of International Transactions.
2. Our tables do not show the intra-sector processes. The only exception is the procurement of new fixed assets for which we the intra-sector activities as well.
3. The fixed assets used and replaced in the production and service activities are not shown as separate items.
4. The BEA tables contain no information on the distribution of import among the sectors; here we used estimates.
5. The BEA tables show lumped data on the production and procurement of new fixed assets for each sector but there is no information on the share of each user from the output of each producer; we used estimates here as well.
6. We ignored the change of stocks during the year.
7. The BEA tables consider owners living in their own home as if they were tenants (paying rent to themselves) (Meyerhouse and Reinsdorp, 2005); we eliminated this item from our tables.

3.1. Parametrization of the Model

The model to be introduced below describes the money flows between the sectors, and their relationships. The primary objective of this modeling activity has been to lay the foundation for the analysis of the effects of offshoring. The approach used is perturbation analysis, assuming that the ratios of the various cost components (in the Production and Service Sectors) do not change in the course of offshoring. The model shown here reflects the reference situation, before offshoring takes place. For the actual perturbation analysis, the model is extended, see (Gertler, 2009).

For the industrial sectors, the main variables are their total annual income, denoted as M for the Production Sector and S for the Service Sector. To parametrize the model, we introduced cost factors at two levels: the "k" factors describe the ratios of main cost items relative to the total production while the "m" factors describe the ratios of sub-items relative to some main item. The first subscript of each factor refers to the sector (M or S). For the Production and Service Sectors, the main cost factors are shown in Table 7 while Table 8 shows their secondary cost factors. The (main) cost factors of the Government Sector are given in Table 9.

TABLE 7. INDUSTRY MAIN COST FACTORS		
	Production	**Service**
Total income (billion $)	**M = 5025**	**S = 8397**
Taxes and duties	$k_{MT} = 0.0042$	$k_{ST} = 0.0431$
Corporate profit	$k_{MP} = 0.0708$	$k_{SP} = 0.0944$
Proprietors' income	$k_{MB} = 0.0569$	$k_{SB} = 0.0903$
Wages	$k_{MD} = 0.2818$	$k_{SD} = 0.5246$
Interest	$k_{ML} = 0.0143$	$k_{SL} = 0.0189$
Purchases from other sector	$k_{MS} = 0.2790$	$k_{SM} = 0.1584$
Import	$k_{MI} = 0.2929$	$k_{SI} = 0.0703$
Foreign wages	$k_{MF} = 0$	$k_{SF} = 0$

TABLE 8. INDUSTRY SECONDARY COST FACTORS		
	Production	**Service**
Elements of corporate profit		
profit tax	$m_{MT} = 0.3708$	$m_{ST} = 0.3380$
dividend	$m_{MD} = 0.2725$	$m_{SD} = 0.3556$
new fixed assets	$m_{MA} = 0.1376$	$m_{SA} = 0.1463$
liquid assests	$m_{ML} = 0.2191$	$m_{SL} = 0.1602$
Small ent. new fixed assets	$m_{MB} = 0.0559$	$m_{SB} = 0.1121$
Employer's Soc. Sec. contribution	$m_{MS} = 0.0664$	$m_{SS} = 0.0640$

TABLE 9. GOVERNMENT COST FACTORS	
Total expenses (net, billion $)	**G = 3975**
Wages	$k_{GD} = 0.3059$
Soc. Sec. contribution	$m_{GS} = 0.0484$
Purchase of goods (net)	$k_{GM} = 0.1152$
Purchase of services (net)	$k_{GS} = 0.0757$
Interest	$k_{GL} = 0.0875$
Transfers to abroad	$k_{GH} = 0.0065$
Social expenses	$k_{GW} = 0.3726$
New fixed assets	$k_{GA} = 0.0365$

Additional quantities of the model are:

Export of industrial sectors

Production Sector	$EX_M = 908$
Service Sector	$EX_S = 396$

Income of Personal Sector

Interest income	$INT_{PI} = 945$
Dividend from abroad	$DIV_F = 320$

Expenses of Personal Sector

Mortgage interest	$INT_{PM} = 409$
General interest	$INT_{PG} = 212$
Real estate tax	$TAX_{PROP} = 137$
Transfers to abroad	$TR_F = 47$
New fixed assets	$FIX_P = 417$

3.2. Tax Structure

The American tax system is extremely complicated. Here we are going to describe the six most important taxes, with simplified rules.

