The role of Sovereign Wealth Funds in the face of shocks: the waning of natural resource rent, of decrease in World demand for domestic products, and the ageing process

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Abstract

This paper studies the resilience allowed by Sovereign Wealth Funds' (SWFs) in case of permanent shocks. We propose a two area general equilibrium model, with a small open economy (with, possibly, a SWF) and the rest of the world. In the face of shocks on the small open economy, consisting respectively of the end of natural resource rents, the decrease of world demand for exported manufactured products and the ageing process, we compare the situations with or without SWF. We find that a SWF can smooth the impacts of shocks and can help improving the resilience to shocks. However, as the SWF may be particularly helpful without shock, the relative losses in the case of shock (compared to levels without shock) may be higher in the long run with a SWF than without, in particular in the case of oil rents waning. Nevertheless, a SWF can in general allow improving inter-temporal welfare. There should be a careful setup of the mode of funding and the parameters of SWF as well as of the level of desired real exchange rate.

JEL Classification: F3; C68; E6; Q3.

Keywords: sovereign wealth fund, general equilibrium model, shocks.

1. Introduction

Sovereign Wealth Funds (henceforth SWFs) are generally meant to comprise government investment vehicles that hold, manage or administer large pools of public funds, separated from foreign official reserves (IMF, 2008). Their resources generally stem from the accumulation of current account surpluses that may themselves result either from exports of raw materials, as in the Middle East, Norway or Russia, or from a structural non-commodity trade or savings surplus, as with Singapore or China. Not surprisingly, relevant SWFs are concentrated in countries showing large and regular current account surpluses.[1]

[1] Among the 40 countries with averaged current account surplus above 2% of GDP over the period 2000-2010 according to IMF data, all of them except Gabon have built one or several national SWFs; among the other 141 countries (most of them show a current account deficit on average), only 15 have built one, mostly small or at the regional level.

SWFs have attracted a growing attention in the recent years. Firstly, their size worldwide has increased dramatically over the past 15 years, in particular following the 1997-98 financial crisis, due to growing global imbalances and/or raw material prices at high levels on a historical scale. Whereas in 1990, SWFs probably held around USD 500 billion (IMF, 2007), in 2010, the total was an estimated USD 4 trillion and could reach USD 7 trillion by 2019 (Kern, 2009). Secondly, their investment policy has been increasingly active.[2]

Recent economic research focuses merely on the impact on countries receiving SWFs' investments. On the one hand, SWFs' public ownership and growing importance spur concerns that SWFs may operate to serve strategic interests (Truman, 2007; GAO, 2008). A significant number of reports aim at analyzing how to avoid political interferences (see, for instance, IMF, 2008), or at measuring political biases (Avendaño and Santiso, 2010). On the other hand, following the 2007-2009 financial turmoil, another part of the literature has analyzed how these possible new sources of funding may contribute to stabilizing the markets (see, for instance, Bortolotti, Fotak and Megginson, 2008; Hesse and Sun, 2009; Fernandes, 2009).

To our knowledge, there has been little economic research dealing with the implications of SWFs on the home country's economy, except for short-term stabilization (Davis et al., 2001). This gap in the literature is surprising, since for governments, the choice to accumulate financial assets and possibly to invest them abroad when the citizens still have unmet needs is particularly sensitive.

In particular, two policy debates have recently emerged and have been amplified following the 2008 slowdown. A first debate discusses the role of SWFs over the long term. In the face of future economic shocks (some of which may be foreseeable, such as the end of natural resource rents or the ageing process), a SWF can allow smoothing consumption and economic activity over time and improve the adaptation of the economic structures. This however implies some constraints in the short term. A second debate discusses the degree of liquidity of foreign reserves, i.e. the specific role of a SWF, as opposed to the central bank.

[2] On average, SWF asset allocation is split between fixed income securities (35-40%), public equity (50-55%) and 8-10% in alternative investments such as hedge funds or private equity (Fernandez and Eschweiler, 2008). There is also a focus on large SWFs' investments in major Western companies, in particular following the financial crisis.

Whereas SWF's assets may be invested in long term and illiquid assets, an adequate level of liquid reserves conversely plays an important role in reducing the risk of crises and lessening their impact when they occur.[3] The global financial crisis since 2008 has underlined the role of reserves for providing liquidity support to domestic banks or to companies, recapitalizing domestic banks, investing in domestic stocks, and financing the budget deficit. Calls for liquidity support and fear of financial losses could prevent from pursuing a long-term investment horizon and holding less liquidity assets (Balin, 2010; for a specific analysis of the case of Norway, see for instance Moskwa and Stoltz, 2009).

On the whole, although many SWFs were created first with fiscal stabilization purpose, a growing number of them have now (also) long-term objectives, which calls for deeper analyses. This paper aims at partly filling the literature gap. It adopts a medium and long term perspective and intends to study the possible macroeconomic implications of the existence of large SWFs on the home country's economy, in case of shocks that emerging countries such as China or Russia may face in the future. To do so, it simulates an open economy, overlapping generations' general equilibrium model, with a small open domestic economy (having possibly a SWF) and the rest of the world.

We find that a SWF can raise the level of consumption, employment and GDP, both at the steady state and in the presence of negative shocks. In the face of shocks, the losses relative to the steady state are limited and smoothed in the short run. However, in some cases, the relative losses in the long run can be higher with a SWF than without. This can for instance occur in the case of a severe oil shock, because the SWF's resources are directly affected. Nevertheless, a SWF can in general allow improving inter-temporal welfare and resilience to shocks.

The structure of the paper is as follows. Section 2 presents the expected role of Sovereign Wealth Funds and some macroeconomic linkages. In section 3, we present a general equilibrium, overlapping generations' model aiming at simulating the possible macroeconomic impact of a large SWF. Section 4 applies this model to the case of countries facing some specific permanent shocks. Section 5 performs sensitivity analysis. Section 6 presents welfare analysis based on observed past shocks. Section 7 concludes.

[3] See for instance Jeanne and Rancière, 2006.

