International mobility of capital, wage indexation, and the cost of policy mistakes under ambiguity: a CGE evaluation

Omar O. Chisari, Gustavo Ferro & Juan Pablo Vila Martínez

International Economics and Economic Policy

ISSN 1612-4804

Int Econ Econ Policy
DOI 10.1007/s10368-016-0343-5

Springer

Int Econ Econ Policy
DOI 10.1007/s10368-016-0343-5

ORIGINAL PAPER

International mobility of capital, wage indexation, and the cost of policy mistakes under ambiguity: a CGE evaluation

Omar O. Chisari[1] · **Gustavo Ferro**[2] · **Juan Pablo Vila Martínez**[3]

Abstract In this paper we focus on the role institutions and structural parameters play in macroeconomic policy design and test the differential effects of tax policies on two structural parameters: the degree of international capital mobility and the rules of wage indexation practiced in the economy. We evaluate counterfactual changes in taxation in the Argentine economy using a Computable General Equilibrium (CGE) Model with unemployment, calibrated with 2006 data, showing that policy mistakes (diagnosis failures) are costlier when the degree of capital mobility is greater and the rules to determine salaries could amplify the losses. Among other taxes, we evaluate the choice of export taxation, historically one of the preferred revenue sources of Argentine governments. We discuss the choice of taxes that an optimistic and a pessimistic policymaker will make under Knightian uncertainty and find that, in the case of our CGE, an optimistic policymaker prefers to tax export goods, while a more pessimistic one tends to tax imports or non-tradable goods.

Keywords Computable general equilibrium models · Economic policy · Taxes, capital mobility

A different version of this paper was presented at the Conference "Homenaje a Roberto Frenkel", Facultad de Ciencias Económicas, Universidad de Buenos Aires (October 11th and 12, 2012), and published as a chapter in Macroeconomics and Development: Roberto Frenkel and the Economics of Latin America, Mario Damill, Martín Rapetti and Guillermo Rozenwurcel, editors. © 2016 Columbia University Press. Adapted for reprint with permission of the publisher.

✉ Gustavo Ferro
gaf97@ucema.edu.ar; gferro05@yahoo.com.ar

[1] Instituto de Economía, UADE & CONICET, Lima 717, 1073 Buenos Aires, Argentina

[2] Universidad del CEMA (UCEMA) & CONICET, Córdoba 374, 1054 Buenos Aires, Argentina

[3] Departamento de Economía, UADE, Lima 717, 1073 Buenos Aires, Argentina

Published online: 26 May 2016

JEL Classification F2 · H3

1 Introduction

Let us imagine a small economy based on tradable natural resources and open capital markets. Policymakers have to develop policies and make choices concerning the tax base. Assume that the country is subject to external shocks and that their authorities face Knightian uncertainty as to the results of their interventions. Also assume two types of policymakers: the "optimistic" one and the "pessimistic" one. Both are subject to mistakes owing to misdiagnoses, uncertainty and misjudgments. What role do institutions and structural parameters play in macroeconomic policy and in the choice of the tax base under different types of policymakers? What are the consequences of the different attitudes of policymakers when they confront deep uncertainty over capital mobility and wage determination?

We hypothesized that structural and institutional parameters in a small economy are important in the design of policy interventions under uncertain environments. In addition to trade specialization, one characteristic of less developed economies is the limited asset base. Reduced endowments and poverty do not help to compensate negative shocks[1] and, in such a case, policy mistakes could yield deleterious and lasting effects. Uncertainty or the lack of knowledge due to overoptimistic or pessimistic policymaking decisions can produce wrong conjectures, worsen the quality of the decision making itself.

Moreover, we will see that the greater the degree of international capital mobility and the more complete the wage indexation in the formal labor market are, the greater the damage from bad taxation policies will be. International capital mobility has a de jure aspect (legitimate activities face formal and exchange controls), as well as a de facto aspect (agents find some way to convert their resources into external assets). We are interested in the de facto aspect. By definition, specific capital in the economy is not mobile and is a sunk cost. In turn, financial capital is liquid and mobile (with a higher or lower mobility, depending in part on the legitimate transactions and exchange controls). The definition of capital flight encompasses both the physical hoarding of hard currency and financial instruments bought in the rest of the world by local agents.

Although we place the analysis in a Walrasian general equilibrium setting, we depart from the traditional presentation and assume unemployment. We also assume that some proportion of total capital is mobile internationally, i.e., it can be reallocated to the rest of the world at no cost. In principle, we will assume policymakers are benevolent but capable of failures in their diagnoses and in their appraisal of the structural and institutional parameters. So, we will assume that they are uncertain or ill-informed about the level of those parameters. We do not necessarily assume rational expectations as that would imply an already concluded learning process in economic cycles (Heymann 2008).

[1] Schumacher and Strobl (2008) summarize the evidence that the same shock to natural disasters has worse consequences for poor economies.

We simulated some policy shocks affecting taxes and the Argentine economy using a Computable General Equilibrium (CGE) Model with unemployment, calibrated with 2006 data. The CGE model is inspired in the analytical structure and data used in Chisari et al. (2013). Our CGE model has all the basic properties of the Walrasian perspective, and it is numerically solved using GAMS/MPSGE.[2] It is a one-country model and the economy is assumed to be small with respect to the rest of the world (therefore the prices of tradables are considered as given). Imports consist of intermediate and capital goods used in fixed proportions for production. Although we will discuss only the results for the first period, the model is a recursive dynamic one that simulates economic growth. In our experiments, we examine differential effects varying two structural parameters: the degree of international capital mobility and the economy rules of wage indexation.