1. *Personal Income Tax.* This applies to most personal income, independent of the source. The most notable exception is the social income which, in general, is just partially taxed. Also the part of the income spent on other taxes and on mortgage interest is exempt of income tax. The tax rates are progressive; its average value is $\tau_P = 0.1465$.
2. *Social Security Tax.* This applies to all income arising from work. For those employed, half of this is paid by the employer (and this "income" is exempt from income tax). The average rate is $\tau_S = 0.1158$.
3. *Sales Tax.* This is levied by the individual states and some localities (cities), on the purchase of goods and some services. Its rate, and the range of services it applies to, is determined locally. Its average rate is $\tau_V = 0.0515$.
4. *General Production Tax.* This is paid by enterprises after various production activities; it included import duties. For its average rate, see Table 7.
5. *Corporate Profit Tax.* Its nominal rate is 35% but the actual rate may be smaller because of the various exemptions. See table 7.
6. *Personal Property Tax.* This is charged primarily on real estate property but some municipalities levy a tax on automobiles as well. The real estate tax is usually about 1% of the assessed value per year.

3.3. Economic Indicators

The model is focused on the annual balances of the various sectors. For the internal sectors, we define two balances:

Gross Balance = Income – Operating Expenditures

Net Balance = Income – (Operating Expenses + Investment)

Here “investment” means procurement of new fixed assets. For the foreign sector, the two balances are defined as:

Gross Balance = Export – Import

Net Balance = (Export + Financial Income) – (Import + Financial Expenses).

The net balances are subject to the following fundamental relationship:

Production Balance + Service Balance + Government Balance + Personal Balance = Foreign Balance

3.3.1. Personal Balance

Personal income from wages and small enterprises

$$PIA = (k_{MD} + k_{MB})\, M + (k_{SD} + k_{SB})\, S + k_{GD}\, G \qquad (1)$$

(This contains the social security contribution by the employers.) Added to this is the income from dividends and interest

$$PIB = m_{MD}\, k_{MP}\, M + m_{SD}\, k_{SP}\, S + (DIV_{F\text{-}IN} - DIV_{F\text{-}OUT}) + INT_{PI} \qquad (2)$$

plus the social security income (that is partially exempt from personal income tax)

$$PIS = k_{GW}\, G \qquad (3)$$

The social security contribution from employers (exempt from personal income tax)

$$PIC = m_{MS}\, k_{MD}\, M + m_{SS}\, k_{SD}\, S + m_{GS}\, k_{MD}\, G \qquad (4)$$

The additional tax-exempt components of personal income are

$$PID = TAX_{prop} + INT_{PM} \qquad (5)$$

Thus the personal income tax is

$$PT_P = \tau_P\, (PIA + PIB + 0.4PIS - PIC - PID) \qquad (6)$$

While the social security tax is

$$PT_S = \tau_S\, (PIA - PIC) \qquad (7)$$

The combined tax, interest and transfer liability of the Personal Sector is

$$PTI = PT_P + PT_S + TAX_{PROP} + INT_{PM} + INT_{PG} + TR_P \qquad (8)$$

Thus the personal income available for consumption is

$$PI = PIA + PIB + PIS - PTI \qquad (9)$$

Thus the gross balance of the Personal Sector is

$$PBG = PI - (1 + \tau_V)\, (PC_M + PC_S) \qquad (10)$$

where PC_M and PCS are the value of personal consumption purchases from the Production and the Service Sector, respectively; these will be computed below. The net balance of the sector is

$$PBN = PBG - m_{MB}\, k_{MB}\, M - m_{SB}\, k_{SB}\, S - FIX_P \qquad (11)$$

Here the second and third terms are the investment expenses of small enterprises while the last term is the value of personal investments (mainly home purchase).