2. The Sovereign Wealth Funds and their expected role

2.1. The changing and overlapping objectives of SWFs

The objectives of SWFs in meeting domestic policy goals can be multiple and overlapping, and they have changed over time (Reisen, 2008). Many SWFs were initially created for fiscal stabilization, especially in order to help smooth large and volatile government revenues (particularly those from exports of natural resources). However, other objectives are longer term: to save funds for pensioners or future generations, or for raising production efficiency as a future driver of growth.

These considerations are particularly relevant in the case of revenues considered to be transitory: countries need to transform transitory or non-renewable resources into sustainable and more stable future income. Saving revenue can also help prevent Dutch disease effects on the non-commodity side of the economy (that arise from crowding out the private sector if commodity revenue is rapidly spent), and possibly maintain a competitive exchange rate (see also below).

In many instances, a reason for establishing a SWF was also to improve the potential return of a government's financial investment, by investing in riskier assets than sovereign bonds. SWFs may be also interested, not only in financial returns, but also in technologies (Summers, 2007; Klodt, 2008), which could increase total productivity and foster development. For instance, joint ventures have been built between enterprises in which SWFs invested and the SWF's home countries, implying technology transfers.

2.2. The impacts and interactions on the domestic economy

Regardless of the initial objectives specified for a SWF, the existence and actions of SWFs can influence other dimensions of their economies. Shields and Villafuerte (2010) underline that SWFs' operations can affect aggregate demand, labour supply, savings and investments. But these effects remain very little analyzed, in particular on the medium term. In particular, the issue of endogeneity and interactions between macroeconomic variables has prevented solid analysis or empirical evidence. This underlines the need for a comprehensive analytical framework, which we try to build in this paper.

2.3. The exchange-rate regimes

The macroeconomic importance of SWFs also raises the question of their interaction with the exchange-rate regime (Brown, Papaioannou and Petrova, 2010). A fixed exchange rate regime may be linked with an accumulation of assets within the SWF, or the central bank. Indeed, if the accumulation means that foreign currency revenues are used to purchase foreign currency assets rather than goods and services, the real exchange rate will appreciate less than it would otherwise. Whereas China follows a fixed real exchange rate regime, the situation for Russia is mixed, as its nominal anchor (fixed nominal exchange rate) is accompanied by high inflation, thus letting some appreciation of the real exchange rate.

In what follows, we focus on a regime of a fixed real exchange rate, which fits the "fear of floating" behaviour of most emerging countries.

3. A general equilibrium overlapping generations model, different regimes

3.1. Overview

Following Galí et al. (2007) and Bénassy-Quéré et al. (2010), we build a general equilibrium overlapping generations' model comprising one country (a small open economy) with two types of households (optimising and constrained), and the rest of the world. The domestic economy takes the world interest rates, commodity price and tradable good price as given in foreign currency. Its currency is not held by non-residents. Four categories of agents are distinguished:

The household sector consists in 10 generations, including 9 active generations and one generation of retirees.

Within each generation of households, two categories are distinguished (e.g. Galí et al., 2007). On the one hand, constrained households (share 1-ζ) do not own any asset and have no liability. Their consumption in each period is constrained by their current income, and consequently they spend their disposable income entirely on current consumption. Their labour supply is flexible so that the labour market clears with a fixed real exchange rate. By contrast, optimizing households (share ζ) have access to financial markets and can buy and sell assets. In our framework, this implies that they are able to save their revenue and earn returns on their savings. Optimizing households maximise an inter-temporal utility function under their inter-temporal budget constraint.

Households receive salaries, profits, possibly returns on their assets (optimizing households only), and pensions (retirees). They may receive transfers from the central bank or the SWF. Households consume both domestic and imported manufactured products.

The production sector encompasses a manufacturing sector and possibly a natural resource sector.

The manufacturing sector consists of two sub-sectors: a sub-sector which produces for the domestic market only (called "the domestic sector"), and a sub-sector which produces for exports only (called "the export sector"). Exports are assumed exogenous, and their price is also defined exogenously on the world market in foreign currency. In both sub-sectors, firms decide on labour and capital inputs. Furthermore, there may be a natural resource sector, which uses (by assumption) capital only. The natural resource is entirely exported (exogenous demand from the rest of the world).

<u>The public sector</u> includes a pension fund, the central bank and possibly a SWF.

By assumption, the pension fund is balanced at each period. Its revenues come from a tax on labour and its transfers are uniformly distributed among retirees. The tax rate adjusts so as to provide to retirees a share of the current average wage received by the workers.

The central bank earns interest on its assets. As its investments are safer and more liquid than those of households (or of the SWF), we assume that the returns on central bank's assets are lower. The central bank makes transfers to households or to the SWF so as to keep its balance sheet constant.

Absent a SWF, oil revenues are transferred to households. Conversely, if a SWF exists, it is fed by current account surpluses, according to a defined rule. The SWF is assumed also to manage its assets according to the defined rule, consistent with empirical evidence (in the case of oil revenues, see Ossowski et al., 2008):

- A share of the SWF's assets is invested overseas. Returns are the same as those of optimizing households. SWF's investments overseas can furthermore bring some technological upgrading into the domestic economy, through technological transfers, consistently with some recent trends and with Lichtenberg and van Pottelsberghe de la Potterie (1996), who find that a country's outward FDI gives access to foreign technology,
- The other share is uniformly redistributed to households.

<u>The rest of the world</u> imports oil and manufactured products. We assume that the interest rate parity holds and that there is no rigidity on the capital market.

3.2. Monetary regime and real price rigidities

We assume that the central bank accumulates reserves so as to keep the real exchange rate constant. As a consequence, the relative price of the domestic good in terms of the foreign one is fixed.

We also assume that the wage rate is defined within the sector producing for the domestic market, under perfect competition. This wage applies also to the exporting sector. This implies that a non-zero profit can exist on the export market, if the price of the exported product exceeds the price of the domestic good: in this case, the wage is maintained low, in the spirit of Rodrik's description of the Chinese dual economy (Rodrik, 2008) and consistent with the large labour reserve in China. We assume that labour supply of constrained households adapts it-self in order to fit the labour demand, whereas optimizing households define their own labour supply by taking into account the wage rate.