The model is used to evaluate how different levels of these parameters can widen the gap between the actual and the expected results of policymaking. If the authorities are aware of their lack of knowledge, they will have to make a decision with unknown probabilities. Their attitude toward uncertainty will then have a non-neutral effect on the economy.

The country under study has interesting features: first, it has an intermediate degree of development; second, its exports rest on natural resources; third, it has a long story of economic instability with great policy changes (i.e., from import openness and capital mobility flights to a closed economy; from high inflation and generalized indexation to stabilization programs with de-indexation processes; from taxation on tradable sectors—on both imports and exports—to taxation on consumption and labor). In such an environment, ill-informed policymakers are more prone to misjudgments and wrong decisions. Damill and Frenkel (2009), for example, explain capital flight events in Argentina by combining unsolved problems and policy mistakes. Note that Argentina underwent one of the most serious international defaults in history in 2001.

Following this introduction, Section 2 summarizes the literature linked to the problem under study; Section 3 provides the institutional setting of the discussion and Section 4 refers to the CGE model in use. Section 5 discusses the simulations—i.e., the computational experiment—and Section 6 presents the results. Section 7 discusses the choice of taxes that a policymaker will make under different behavior criteria because of uncertainty or ignorance, à la Luce and Raiffa (1957). Section 8 summarizes the main conclusions.

2 Literature

The inclusion of capital mobility in the analysis has also been discussed in the literature. Fullerton and Lyon (1983) suggest taking capital mobility into account when using tax policy choices to illustrate and investigate the more general problem of uncertain parameter values in models devised to evaluate policy choices. Koskela and Schöb (2000) state that, according to conventional wisdom, internationally mobile

[2] We use the representation of General Equilibrium and the Mixed Complementarities Approach. The model is developed in the environment of GAMS/MPSGE. At present, it can be used in interface with GAMS.

capital should not be taxed or should be taxed at a lower rate than labor, when the latter is immobile. In the presence of unemployment, the conventional wisdom is defied. Under involuntary unemployment, the supply of labor is locally infinitely elastic. According to the Ramsey rule, labor should not be taxed at a higher rate than other factors with similar elasticity.

As Frankel (1992) points out, there are at least four distinct definitions of perfect capital mobility. The first, the Feldstein-Horioka test[3] concludes that exogenous changes in national savings rates have no effect on investment rates; second, real interest parity: international capital flows equalize real interest rates across countries; third, uncovered interest parity: capital flows equalize expected rates of return on countries' bonds, regardless of exposure to exchange risk; and fourth, covered interest parity: capital flows equalize interest rates across countries when contracted in a common currency. The four approaches are in ascending order of specificity.

Since our simulations basically test how the economy responds to changes in taxation, we examine the analysis of taxation and optimal taxation under unemployment. One of the first papers to analyze these subjects is Marchand et al. (1989), who emphasize how relevant the presence of unemployment is to optimal tax determination. They consider modifying the Ramsey rule in this case and find that the relative tax structure has to be modified because unemployment affects welfare. Hence, taxes charged on inelastic goods have to be lower than the Ramsey rule recommendation if employment-creation sectors are affected. Their model states that capital is specific and not mobile, even between sectors of the economy.

Azariadis and Pissarides (2004) study the response of domestic unemployment rates to shocks in total factor productivity for economies with different capital mobility. In a mobile capital environment, unemployment responds faster and more amply to total factor productivity shocks. If an economy is hit by such a negative shock, it reduces labor demand, but its capital stock cushions the fall in demand. If capital can leave the country in the pursuit of higher rates of return abroad, the cushion is not as effective, and unemployment increases more. Workers' incomes and jobs become relatively less secure than capital returns. In the absence of capital mobility, the key influence on employment is the capital accumulation with local savings. In the absence of a perfect correlation in the shocks within countries, the variance of employment with capital mobility is always higher than the variance with immobile capital. The maximum variance is achieved when the shocks are perfectly and negatively correlated. The average unemployment rate does not necessarily increase with higher capital mobility. Instead, its variance rises.

Boehringer et al. (2004) present an applied general equilibrium modeling approach to analyze the unemployment effects of labor tax modifications in an economy where wages are determined through firm-union bargaining at the sector level. The simultaneous explanations of income generation and spending enable us to address both efficiency and distributional effects of policy shifts. To track the causal chain from policy intervention in labor markets, it is necessary to model explicitly the wage-setting process.

[3] The Feldstein-Horioka test consists of running a regression of the national investment rate on the national savings rate. The estimated coefficient is 1 in the case of financial autarky and 0 in the full mobility case (Bebczuk and Schmidt-Hebbel 2010).

Frenkel and Ros (2006) present a model of unemployment rate determinants, the channels through which the real exchange rate influences unemployment performance, as well as empirical results for Latin American countries. They identify three channels through which the real exchange rate influences employment performance: first, the macroeconomic channel—the real exchange rate impacts the activity level in the short run; second, and less explored, the labor intensity channel; and third, the influence on economic growth and the speed of job creation. Formal sector unemployment is affected by capital accumulation, which generates increases in the formal sector productivity of the economy and the migration of informal workers to the formal sector owing to wage differences. They highlight that most of the development literature attributes the generation of externalities favoring modernization and growth in other economic sectors to the tradable sector expansion. A depreciated real exchange rate is relatively easy to implement and it is a way to subsidize all tradable sectors without incurring administrative costs and/or risking rent-seeking behavior and corruption.