Personal consumption is computed from data of the Production and Service Sectors, using the following relationship:

Total Production = Personal Consumption + Consumption of the Other Industrial Sector +

Consumption of Government + New Fixed Assets Produced + Export (12)

The total value of new fixed assets, produced by the two industrial sectors, as approached from the side of consumption, is

$$FIX = m_{MA}\, k_{MP}\, M + m_{SA}\, k_{SP}\, S + k_{GF}\, G + m_{MB}\, k_{MB}\, M + m_{SB}\, k_{SB}\, S + FIX_P \qquad (13)$$

Here the first two terms are the values of corporate investments in new fixed assets, the third is the value of government investments, the next two are the investments of small enterprises while the last term is the non-productive investment of persons. The production of new fixed assets, based on approximate data, is split as 80/20 between the Production Sector and Service Sector. (Note that major software systems produced by the Service Sector are considered fixed assets.) Thus Eq. (12) for the two sectors becomes

$$M = PC_M + k_{SM}\, S + k_{GM}\, G + 0.80\ FIX + EX_M \qquad (14)$$

$$S = PC_S + k_{MS}\, M + k_{GS}\, G + 0.20\ FIX + EX_S \qquad (15)$$

In these equations, three items are defined from the consumption side; if the value of export is known, personal consumption can be computed.

3.3.2. Corporate Balance

The gross corporate balance is the sum of new liquid assets (money saved) and fixed assets (investment) generated during the year, together for the two industrial sectors. This is

$$CBG = (m_{MA} + m_{ML})\, k_{MP}\, M + (m_{SA} + m_{SL})\, k_{SP}\, S \qquad (16)$$

The net corporate balance contains only the new liquid assets

$$CBN = m_{ML}\, k_{MP}\, M + m_{SL}\, k_{SP}\, S \qquad (17)$$

3.3.3. Government Balance

The total tax income of the government is

$$TAX = PT_P + PT_S + TAX_{PROP} + \tau_V\,(PC_M + PC_S) + k_{MT}\, M + k_{ST}\, S + m_{MT}\, k_{MP}\, M + m_{ST}\, k_{SM}\, S \qquad (18)$$

Here PT_P and PT_S are the personal income tax and social security tax, respectively; TAX_{PROP} is the personal property (real estate) tax, $\tau_V\,(PC_M + PC_S)$ is the sales tax, $k_{MT}\, M + k_{ST}\, S$ is the production tax and $m_{MT}\, k_{MP}\, M + m_{ST}\, k_{SM}\, S$ is the profit tax, the latter two in the industrial sectors. The gross balance of the Government Sector is

$$GBG = TAX + INT_G - (1 - k_{GF})\, G \qquad (19)$$

where INT_G is the government's interest income while $(1 – k_{GF})\ G$ is the government's total expenditures, without the investments in new fixed assets. The net balance of the sector, though, takes into account the cost of the new fixed assets as well:

$$GBN = GBG – k_{GF}\ G \qquad (20)$$

3.3.4. Foreign Balance

The gross foreign balance is the difference between exports and imports, together for the two industrial sectors (assuming that the import needs of government and persons are met indirectly, via the industrial sectors):

$$FBG = EX_M + EX_S – (k_{MI}\ M + k_{SI}\ S\ ) \qquad (21)$$

The net foreign balance contains, in addition, the international financial transactions:

$$FBN = FBG + (DIV_{F\text{-}IN} - DIV_{F\text{-}OUT}) + (INT_{F\text{-}IN} - INT_{F\text{-}IN}) - TR_F \qquad (22)$$

where $(DIV_{F\text{-}IN} - DIV_{F\text{-}OUT})$ is the balance of foreign dividends, $(INT_{F\text{-}IN} - INT_{F\text{-}IN})$ is the balance of foreign interests and TR_F is the value of transfers to abroad. Finally, the equation describing the "grand balance" of balances is