3.3. Equations of the model

All nominal variables of the model are deflated by a numéraire which is the price of the imported good on the domestic market. Normalizing to 1 the price of the imported good in foreign currency, this amounts to deflating all variables by the nominal exchange rate E_t. We also assume that the rest of the world produces and consumes tradable goods only.[4]

The size of the total population, L_t, includes the size of populations of all age categories i :

$$L_t = \sum_{i=1}^{10} L_t^i \tag{1}$$

For each active age category i (between 1 and 9), we denote by $L_t^{opt,i}$ (respectively $L_t^{c,i}$) the numbers of optimizing (respectively constrained) households. Similarly, for the age category r of the retirees (r=10), $L_t^{opt,r}$ ($L_t^{c,r}$) is the number of optimizing (constrained) retirees. We have:

$$L_t^{opt,i} = \zeta . L_t^i \qquad L_t^{opt,r} = \zeta . L_t^r \tag{2}$$

$$L_t^{c,i} = (1-\zeta) . L_t^i \qquad L_t^{c,r} = (1-\zeta) . L_t^r \tag{3}$$

where ζ is the share of optimizing households ($0 < \zeta < 1$).

By denoting r_t the domestic real interest rate and r_t^* the world real interest rate, the real interest rate parity can be written (note that the variation of real exchange rate is implicit due to the deflator used):

$$1 + r_t = 1 + r_t^* . \tag{4}$$

We consider r_t^* exogenous.

__The households__

For each individual household j, lifetime utility is the expected discounted value of utility at each period over an infinite horizon. The utility function is additive in consumption and leisure:

$$U_t^j = \sum_{s>t} \beta^{s-t} [k \ln(C_s^j) + (1-k) \ln(\overline{H^j} - H_s^j)]$$

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[4] Or, alternatively, that the price of the non-tradable good in the rest of the world is equal to the price of tradable goods.

with β is the discount factor, k is a positive parameter representing the weight of consumption. $\overline{H}$ is exogenous labour endowment and H is the number of hours worked.

For each age category i, we define the following (endogenous) variables: $C_t^{opt,i}$ (respectively $C_t^{c,i}$) the consumption of a representative optimizing (respectively constrained) household, $H_t^{opt,i}$ (resp. $H_t^{c,i}$) is the number of hours of work supplied by a representative optimizing (respectively constrained) household, and B_t^i the real value of assets held by an optimizing household at the end of period t. We denote by p_t the consumer price index in terms of our numéraire (by construction, p_t is also the real exchange rate), and w_t the wage rate (both, again, expressed in terms of the foreign currency price of imports). Let's also denote by T_t and Ω_t the real value of the public transfers (except pensions) and of the pensions received, by τ_τ the tax rate raised to finance the pension fund, and by π_t the profit of the manufacturing sector.

The budget constraint of the representative household is:

<u>For optimizing households (proportion ζ):</u>

Active household of age i:[5]

$$p_t.C_t^{opt,i} + B_t^i = (1-\tau_t).w_t.H_t^{opt,i} + [1+r_{t-1}].B_{t-1}^{i-1} + \frac{\pi_t}{L_t} + \frac{T_t}{L_t} \qquad (5)$$

Retiree:

$$p_t.C_t^{opt,r} = \Omega_t + [1+r_{t-1}].B_{t-1}^{r-1} + \frac{\pi_t}{L_t} + \frac{T_t}{L_t} \qquad (6)^6$$

At the beginning of each period t, optimizing households decide their consumption and labour supply in order to maximize their inter-temporal utility function. The optimal consumption path (the Euler's condition) can now be written:[7]

$$\left[\beta(1+r_t).\frac{C_{t+1}^{opt,i+1}}{C_t^{opt,i}}.\frac{p_t}{p_{t+1}}\right] = 1 \qquad (7)$$

[5] Optimizing households are assumed to have no savings at the beginning of their life.

[6] Age category r-1 at t-1 in equation (6) represents the households which becomes retiree at t.

[7] i+1 is the age at time (t+1) following the age i at time t.

For a representative household within each age category i of optimizing households, the maximization of the utility function under budget constraint also leads to the consumption-leisure trade-off:

$$\frac{k}{1-k}.C_t^{opt,i} = \left((1-\tau_t).\frac{w_t}{p_t}\right).(\overline{H^i} - H_t^{opt,i}) \quad (8)$$

For constrained households (proportion 1-ζ):

Active household of age i:

$$p_t.C_t^{c,i} = (1-\tau_t)w_t.H_t^{c,i} + \frac{\pi_t}{L_t} + \frac{T_t}{L_t} \quad (9)$$

Retiree:

$$p_t.C_t^{c,r} = \Omega_t + \frac{\pi_t}{L_t} + \frac{T_t}{L_t} \quad (10)$$

As already mentioned, constrained households are supposed to have an elastic labour supply: their labour supply will fit the labour demand, whatever the real wage that is fixed due to the constant real exchange rate.

Aggregate consumption and trade:

The representative household can buy imported products, with a proportion χ. $C_t^{opt,i}$ (respectively $C_t^{c,i}$) is broken down between the consumption of domestic goods $C_{H,t}^{opt,i}$ and of imported goods $M_t^{opt,i}$ (respectively $C_{H,t}^{c,i}$ and $M_t^{c,i}$ for constrained households). Denoting by $p_{H,t}$ the price of the domestic good, and ξ the inverse of the elasticity of substitution between domestic consumption and imports, the consumer price index associated with the basket of consumer goods of households is then:[8]

$$p_t = \left[(1-\chi)p_{H,t}^{1-\xi} + \chi\right]^{\frac{1}{1-\xi}} \quad (11)$$

A constant real exchange rate regime then implies $p_t = cste$, or, equivalently, $p_{H,t} = cste$.