3 The model and the institutional setting

In this section we present a brief discussion of the basic elements of the model in a simplified version. Although we have several agents in our CGE model, let us assume that there is only one representative household that maximizes utility. Equation (1) gives the equalization of the rate of substitution with relative prices corrected by ad valorem taxes, in this case only charged on good 1 (the general model includes several taxes, as well as agents and goods).

$$U_1/U_2 = (1 + t_1)P_1/P_2 \tag{1}$$

Equation (2) gives the budget constraint. It is assumed that there is only one kind of labor, L_0 (W is the wage rate) but two kinds of capital—fixed and mobile—between industries. There is one unit of specific capital in each industry and their prices are indicated with π_i (alternatively this can be interpreted as total profits of the sector with constant returns to scale). The endowment of internationally mobile capital owned by the domestic household is given by K_0 and its remuneration is R^*. At the benchmark the proportion of fixed capital owned by the domestic household with respect to mobile capital is therefore $2/K_0$ (in fact, this parameter can be unobservable and uncertain). This is one of the main critical parameters under uncertainty; though here it is taken as given, the share of mobile capital can be variable. The computational model is solved for different levels of fixed/mobile capital and for different states of nature.

$$P_1C_1(1 + t_1) + P_2C_2 = WL_0 + R^*K_0 + 1\pi_1 + 1\pi_2 \tag{2}$$

Equations (3) to (6) present the definition of profits for sector 1, the production function, and the optimal benefits of first order conditions, respectively. The price

received by producers is net of expenses in intermediate inputs, both domestic and imported (given by a, and α). Imported goods are used as the numeraire. Equations (7) to (10) are analogous for sector 2.

$$\pi_1 = (P_1 - P_2 a - \alpha) Q_1 - W L_1 - R^* K_1 \tag{3}$$

$$Q_1 = F(L_1, 1, K_1) \tag{4}$$

$$(P_1 - a P_2 - \alpha) F_L = W \tag{5}$$

$$(P_1 - a P_2 - \alpha) F_K = R^* \tag{6}$$

$$\pi_2 = (P_2 - P_1 b - \beta) Q_2 - W L_2 - R^* K_2 \tag{7}$$

$$Q_2 = G(L_2, 1, K_2) \tag{8}$$

$$(P_2 - P_1 b - - \beta) G_L = W \tag{9}$$

$$(P_2 - P_1 b - - \beta) G_K = R^* \tag{10}$$

Equation (11) corresponds to the budget condition for the public sector; in this simplified case it is assumed that all revenue is used to hire labor (the general model includes purchase of goods, transfers to households, investments, and net changes in the financial result).

$$W L_g = t_1 P_1 C_1 \tag{11}$$

Equations (12) to (15) are the equilibrium market conditions. The first one includes exports, x; the third determines unemployment, un, and the last gives the equalization of demand and supply of mobile capital.

$$C_1 + b Q_2 + x = Q_1 \tag{12}$$

$$C_2 + aQ_1 = Q_2 \tag{13}$$

$$L_1 + L_2 + L_g + un = L_0 \tag{14}$$

$$K_1 + K_2 + K_m = K_0 \tag{15}$$

Equation (16) fixes the price of good 1 at the level given by the rest of the world because it is a tradable good (this is the case of a small economy).

$$P_1 = P^* \tag{16}$$

Equation (17) corresponds to nominal wages determination as a weighted average of prices of tradable goods, non-tradable goods and imports (it is assumed that the price of imports is 1).

$$W = \gamma_1 P_1(1 + t_1) + \gamma_2 P_2 + \gamma_3 1 \tag{17}$$

The former encompasses three additional structural parameters with deep uncertainty, critical to the model. As in the case of capital mobility, parameters γ_i are taken as given but in reality their levels vary in each state of nature and the policymaker does not know the true value. Thus, the model is solved for each plausible level of γ_i and the decision must be made according to their attitude towards uncertainty.

In Eq. (18) we define imports, limited to those for industrial uses, which in this simplified version does not include imports of final goods (the CGE model includes imports of final and intermediate goods).

$$\alpha Q_1 + \beta Q_2 = m. \tag{18}$$

The 18 unknowns are: $P_1\ C_1\ P_2\ C_2\ W\ \pi_1\ \pi_2\ L_1\ L_2\ un\ K_1\ K_2\ Q_1\ Q_2\ L_g\ m\ x\ K_m$.

We explore the consequences of determining taxes without knowing the total or partial value of parameters γ_i and the share of the mobile capital in the total. We approximate that proportion by $2/K_0$ (when the initial prices in the benchmark are all equal to one, a hypothesis regularly adopted in computed general equilibrium).

4 The computable general equilibrium model

The simulations to be analyzed are based on 2006 data for Argentina. The basic data for the model were organized in a social accounting matrix (SAM). As is customary in applied general equilibrium analysis, the model is based on economic transactions in a particular benchmark year. Benchmark quantities and prices—together with exogenously determined elasticities—are used to calibrate the functional forms. For this study, we used 2006 sector information. The initial matrix of intermediate transactions was based on 1997; it was updated in Chisari

et al. (2009). The income factor distribution was based on the distribution observed in Argentina in 2006 according to household income surveys. The distribution of the consumption basket per type of goods and services is based on aggregates from the household consumption survey for 2005.