$$PBN + CBN + GBN = FBN \qquad (23)$$

4. The Effect of Offshoring and Rehiring

The most important effect of globalization on the American economy is the offshoring (moving to abroad) of a significant part of production. American companies establish foreign subsidiaries where they employ foreign (local) workers. Simultaneously, they reduce their domestic (US) production activities and lay off their US workers. The main drivers of this process are the cheaper foreign labor and more advantageous foreign taxation. (An added driver is the loopholes of the US tax system that allow tax reduction using tricks with the handling of profits of foreign origin.) Cheaper labor obviously increases the profit while lighter taxes increase the part of profit that can be accumulated or paid as dividend. Initially, offshoring was characteristic of the goods production sector but later it extended to the service sector as well (call centers, software development).The main target country in goods production has been China while in services it has been India. Wages and taxes paid abroad, as well as investments made abroad, of course damage the US foreign balance.

As a result of offshoring, unemployment grows in the US which, in turn, depresses the average wages of those who still work. Both effects result is a reduction of incomes in the personal sector. This is somewhat compensated for by a slight increase of dividend incomes, arising from higher profits. (The dividends in general affect a different part of the populace, not the one that lost their jobs, though there is some overlap, resulting in an increased income gap.)

The freshly jobless receive unemployment compensation from the government while the long-time unemployed get some social support. Besides, the government loses the income tax of those who have lost their income. This is partially compensated by higher income tax from higher dividend income, plus the increased profit tax. The latter, even with the best intentions, is reduced by the corporate tax paid abroad, while more is lost due to the corporations abusing the loopholes in the tax law. Thus, at the end of the day, the greatest loser from offshoring is the government sector. Though this is scarcely realized (or admitted), one of

the main reasons behind the significant government deficit of the recent decades has been the offshoring of US production and services to abroad.

As a result of offshoring, the purchasing power of the populace diminishes, even though a part of their lost income is replaced by the government. The balance between supply and demand can only be restored if the prices charged to consumers are slashed, that is, if the corporations split their extra profit with the consumers. The balance usually is just partially restored so the personal sector goes deeper into debt. Ideally, the market adjusts the prices so that the budget deficit of the personal sector stays constant (equilibrium pricing). Then the populace from its reduced income pays less for the same quantity of goods and services. The production and service sectors still gain from offshoring while the entire loss is paid by the government.

The supporters of offshoring would argue that the laid-off workers will find new employment, primarily in the service sector. This is true to some extent. The government, no doubt, is benefiting since it regains some income taxes and sheds some of the social expenses. The incomes of the personal sector grow, both the wages of the re-employed and the income of the proprietors of small enterprises. At the same time, the re-employed lose their government support. The service sector, though, serves primarily the domestic consumption, so it is the populace that pays for those services. And the price of new services exceeds the new personal income since the former contains, in addition to the latter, the cost of additional imported goods and an increase of corporate profit. Thus the personal sector, in a paradoxical way, loses financially with rehiring (it gains in terms of increased consumption). Also loses the foreign balance for there are more imported goods. The situation is, of course, different, if a part of the additional services is exported.

4.1. The Modeling of Offshoring

The macro-economic model presented in Chapter 3. serves as the basis for the analysis of the effects of offshoring and rehiring (Gertler, 2009). The model is static and fundamentally linear. The basic approach is to first model the reference situation (before offshoring) and then represent offshoring as a linear perturbation.

The sole input to the perturbation model is the value of offshoring, expressed in US wage dollars; for example, what happens if 1000 dollars' worth of US labor is moved overseas. A simplifying assumption is that offshoring concerns only the goods production sector. There are separate variants of the perturbation model for the various scenarios (basic offshoring, offshoring with profit sharing, rehiring in the service sector, etc.). The main outputs are the annual balances of each sector, corporate profit in the production and service sectors, and the consumption of the personal sector. Beyond these, all inter-sector dollar flows can also be observed in the course of the analysis.