Households' consumptions can then be written, for each age i of households (constrained or optimizing):

[8] By construction, the deflated price of imports is 1.

$$C_{H,t}^{opt,i} = (1-\chi)\left(\frac{p_{H,t}}{p_t}\right)^{-\xi} C_t^{opt,i} \tag{12}$$

$$C_{H,t}^{c,i} = (1-\chi)\left(\frac{p_{H,t}}{p_t}\right)^{-\xi} C_t^{c,i} \tag{13}$$

$$M_t^{opt,i} = \chi\left(\frac{1}{p_t}\right)^{-\xi} C_t^{opt,i} \tag{14}$$

$$M_t^{c,i} = \chi\left(\frac{1}{p_t}\right)^{-\xi} C_t^{c,i} \tag{15}$$

Then, by defining aggregate consumption C_t, aggregate consumption of domestic goods $C_{H,t}$ and aggregate imports M_t, those are the weighted sums of the consumption levels of both types of households:

$$C_{H,t} = \sum_{i=1,\dots r}(L_t^{opt,i}.C_{H,t}^{opt,i} + L_t^{c,i}.C_{H,t}^{c,i}) \tag{16}$$

$$M_t = \sum_{i=1,\dots r}(L_t^{opt,i}.M_t^{opt,i} + L_t^{c,i}.M_t^{c,i}) \tag{17}$$

$$C_t = \sum_{i=1,\dots r}(L_t^{opt,i}.C_t^{opt,i} + L_t^{c,i}.C_t^{c,i}) \tag{18}$$

Finally, aggregate households' bonds holding, B_t, are also the weighted sums of the holdings of the generations of optimizing households:

$$B_t = \sum_{i=1,\dots r-1} L_t^{opt,i}.B_t^i \tag{19}$$

The productive sector

The two manufacturing sectors (producing either for the domestic market or for the exports) use the same production function (Cobb-Douglas type): $Y_{s,t} = TFP_t.(K_{s,t-1})^{1-\alpha}.(L_{s,t})^{\alpha}$, with $0 < \alpha < 1$, and where TFP_t is total factor productivity, for each manufacturing sector $s = H, X$; $K_{s,t-1}$ is the stock of capital at the beginning of period t, and $L_{s,t}$ is the employment in sector s during period t.

We assume that total factor productivity depends on the real value of assets of the SWF, denoted by A_t :[9]

$$TFP_t = f(A_{t-1}) = (1 + A_{t-1})^{\varepsilon}, \qquad \varepsilon \geq 0 \tag{20}$$

Absent a SWF, there is no technological progress. With a SWF, as a first step, we will consider $\varepsilon = 0$ and then that technological transfers apply ($\varepsilon > 0$).

Assuming complete depreciation in one period, we have: $K_{s,t} = I_{s,t}$, where $I_{s,t}$ is gross investment in sector s. We also assume that capital is entirely imported, at the price of foreign manufactured goods (hence normalized to 1 in our model).

We now describe the behaviour of the representative firm in each manufacturing sector ($s = H, X$), before turning to the oil sector which is assumed to be a pure rent sector.

(a) Domestic good sector:

At each period, the representative firm maximizes its profit, taking TFP_t, the real wage w_t and the real interest rate r_t as given.[10] This yields:

$$K_{H,t-1} = \frac{(1-\alpha).p_{H,t}.C_{H,t}}{1 + r_{t-1}} \tag{21}$$

$$L_{H,t} = \frac{\alpha.p_{H,t}.C_{H,t}}{w_t} \tag{22}$$

[9] See, for instance Keller (1998), Branstetter (2001).

[10] In order to produce at time t, a firm invests one period before, but hires employees at time t.

We assume that perfect competition applies on the domestic good market.[11] The following equation then links the real price, the real wage and the real interest rate:

$$p_{H,t} = \left[TFP_t.\alpha^{\alpha}.(1-\alpha)^{1-\alpha}\right]^{-1}.w_t^{\alpha}.(1+r_{t-1})^{1-\alpha} \qquad (23)$$

This equation determines the real wage, as r_{t-1} and $p_{H,t}$ are given and exogenous.

(b) Export manufacturing sector:

Exporting enterprises produce to fit the exogenous demand of the rest of the world, X_t (by construction, its price is 1). Profit maximization of exporting firms, under the constraints of existing world demand and of wages and interest rate leads to:

$$K_{X,t-1} = \left(\frac{1-\alpha}{\alpha}\right)^{\alpha}.\left(\frac{X_t}{TFP_t}\right).\left(\frac{w_t}{1+r_{t-1}}\right)^{\alpha} \qquad (24)$$

$$L_{X,t} = \left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}.\left(\frac{X_t}{TFP_t}\right).\left(\frac{1+r_{t-1}}{w_t}\right)^{1-\alpha} \qquad (25)$$

If the world price is above the domestic price of exports, then a profit appears in the exporting sector. The real profit within the manufacturing sector can then be written:

$$\pi_t = (1-p_{H,t}).X_t \qquad (26)$$

The total demand for labour then is:

$$\Lambda_t = L_{H,t} + L_{X,t} = \alpha\left(\frac{p_{H,t}C_{H,t} + X_t}{w_t}\right) \qquad (27)$$

The equilibrium on the labour market implies:

$$\Lambda_t = \sum_i H_t^{opt,i}.L_t^{opt,i} + H_t^{c,i}.L_t^{c,i} \qquad (28)$$

[11] Profit in the manufacturing sector producing for the domestic market is then nil.

(c) Oil sector:

If a natural resource sector exists, $Y_{o,t}$ is the exogenous export volume of the natural resource (say oil), $p_{o,t}$ its exogenous real price. At each period t, the oil sector uses capital $K_{p,t}$, to produce $Y_{0,t} = B.(K_{p,t-1})^{\gamma}$ with B and $\gamma > 0$. The capital used is then: $K_{p,t-1} = (Y_0/B)^{\frac{1}{\gamma}}$.