Without capital mobility the closure of the model assumes a trade balance and the exchange rate is endogenous and estimated as the relative price of non-tradable to tradable goods. Of course, capital mobility scenarios make it necessary to take into account international capital flows and that obliges the economy to modify its trade balance, i.e., to increase exports over imports when there is a capital outflow. The model assumes that there are neither modifications in the central bank reserves nor possibilities for borrowing funds from the rest of the world.

As for the government expenses for distribution between goods and services, data are available for 2006 for the national and provincial governments. Municipal expenditures are assumed to be distributed in the same proportion as the average for the other two government levels.

The model includes 29 production sectors—four for agriculture, one for petroleum and mining, sixteen for industrial goods and eight for services. Regarding the demand side, domestic consumer groups are divided into ten income brackets—the government, one foreign consumer, and one foreign producer. The small open economy assumption is adopted, implying that Argentina is a price taker in the international markets. Information on the government accounts was obtained from the Ministry of the Economy (National Office of the Budget).[4] Public sector revenue and expenditures are consolidated results for the federal administration, provinces, and municipalities. The information on national and local taxes was provided by the Federal Revenue Administration and Provincial ministries, respectively.[5]

The information on the balance of payments was obtained from the Central Bank of Argentina. Aggregate demand and supply in the SAM are consistent with national accounts. The consistency of these data with national accounts and sector information was obtained using the Cross-Entropy Method.

A summary of the SAM for the Argentine economy of 2006 is shown in Table 1. This small-sized SAM has three activity sectors (primary, industrial, and services), two factors (with capital representing an aggregate of land, and physical and financial capital), taxes, public and private investment, and the rest of the world (ROW). Columns show the decomposition of budget conditions for agents, while rows represent markets. The input–output matrix is the sub-matrix of the SAM that represents transactions between activity sectors (activities, activities). Below this is the matrix of factor demands (factors, activities), followed by the matrix of taxes paid by activity (taxes, activities). The SAM separates taxes paid by exports, intermediate uses, final consumption, and investments. Finally, the matrix of imported purchases is included (ROW, activities). Totals of rows and columns of each sector are the respective gross output value.

The factors accounts show how the remuneration of factors is allocated to households (households, factors). Part of the capital is owned by the rest of the world. For the

[4] www.mecon.gov.ar/onp

[5] Chisari et al. (2009) present a complete description of the sources and methods used to build the SAM for Argentina for 2006.

Table 1 Argentina, 2006. Aggregated SAM (Millions of $)

		Activity Sectors			Factors		Taxes	Households		Govern-ment	Investment		ROW
		S01	S02	S03	L	K		H1	H2		Priv.	Pub.	
Activity Sectors	S01	7,819	61,545	18,785				3,627	2,257	0	1,838	266	30,767
	S02	15,207	115,971	70,928				70,000	52,175	0	10,127	1,466	110,497
	S03	13,410	63,004	164,495				101,381	124,315	81,248	89,509	12,959	20,771
Factors	L	9,796	32,461	154,518									
	K	59,213	61,477	176,976									
Taxes	IM	55	2,549	105				320	350		1,640		
	VAT	2,775	17,316	18,284									
	Indi	6,332	14,261	22,649									
	IX	3,182	11,529	0									
	IL	1,768	6,865	20,251									
	IK	6,347	7,563	7,126									
	IH							4,098	25,111		3,125		
House-holds	H1				61,053	43,861			53,443	31,325			
	H2				135,723	245,815				30,649			
Govemment						183,603							
Invest-ments	Priv.								136,819				1,328
	Pub.									14,691			
ROW	S1	1,000	51,830	16,974		7,990		10,253	13,898		31,907	0	
BNI								3,820	25,691			−29,511	
Totals	126,904	446,372	671,090	196,775	297,666	183,603	189,681	412,187	183,603	138,147	14,691	133,853	

Activities: *S01* agriculture and mining, *S02* manufacturing industry, *S03* trade, construction and services

Factors: *L* labor, *K* capital and land

Households: *H01* first 5 income deciles (poorest), second 5 income deciles (richest)

Investments: *Priv.* private, *Pub.* public

Taxes: *IM* import tariffs, *VAT* value added tax, *Indi* rest of indirect taxes, *IX* tax on exports, *IL* labor taxes and contributions, *IK* taxes on capital, *IH* taxes paid by households

ROW rest of the world

Source: Own elaboration

demand side, we summarize the matrix of household expenditures (activities, households), government consumption (activities, government), private and public investments (activities, investments), and the vector of exports (activities, ROW). The matrices (household, household) and (household, government) correspond to transfers between agents. From the supply side, the production function in each sector is a Leontief function between value-added and intermediate inputs: one output unit requires an x percent of an aggregate of productive factors (labor, physical capital, financial capital, and land) and $(1–x)$ percent of intermediate inputs. The intermediate inputs function is a Leontief function of all goods, which are a strict complement in production. Instead, value-added is a Cobb-Douglas transformation of productive factors into goods. Private savings, public savings and foreign savings are totaled to finance investments. The row BNI closes the model and it represents the surplus or deficit of every agent; it corresponds to 2006 financial transactions.