The analysis uses a few assumed parameters, each one specific to a particular scenario. These are:

β: the ratio of the average foreign versus American wages (assuming identical skills and productivity)

κ: the ratio of the average social aid to wages

τ: the ratio of the average foreign versus US profit tax

λ: the ratio of rehiring

γ: the ratio of profit sharing.

4.2. Offshoring and Rehiring Scenarios

Figure 9 shows what happens if 1000 dollars' worth of US labor is sent to abroad (without profit sharing and rehiring). For this basic scenario, the perturbation model consists of 7 equations. As seen, the corporations gain $ 750 extra profit, of which $164 goes into their liquid assets (this is the balance of the industrial sectors). The personal sector loses $ 184 while the loss of the government sector is $ 473. The "rest of the world" gains $ 493, which agrees with the sum of losses minus gains of the domestic sectors (-184-473+164 = -493).

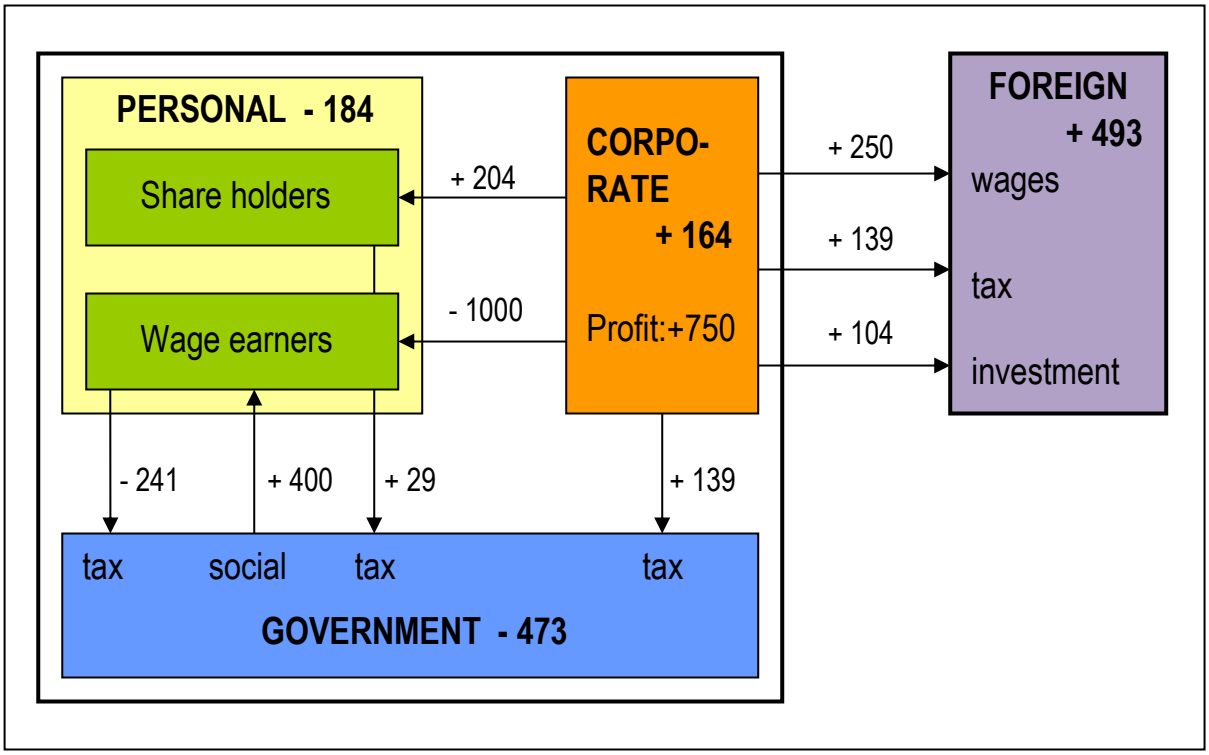

Figure 9. Offshoring 1000 dollars' worth of US labor from production industry (β=0.25; κ=0.4; τ=0.5)