This yields total investment: $I_{t-1} = K_{t-1} = (Y_0/B)^{\frac{1}{\gamma}} + (1-\alpha).\dfrac{p_{H,t}C_{H,t} + X_t}{1+r_{t-1}}$ (29)

The public authorities: a pension fund, the Central Bank and possibly a SWF

The pension fund provides to retirees a share x of the current average labour income received by workers: $\overline{w}_t = w_t.\Lambda_t \Big/ \sum_{i \neq r} L_t^i$. Denoting by Ω_t the pension received by a household, the pension fund's equilibrium implies:

$L_t^r.\Omega_t = \tau_t.w_t.\sum_i (H_t^{opt,i} L_t^{opt,i} + H_t^{c,i} L_t^{c,i})$. This implies:

$$\tau_t = x.L_t^r \Big/ \sum_{i \neq r} L_t^i \quad (30)$$

$$\Omega_t = x.w_t.\sum_i (H_t^{opt,i} L_t^{opt,i} + H_t^{c,i} L_t^{c,i}) \Big/ \sum_{i \neq r} L_t^i \quad (31)$$

Transfers to households and SWF's assets:

We assume the returns on central bank assets to be lower than those of households and of the SWF by a factor μ : $1 + r_t^{cb} = (1 + r_t)/\mu$, $\mu > 1$

The central bank operates transfers, only to the SWF if it exists (which, in turn, may operate transfers to households), or only to households. Denoting RES_t the real value of foreign exchange reserves held by the central bank at the end of period t, the central bank makes transfers S_t to keep a constant balance sheet, corresponding to the real value of the seigniorage gains of the central bank:

$$S_t = \frac{1+r_{t-1}}{\mu}.RES_{t-1} - RES_{t-1}. \tag{32}$$

Households are also transferred the proceeds of oil exports. Absent a SWF, total transfers to households are:

$$T_t = S_t + p_{o,t}Y_{o,t} \tag{33a}$$

If there is a SWF, the latter receives S_t from the central bank and $p_{0,t}Y_{0,t}$ from oil exports. It transfers T_t to households so that the transfers from Central Bank to SWF are tt. In this case, SWF's assets are, with $0 \leq z_1, z_2 \leq 1$:

$$T_t = z_1.(1+r_{t-1}).A_{t-1} + z_2.p_{o,t}.Y_{o,t} \tag{33b}$$

where A_{t-1} is the real value of the SWF's assets at the end of period t-1, and z_1, z_2 two positive parameters. The accumulation of assets by the SWF is then:

$$A_t = (1-z_1).(1+r_{t-1}).A_{t-1} + (1-z_2).p_{0,t}Y_{0,t} + S_t \tag{34b}$$

Other equations

Investment being imported and its price being 1, the real value of GDP, Y_t, can be written:

$$Y_t = p_tC_t + X_t + p_{o,t}Y_{o,t} - M_t \tag{35}$$

The equation of the balance of payments is written:

$$A_t + B_t + RES_t = (1+r_{t-1}).(A_{t-1} + B_{t-1}) + \frac{1+r_{t-1}}{\mu}RES_{t-1} + p_{0,t}Y_{0,t} + X_t - M_t - I_t \tag{36}$$

The central bank sets RES so that the real exchange rate stays constant.

3.4. Calibration

The calibration of the model is based on relevant economic features of China and Russia (see Table 1), as well as standard parameters used in the literature (see Table 2).

A first set of parameters are calibrated so as to reproduce relevant macroeconomic ratios for Russia and China, without the shocks modeled. The ratios considered are a mix between the situation of China (in particular, relatively large manufactured exports) and of Russia (in particular, large oil exports, relatively higher consumption than in China). We focus on reproducing their openness ratios, as well as the sizes of their exports of manufactured products and oil, imports and consumption (as % of GDP). Furthermore, we reproduce the accumulation of their foreign exchange assets that occurred in the 2000 decade.

Table 1: Main Relevant Aggregates for China, Russia and the domestic economy
(proxies, 2000s decade or last available year)

	China	Russia	Value*
Exports of manufactured products (% of GDP)	31%	14%	27%
Net oil exports (% of GDP)	-	20%	11%
Imports of goods (% of GDP)	26%	22%	25%
Final consumption expenditures (% of GDP)	54%	67%	59%
Share of imported goods in consumption (χ)	49%	33%	40%
Accumulation of foreign exchange reserves per period of 5 years (% of GDP)**	11%	7%	7.5%
Share of labour in income, excluding oil (α)	40%	40%	40%
Pension entitlement (% of current average labour income) (x)	60%***	50%	50%

* For export, import and consumption proxies, the GDP was re-inflated with investment expenditures in order to fit with the assumption of imported investment.
** Proxies for foreign exchange reserves accumulation in the 1990s and until 2005.
*** For urban workers.
Sources: World Bank Indicators (2011); author; (α): National Accounts; China: Wang and Wei (2004); Russia: Kubinowa (2011); (x): OECD (2011); China: for urban workers.

A second set of parameters are calibrated based on the literature, e.g. rate of time preference, share of optimizing and constrained households, and various elasticities of the model.