The demand side is modeled after ten representative households, the government, and the external sector. Households buy or sell bonds, invest, and consume in constant proportions given the remuneration for the factors they own (and the government transfers they receive). The choice of the optimal proportion of the consumption good is obtained from a nested production function in the utility function through a cost minimization process. The government is represented as an agent that participates in markets for investments, consumes, makes transfers to households, and has a Cobb-Douglas utility function; its main source of income is tax collection (though it also makes financial transactions through the bonds account). The external sector buys domestic exports and sells imports, in addition to making bonds transactions and collecting dividends from investments.

The rest of the goods are complementary and the elasticity of substitution between them is zero. As was mentioned before, the version of the model presented here is recursive dynamic. Investments for year t are added to mobile capital at time t + 1, and it is allocated between sectors until its reward is equalized.

Prices for every period are computed to clear all markets simultaneously. Although we will discuss only the results for the first period, the model is a recursive dynamic one that simulates growth for the economy. It is not an optimal growth model; agents make savings decisions in period t based only on information for the same period; savings are then converted in the following period $t+1$ into additional capital. This new capital is not specific by sector but is malleable, and fully mobile between sectors of production. Therefore, it is allocated at the same time as prices are being determined by the model; the final allocation of "brand-new" capital responds endogenously to the relative profit opportunities and it is reallocated until the reward for new capital is the same in all industries. Henceforth, the final industrial scale depends on market incentives determined by the model itself.

5 The computational experiments

We propose the following computational experiments: four different tax policies, combined with two different rules of wage determination, and different levels of international capital mobility. The latter is developed to show the concavity of the curve which relates the GDP variation with the degree of capital mobility. This means

that the costs of policies become steeper when the capital is more mobile. For the sake of simplicity, we will report the figures of only two extreme results of capital mobility, which we call "High K" (73 % mobile) and "Low k" (0 % mobile). The possible combinations number 16. The list is presented in Table 2 but we will concentrate on the set of high capital mobility against low capital mobility, and on the consequences of both rules of wage indexation.

In the context of the paper, "nominal" means that the numeraire is "value added of the rest of the world". Thus, "nominal" indexation means wages denominated in dollars. Since the CPI is part tradable and part non-tradable, CPI or "real" indexation means that wages only partially follow the dollar (for the tradable component of the CPI). A devaluation is fully pass through to wages if we assume "nominal" indexation, and it is partly trespassed to wages if the rule is "real" or CPI indexation.

The first tax rise we simulate is a 20-percent increase in export taxes charged on all sectors. In Argentina, export taxes were generally established in the wake of significant devaluations as a way to compensate local consumers of export goods (food) and to limit inflationary pressures. This was due to the peculiar economic structure of the economy: in the past the exports were almost exclusively based on commodities that at the same time were wage-goods. We consider the following alternative policies: a VAT increase, an Import Tariffs increase, and a Payroll Tax increase. In all cases we assume an "equal-yield replacement". The government is endowed with a Cobb-Douglas utility function and we compute its welfare level as for any other household using the Equivalent Variation.

The importance of considering all the taxes has to do with local history and polarized local politics. VAT and Income taxes are "neutral" among sectors, while export taxes are the preferred option for governments which support import substitution and finance the subsidization of local industry by taxing tradable goods (primary sector). Likewise, they gain support for their policies from the service sector that can buy cheaper primary goods than at international prices. Import taxes protect the local industry, but they do not transfer rents directly from the primary sector to secondary and service ones. They do transfer rents indirectly via local (protected) industry products, which are more expensive than the imported ones.

For all of the following simulations we have assumed that the elasticity of substitution is one, either for utility or production functions. It is only a benchmark case because the model can easily be simulated for different elasticities of substitution.

Table 2 The cases under analysis and their variants

1) Exports W = CPI High K	2) Exports W = 1 High K
3) VAT W = CPI High K	4) VAT W = 1 High K
5) Imports W = CPI High K	6) Imports W = 1 High K
7) Labor I = CPI High K	8) Labor W = CPI High K
9) Exports W = CPI Zero k	10) Exports W = 1 Zero k
11) VAT W = CPI Low k	12) VAT W = 1 Low k
13) Imports W = CPI Low k	14) Imports W = 1 Low k
15) Labor W = 1 Low k	16) Labor W = 1 Low k

Each tax increase yields a revenue rise equal to a 20 % rise in export taxes of all sectors Wage indexation rules: W = CPI or W = 1 Degree of capital mobility: high (73 %) or low (0 %)

Let us set the nominal salary (in dollars) at 1. The tax increases are combined with two different rules for wage indexation. The first rule is CPI indexation (constant real wages, or $W = \text{CPI}$). The rule is compatible with Keynesian unemployment at the point of departure. When prices rise, real salaries decrease and labor employment increases, and vice versa. It allows us to introduce cyclical unemployment in this economy. The second rule is flexible real wages, or $W = 1$; we define it as nominal rigidity in dollar terms).

We number the cases starting with high capital mobility (1 to 8), starting from $W = \text{CPI}$ and following with the $W = 1$ rule. Cases 9 to 16 are the low capital mobility ones.

6 Results of simulations

The dynamic model was calibrated for the economy's total GDP to grow at 4 % for 2006, leaving aside exogenous shocks identified for the economy in the same year. The simulations assume that the labor force is not growing, which is a neutral assumption, taking into account that what matters are the comparative dynamics of the basic scenario of growth with respect to the simulated cases.