Figure 10 shows the situation when 1000 dollars' worth of US labor is offshored but the corporations yield a part of their extra profit to the consumers, in the form of price reduction. By our assumption, the market adjusts the prices in such a way that the net deficit of the personal sector (without taking into account the new fixed assets purchased) should be unchanged relative to the pre-offshoring reference situation. This scenario requires 16 equations to model. The corporate profit now is just $ 329 (compare to $ 750 in the previous scenario; γ=0.439), of which just $ 23 is the liquid asset accumulation. The net deficit of the personal sector does not change (relative to the reference situation) but the gross deficit is reduced since the fixed assets the persons buy are cheaper. The volume of personal consumption does not change but it costs less because of the price reduction. In foreign trade, the value of the original export volume decreases due to lower prices; this is partially compensated by an increase of the export volume resulting from more competitive prices.

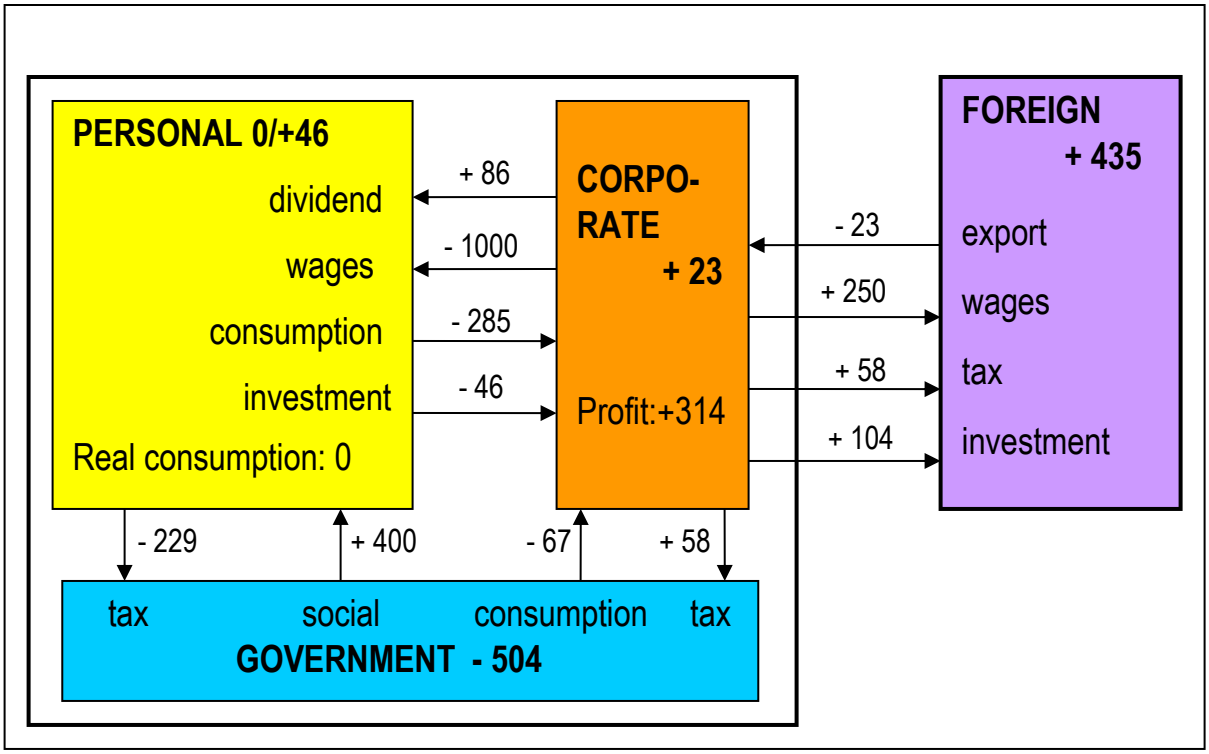

Figure 10. Offshoring of 1000 dollars' worth of US labor (from production industry) with equilibrium pricing