Table 2: Calibration of the Base Model Parameters and Exogenous Variables

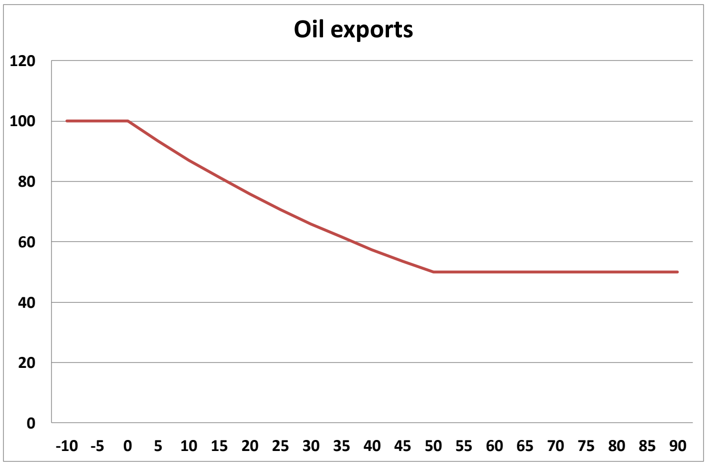
Parameter description	Name	Value	Source
The households' choices			
Rate of time preference (annualized)	β	0.99	Real business cycle literature, starting with Kydland and Prescott (1982)
Share of optimizing households	ζ	50%	See for instance IMF (2009) for emerging Asia
Coefficient of consumption in the utility function	κ	0.8	Author
The household's consumption			
Inverse of the elasticity of substitution between domestic and foreign goods	ξ	0.75	Between 0.5 and 2; see for instance Obstfeld and Rogoff (2005) ; Bénassy-Quéré et al. (2010)
The oil sector			
Output elasticity of capital	γ	0.6	Author
The public sector			
Share of SWF's assets redistributed to households (per period of 5 years)	z_1	34%	Author
Share of oil revenues directly distributed to the households	z_2	30%	Author; Ossowski et al. (2008)
Factor reflecting the lower returns of Central Bank's investments	μ	1.015	Hypotheses on annualised real returns over a period (5 years): bonds: 1.5%; riskier assets: 3%
Exogenous variables	Name	Value	Source
Foreign real interest rate	$r*$	0.03	Based on past world real growth rates World Development Indicators (2011)

4. The impact of deterministic shocks on the domestic economy, with or without a SWF

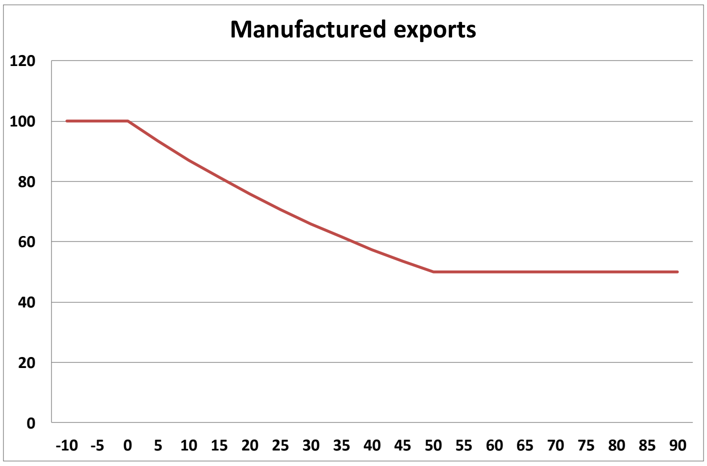
We now compare the impact of negative shocks, with or without a SWF.[12] The shock is large and permanent, and occurs progressively (as shown in figure 1 below). It may concern, respectively, oil exports (waning of resource rent), manufactured exports (decrease in world demand) and ageing.

Figure 1: The three types of shocks modelled

- a. the waning of resource rent: exported oil divided by 2 in 50 years

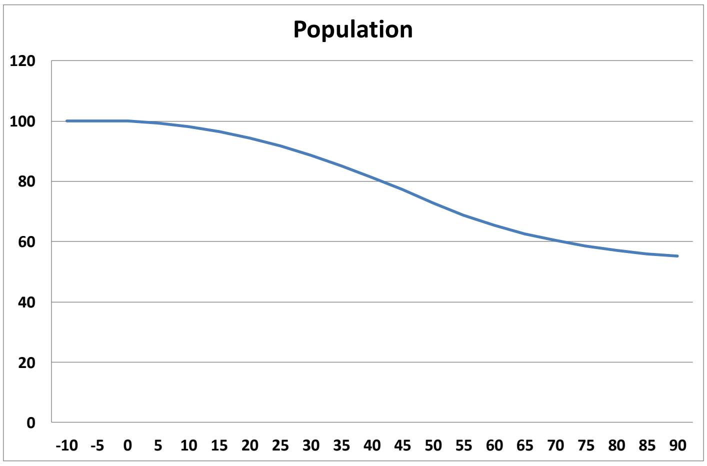


- b. the decrease in world demand: exported goods divided by 2 in 50 years



[12] The simulations are generated by the Dynare-Matlab software (Juillard, 1996).

- c. the ageing process: nativity divided by 2 in 50 years



Note : Values at 100 before the beginning of the decline
Source : Author.