The key result, arising in all scenarios presented, is that underestimating capital mobility can lead to unexpected losses from taxation. First consider the results of a 20-percent export tax increase for all sectors under two different degrees of capital mobility and two different rules of wage indexation. With the wage indexation to CPI rule and zero capital mobility, the GDP grows at the same value as for the benchmark. When export taxes are applied, wages show a reduction in dollar terms and an increase in CPI terms (since domestic prices of tradable goods paid by consumers are falling). With high capital mobility, the GDP falls by more than 2 %. The results are magnified in the case of dollar wage indexation. The losses start at almost 2 %, with zero capital mobility, and are almost 7 % in the high capital mobility environment.

Thus, the worst case scenario is dollar indexation and high capital mobility. The rationale is the following: with CPI indexation, when the GDP falls below the benchmark's expected growth rate, prices in the economy decelerate; since wages follow CPI, the decrease in real wages limits both the GDP fall and the rate of unemployment increases. Instead, without capital mobility, the losses for the economy are more moderate. An inaccurate appraisal of the true level of the parameters could render a disappointing loss in GDP if policymakers expect low capital mobility (i.e., they would underestimate capital outflows as a result of the export tax) and CPI wage indexation.

Now let us focus on a VAT increase (with equal yield for a 20-percent export tax increase in all sectors) under two different degrees of capital mobility, and two rules of wage indexation. If $W = 1$, the results are negative but modest. This is because prices are rising, but real wages are being reduced and that stimulates the economy and reduces unemployment. The GDP falls about the same 0.5 % in both scenarios for capital mobility. If salaries are indexed to CPI, the above concave pattern stays the same and the drop in the GDP with respect to the benchmark is from 1.3 % under low capital mobility to 2.7 % in the high mobility case.

For the third case, we consider an increase in taxes on imports (equal yield rather than a 20-percent export tax increase for all sectors) under two different degrees of capital mobility and two rules of wage indexation. Losses in GDP growth under both wage indexation rules are lower than in the previous cases. Again, greater losses occur when the degree of capital mobility is higher. Since most of the imports are used as intermediate inputs for manufactures, the tax increase is absorbed by specific capital in the form of a reduction in its rent. Since there is also a reduction in the activity level, the CPI is reduced and wage adjustment is less damaging than in the case of dollar adjustment.

The last experiment is related to a labor tax increase (equal yield rather than a 20-percent export tax increase for all sectors) under the same varying degrees of capital mobility and rules of wage indexation presented above. In this case, the difference in GDP loss between both wage indexation rules is slight, though the fall is higher in the case of CPI indexation. This can be attributed to the growing prices of services owing to the increase in labor costs. Instead, when there is dollar indexation, the higher prices reduce real wages and that helps to limit the fall in the level of employment.

Let us now examine the results and explanation in greater detail. Table 3 shows the results. Starting with export taxes, when capital mobility is higher (cases 1 and 2) the results in the activity level are worsened. As was mentioned, the results are the worst in the case of dollar indexation. As was expected, the trade balance is strongly affected in the high capital mobility cases and is moderately affected under low capital mobility. The model offers some information about income distribution. For cases 1 and 2, the results for the poorer and the middle classes are negative and almost the same. Constant dollar wages reduce the employment and welfare of the poorest, and it is not a successful instrument to defend their welfare. Instead, capital mobility would appear to be an effective instrument to protect the welfare of the richest: the redistribution favoring the lower classes occurs in the low mobility cases.

In the high mobility scenarios, the Agriculture and Mining sector is the most affected since exports are concentrated there. With lower capital mobility and $W=1$, the other sectors underperformed the primary sectors (since employment is concentrated in the industry and especially in the services). Case 9 is the worst scenario for the economy as a whole, the fiscal result, the unemployment rate, the income distribution, and the sector response. In none of the cases does the Manufactures sector as a whole improve because this sector encompasses a commodity processing industry, which exports and is capital intensive, and an import substitution sub-sector, which imports and is labor intensive. The worst policy mistake would be, therefore, to assume that capital mobility is low when it is high. The error is even more costly if salaries are dollar indexed and are downwards inflexible.

Let us now examine the VAT increase which is designed to yield the same revenue as the 20-percent increase in export taxes. The sector's impact is very different to the cases of export taxes. The worst policy mistake in this case is to assume low capital mobility when it is high, under fully indexed wages. Consider now the import tax case. In both wage determination scenarios, the higher the capital mobility in the economy is, the worse the results for the GDP, unemployment, trade balance, and the welfare of the income groups will be. Our last set of experiments, considers an increase in payroll taxes. High capital mobility cases are the worst for the economy, unemployment, the trade balance, and the welfare of the income classes (especially for the poor, where

Table 3 Results in the first year after 20 % export taxes increase or equal yield alternative taxes rises in all sectors