Figure 11 shows the situation when 1000 dollars' worth of US labor is rehired (of those who lost their job previously, due to offshoring). The assumption here is that by the new hires only the domestic service sector expands, the goods production sector only to the extent needed to meet the increased demand of the service sector. Simultaneously, the import needs of service sector also grow, proportionally. The entire new service capacity is consumed by the domestic population. The perturbation model now consists of 10 equations. Obviously, the government sector gains significantly, with the increased tax income and reduced social expenses. The corporate profit and liquid asset accumulation are growing moderately. The foreign trade deficit grows because of the increased import. The consumption of the personal sector grows significantly (by $ 1486). However, the balance of the personal sector falls substantially, partly because the increase of income ($ 1000 wages and $ 60 dividends) is partially compensated by higher taxes and lost social income ($ 251 plus $ 400), but mostly because the cost of the excess services consumed is higher than the excess income from wages and dividends ($ 1486 versus $ 1060).

Figure 12 shows the combination of offshoring and rehiring. $ 1000 dollars' worth of US labor is offshored in the goods production sector and the entire labor force, so becoming available, is hired in the service sector (actually, a small fraction is rehired in the production sector, corresponding to the increased demand of the expanding service sector). The total of excess services is consumed and paid for by the domestic personal sector. As can be seen, corporate profit and its liquid asset part grow significantly (by $ 927 and $ 194, respectively). The government balance also increases (by $ 355), because of the higher tax income. The foreign balance of the economy becomes substantially worse (by $ 723). The real consumption of the personal sector grows significantly (by $ 1486), but so does its deficit (by $ 1270), that is, the increased consumption is covered almost completely from debt.