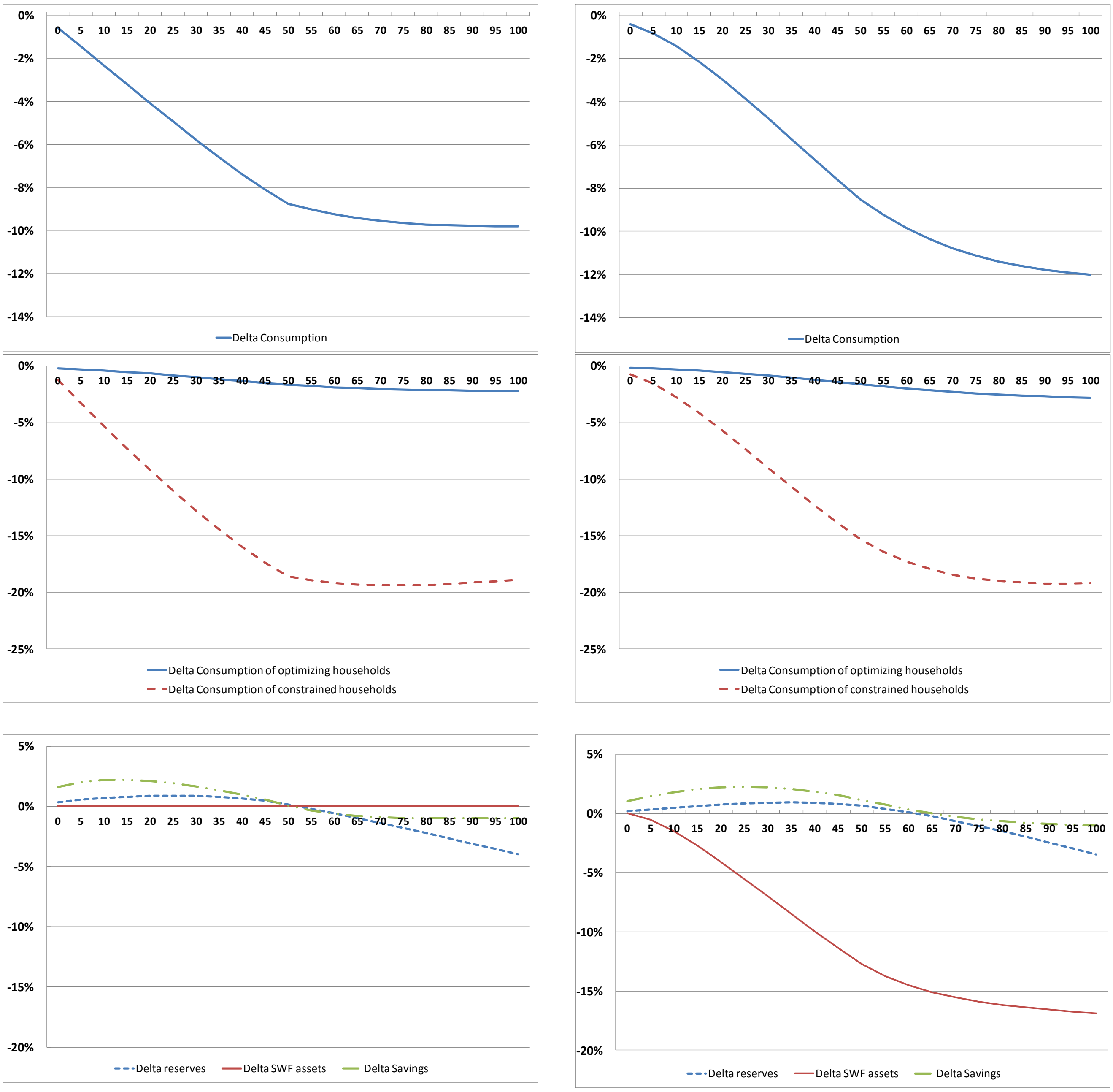
We compare the cases with or without SWF based on the impulse-response functions (IRFs). The IRFs are reported in Figures below. In the three first sub-sections, they do not take into account the possible productivity increases associated with SWF's investments. In the fourth sub-section, we briefly present the case of a shock on manufactured exports with productivity increases associated with SWF's investments.

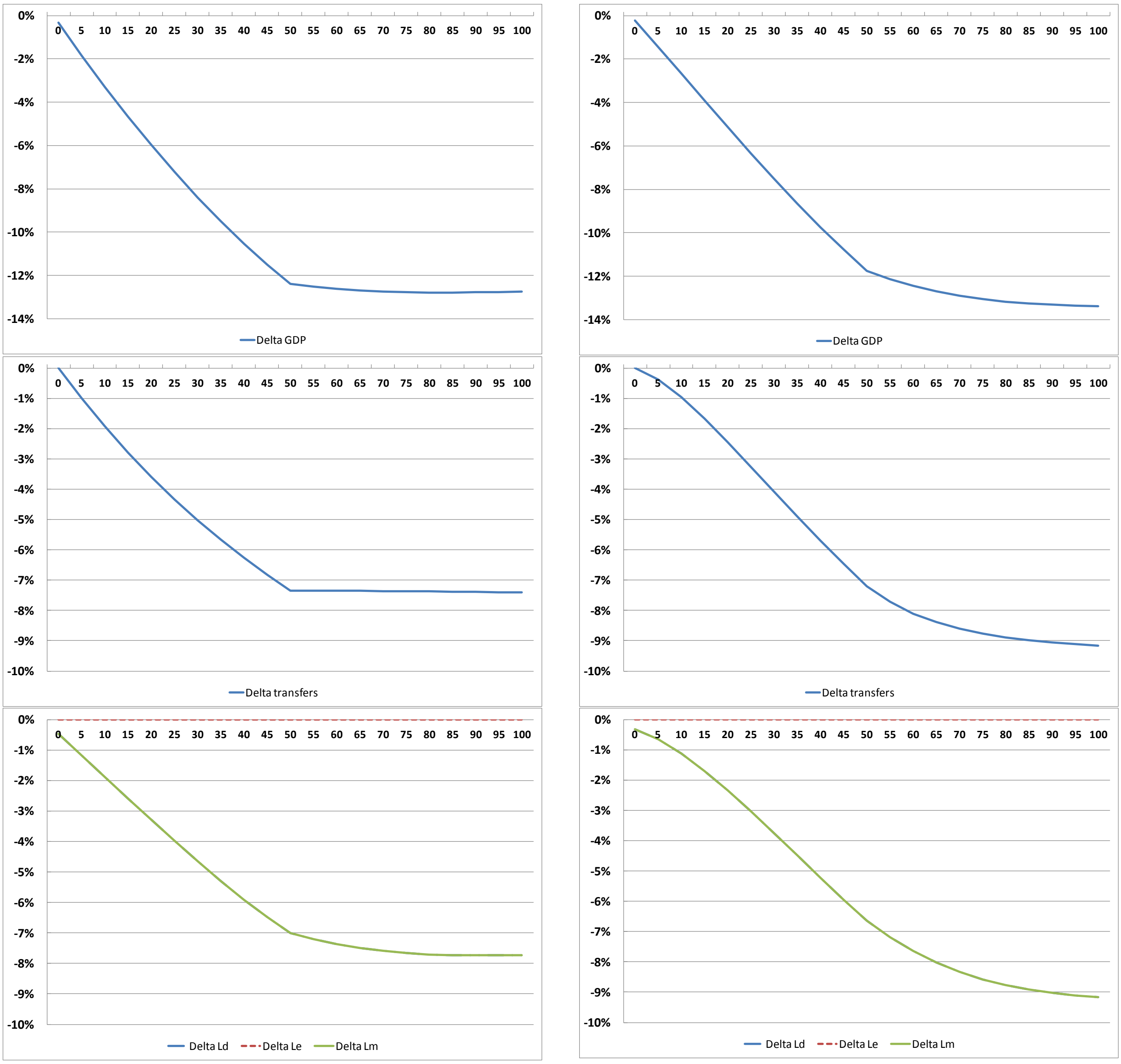
4.1. *The waning of resource rent*

Relative change compared to baseline

% of GDP without shock or % of employment without shock

Without SWF | With SWF





Notes: transfers denote the public transfers, savings the household's savings, reserves the central bank's reserves, Le the employment in the exporting manufactured sector and Lm total employment.