Difference between benchmark and simulation in percentage points	1) Exports $W=$CPI $K=0.73$	9) Exports $W=$CPI $K=0$	2) Exports $W=1$ $K=0.73$	10) Exports $W=1$ $K=0$	3) VAT $W=$CPI $K=0.73$	11) VAT $W=$CPI $K=0$	4) VAT $W=1$ $K=0.73$	12) VAT $W=1$ $K=0$
GDP	−2.25	0.09	−6.72	−1.88	−2.72	−1.33	−0.55	−0.40
Fiscal result	−0.40	0.71	−3.15	−0.79	−0.78	−0.10	0.58	0.62
Unemployment	0.45	−0.16	4.22	1.84	1.73	0.77	−0.12	−0.18
Trade balance	−28.55	−0.42	−48.68	−2.94	−10.95	−1.40	−1.31	−0.20
Welfare poorest household	−1.41	0.39	−5.88	−1.43	−2.82	−1.33	−0.63	−0.47
Welfare middle-income household	−1.43	−0.04	−5.45	−1.64	−2.55	−1.23	−0.61	−0.47
Welfare richest household	0.75	−0.73	−0.61	−2.51	−0.84	−1.03	−0.17	−0.18
Agriculture and mining	−11.28	−1.14	−11.60	−1.90	−0.26	−0.39	−0.15	−0.03
Manufactures	−1.15	−0.06	−7.77	−2.28	−3.35	−1.05	−0.13	0.00
Services	−0.78	0.17	−5.38	−2.06	−2.14	−0.89	0.09	0.17
Difference between benchmark and simulation in percentage points	5) Imports $W=$CPI $K=0.73$	13) Imports $W=$CPI $K=0$	6) Imports $W=1$ $K=0.73$	14) Imports $W=1$ $K=0$	7) Labor $W=$CPI $K=0.73$	15) Labor $W=$CPI $K=0$	8) Labor $W=1$ $K=0.73$	16) Labor $W=1$ $K=0$
GDP	−0.73	−0.09	−1.04	−0.18	−2,64	−1.03	−2.46	−0.97
Fiscal result	0.28	0.63	0.08	0.56	−0,97	−0.12	−0.85	−0.08
Unemployment	0.52	−0.03	0.78	0.07	2,4	1.18	2.23	1.12
Trade balance	−2.86	0.40	−4.28	0.28	−11,26	−1.04	−10.49	−0.97
Welfare poorest household	−0.83	−0.04	−1.14	−0.12	−2,65	−0.87	−2.46	−0.81
Welfare middle-income household	−0.94	−0.24	−1.22	−0.31	−2,9	−1.29	−2.73	−1.24
Welfare richest household	−0.48	−0.48	−0.58	−0.56	−0,85	−1.01	−0.80	−0.96
Agriculture and mining	0.76	0.00	0.71	−0.03	0,5	−0.30	0.47	−0.28
Manufactures	−2.29	−0.54	−2.73	−0.65	−4,39	−1.38	−4.11	−1.32
Services	−0.35	0.16	−0.67	0.05	−2,58	−1.04	−2.39	−0.97

Table 4 States of nature and payoffs (GDP growth rate in percentage-point difference from benchmark)

	$W=1, K=0$	$W=\text{CPI}, K=0$	$W=\text{CPI}, K=0.73$	$W=\text{CPI}, K=0.73$
Exports	−1.88	0.09	−6.72	−2.25
VAT	−0.4	−1.33	−0.55	−2.72
Imports	−0.18	−0.09	−1.04	−0.73
Labor	−0.97	−1.03	−2.46	−2.64

wages represent the greatest part of income). Manufactures shows higher losses but Services (intensive in labor) are also strongly affected.

7 Decisions with unknown probabilities

Policymakers often have to make quick decisions and, at times, they lack the opportunity to evaluate the probability of events. The same policy may even produce different outcomes depending on structural parameters, institutional environments, and historical circumstances. Let us take the problem, then, as one decision with unknown probabilities—true uncertainty à la Frank Knight—and explore what a policymaker can do in our case.[6]

Modern literature considers the case of agents that do not have a unique assessment of a distribution function of probabilities—see for example Anscombe and Aumann (1963) and Gilboa and Schmeidler (1989).

We will reduce the problem to one for which there are four possible states of nature:

- $W=1, K=0$.
- $W=\text{CPI}, K=0$.
- $W=1, K=0.73$.
- $W=\text{CPI}, K=0.73$.

The decision maker can choose an action from the set of possible increases in tax simulated in the previous section (exports, VAT, imports, labor) all of which hypothetically accrue the same revenue. This is a simplification because the policymaker could consider other possible actions or use some combination of taxes to obtain the same result. Our intention, however, is to show how the attitude towards uncertainty can modify the decision. Note another important simplification. We will assume that the payoffs of every state of nature and action can be synthesized in the percentage change of the GDP. This is, of course, a simplistic approach for the policymaker could be interested in other attributes, such as income distribution, fiscal or trade balance results. The following matrix summarizes the actions, states of nature, and payoffs (Table 4).

Now, let us see which action is preferable considering the three alternative criteria:

- *Optimism or Maximax*: assume that "Nature" will play the most favorable state for every action.

[6] See Barlevy (2009)

Table 5 Criteria and payoffs

	Optimism	Pessimism	Minimum Regret
Exports	0.09	−6.72	6.17
VAT	−0.4	−2.72	1.99
Imports	−0.09	−1.04	0.49
Labor	−0.97	−2.64	1.91

- *Pessimism or Maximin*: "Nature" will play the worst state for every action.
- *Minimum regret or Minimax*: choose the action that minimizes regret assuming that "Nature" will play the worst state for every action.