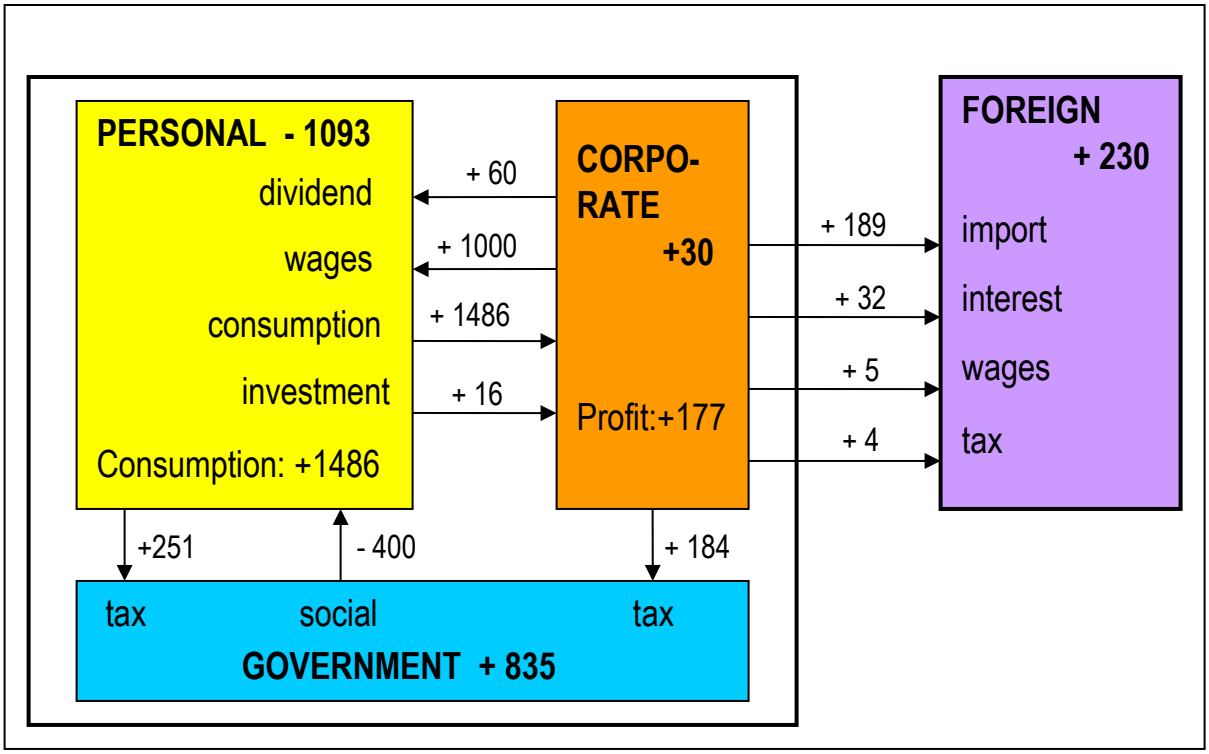

Figure 11. Rehiring of 1000 dollars' worth of US labor to expand domestic service consumption (κ=0.4)

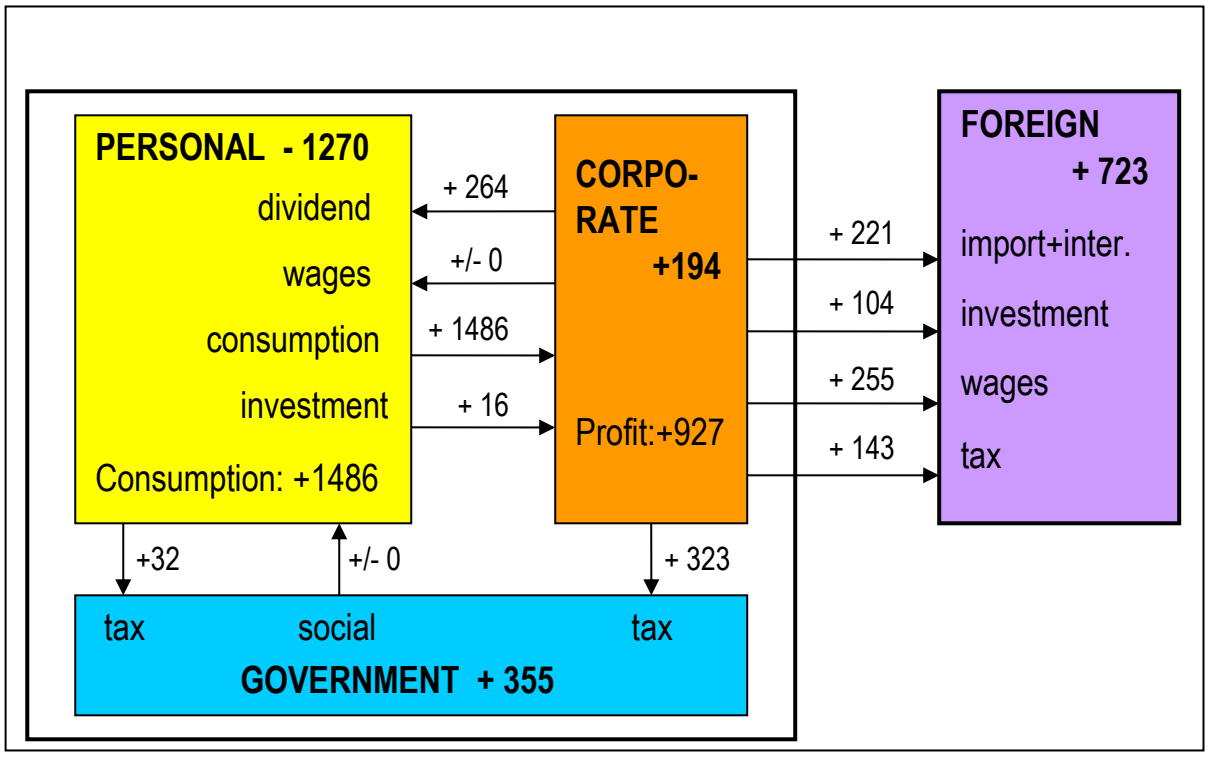

Figure 12. Offshoring of 1000 dollars' worth of US labor (from production sector) with full rehiring in the service sector, for domestic service consumption (β=0.25; κ=0.4; τ=0.5; λ=1)

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