Undoubtedly, these criteria do not satisfy some of the axioms of behavior for a rational decision maker[7] (like the axiom of independence of irrelevant alternatives), but rationality can also be costly or demand additional time for the policymaker to reflect. Thus, let us examine which course of action will be selected given the limitations of information and knowledge. We can see the following payoffs under the three criteria (Table 5):

The last column should be interpreted as the cost of choosing one action, given the possible regret. The least cost action is to tax imports; however, this evaluation tends to underestimate the full impact of taxes on imports, which is seen in the following periods since imports are a main component of investments goods. When import taxes are not taken into account, the least cost action selected under minimum regret is taxes on labor even though, in principle, the action will not be chosen for it is always dominated by some other action.[8] Thus, under minimum regret the policymaker will choose to tax imports (which are in inelastic demand) followed by non-tradable goods and services, for they are more intensive in the use of labor and less intensive in capital. However, when optimism is preferable, taxes on exports will be selected; under pessimism, taxes on imports are preferable. Thus, under optimism the policymaker prefers to tax tradable goods. Note that the cost of a mistake can be highly detrimental when taxes on exports are chosen.

8 Conclusions

In general, simulations show that policy mistakes (diagnosis failures) are costly and even more costly with higher capital mobility. We also show how structural parameters, in our case the proportion of capital that is mobile and the institutional fabric behind the rules of determination of wages, are relevant to policy outcome. The key result, arising in all scenarios presented, is that underestimating capital mobility could lead to unexpected losses from taxation. The worst policy mistake would be, therefore, to

[7] Luce and Raiffa (1957) and more recently Binmore (2009) discuss how these criteria perform when faced with the axiomatic basis given by Milnor.

[8] In fact, one dominant action can be selected when all actions are considered simultaneously because the independence of irrelevant alternatives is not fulfilled under minimum regret. See Luce and Raiffa (1957).

assume that capital mobility is low when it is actually high. The error is even more costly if salaries are not fully indexed to CPI and are downwards inflexible in dollar terms.

The model shows that a favorite policy could be sensitive to policymakers' attitude to uncertainty. Structural change and social unrest create uncertainty for the degree of mobility of capital (the animal spirits of international investors) and for the reaction of trade unions; the results for the economy cannot be estimated using traditional econometrics or computable general equilibrium via sensitivity analysis. Under those circumstances, our analysis shows that the results depend on the policymakers' individual characteristics or the decision-making process. Surprisingly, from our examples, we have found that optimistic policymakers prefer to tax export goods, while the most pessimistic ones using minimum regret implicitly prefer to tax imports or non-tradable goods and services.

Our simulations should be understood as illustrations and exercises to educate intuition and not policy prescriptions. They are subject to many caveats. We have not conducted sensitivity analysis for elasticities of substitution that could be very relevant to the case of taxes on imports. Neither have we analyzed the long-run impact in a dynamic setting; capital mobility and substitution could modify the results significantly. These are aspects to explore in future research. A lower level of uncertainty, ambiguity in the true probability distributions, could also be incorporated into the analysis.

Acknowledgments We are grateful to Leandro Serino, Carlos Winograd, Guillermo Rozenwurcel, Roberto Frenkel, Daniel Heymann and the thorough review of one anonymous Referee for their interesting comments.

References

Anscombe FJ, Aumann R (1963) A definition of subjective probability. Ann Math Stat 34:199–205

Azariadis C, Pissarides C (2004) Unemployment dynamics with international capital mobility

Barlevy G (2009) Policymaking under uncertainty: gradualism and robustness. Econ Perspect. Federal Reserve Bank of Chicago

Bebczuk R, Schmidt-Hebbel K (2010) Revisiting the Feldstein-Horioka puzzle: an institutional sector view. Económica. UNLP. Vol. LVI. La Plata, January/December

Binmore K (2009) Rational decisions. Princeton University Press

Boehringer C, Boeters S, Feil M (2004) Taxation and unemployment: an applied general equilibrium approach. CESIFO Working Paper N. 1272. Category 4: Labour Markets. September

Chisari OO, Romero CA, Ferro G, Theller R, Cicowiez M, Ferraro J, González M, Blanco A, Maquieyra J (2009) Un modelo de equilibrio general computable para la Argentina. UNDP, Argentina

Chisari OO, Estache A, Lambardi G, Romero CA (2013) The trade balance effects of infrastructure services regulation. Int Econ Econ Policy 10(2):183–200

Damill M, Frenkel R (2009) Las políticas macroeconómicas en la evolución reciente de la economía argentina. In: Damill, Frenkel, Delgado G, Herrera, Lenicov, Sica (eds) Economía y crisis internacional: impacto en la República Argentina. EDICON, Buenos Aires

Frankel J (1992) Measuring international capital mobility: a review. Am Econ Rev 82(2):197–202

Frenkel R, Ros J (2006) Unemployment and the real exchange rate in Latin America. World development, vol. 34 N. 4. Elsevier Ltd

Fullerton D, Lyon A (1983) Uncertain parameter values and the choice among policy options. Working Paper N. 1111, NBER

Gilboa I, Schmeidler D (1989) Maxmin expected utility with a non-unique prior. J Math Econ 18:141–153

Heymann D (2008) Evolución y vaivenes: cincuenta años de macroeconomía. Documento de Proyecto (ARG/06003). ECLAC, Santiago de Chile

Koskela E, Schöb R (2000) Optimal factor income taxation in the presence of unemployment. CESIFO Working Paper Series N. 279. Munich

Luce RD, Raiffa H (1957) Games and decisions. Wiley, New York

Marchand M, Pestieau P, Wibaut S (1989) Optimal commodity taxation and tax reform under unemployment. Scand J Econ 91(3):547–563

Schumacher I, Strobl E (2008) Economic development and losses due to natural disasters: the role of risk. Department of Economics, Ecole Polytechnique, Paris