The IRFs representing delta Ld and delta Lm are the same, as employment in the export manufacturing sector is not affected.

In the aftermath of the decline of oil rents, consumption, GDP, public transfers to households and employment in the domestic sector decrease continuously. Constrained households are particularly affected: whereas optimizing households increase their labour supply (and their savings) to maintain a relatively constant level of consumption over time, constrained households face the losses in total employment levels (amplified by the fact that optimizing households work more), together with the losses in transfers they receive. As a result, their consumption is much more severely affected than optimizing households' consumption.

The SWF allows smoothing the relative consumption and GDP losses, and limiting the relative losses in the short term, in particular for the constrained households. However, on the longer term, depending on the amplitude of the oil shock, the relative losses (compared to the steady state levels) can be higher in the case with a SWF than without.[13] Indeed, as the SWF's resources come (in part) directly from oil revenues, these are directly affected by a severe oil shock (conversely, the central bank's reserves are little affected). In turn, in the long term, this may lead to deeper losses of transfers to households. Nevertheless, we will see in the next sections that inter-temporal welfare losses are relatively lower (as compared with the steady state levels) with a SWF than without, thanks in particular to the gains in the short term.

In the same line, whereas employment losses are limited in the short term, they may suffer relatively more with a SWF than without in the longer term: indeed, the relatively higher losses of revenues (with a SWF than without) imply that households limit their consumption to a bigger extent, and hence in particular their demand for domestically produced goods. As a result, employment in the domestic good sector may show larger relative decreases.

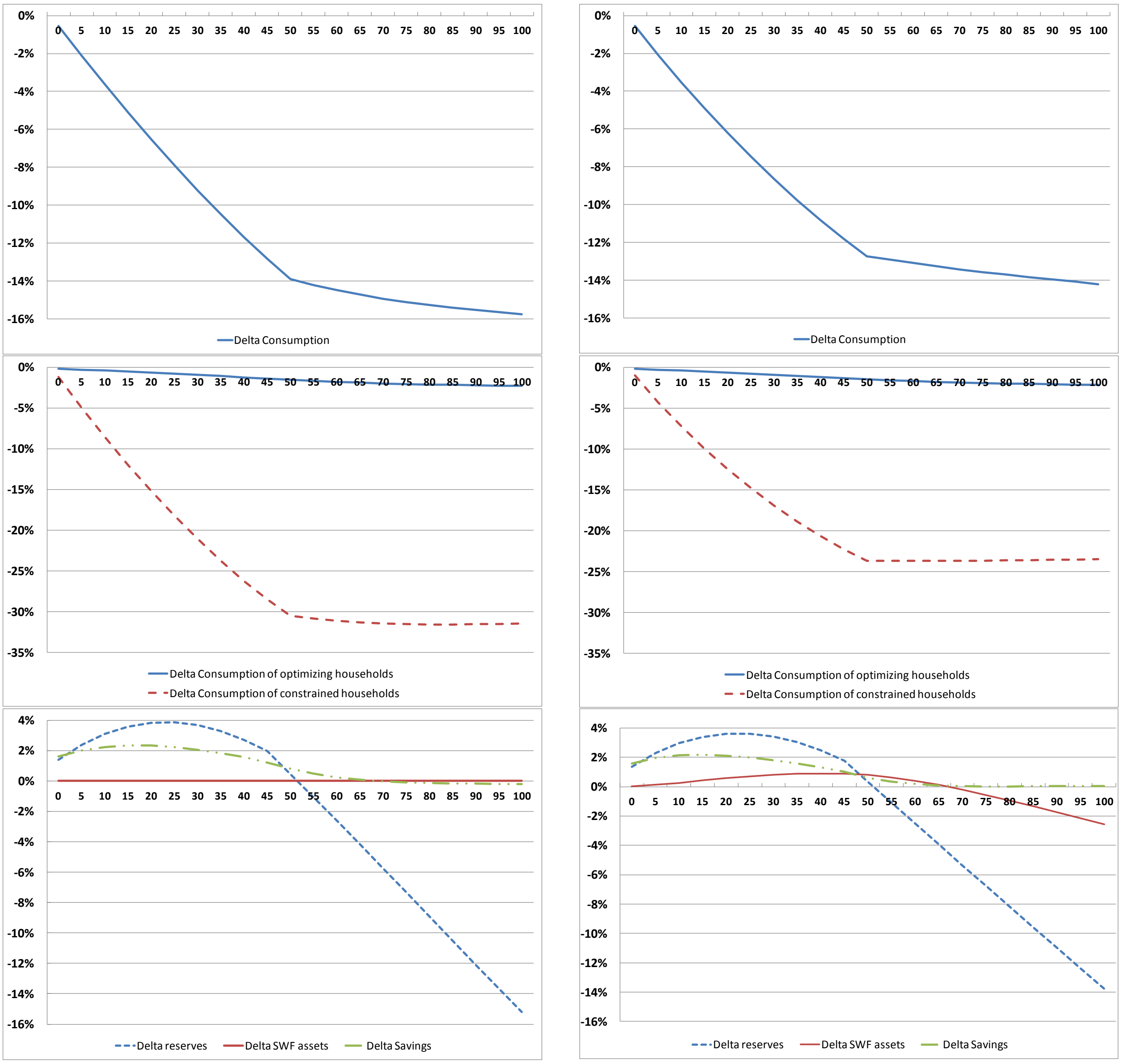
[13] whereas the levels of consumption and GDP remain higher with a SWF than without. This comes from the fact that, in case of resource rents, a SWF can significantly improve consumption and GDP.

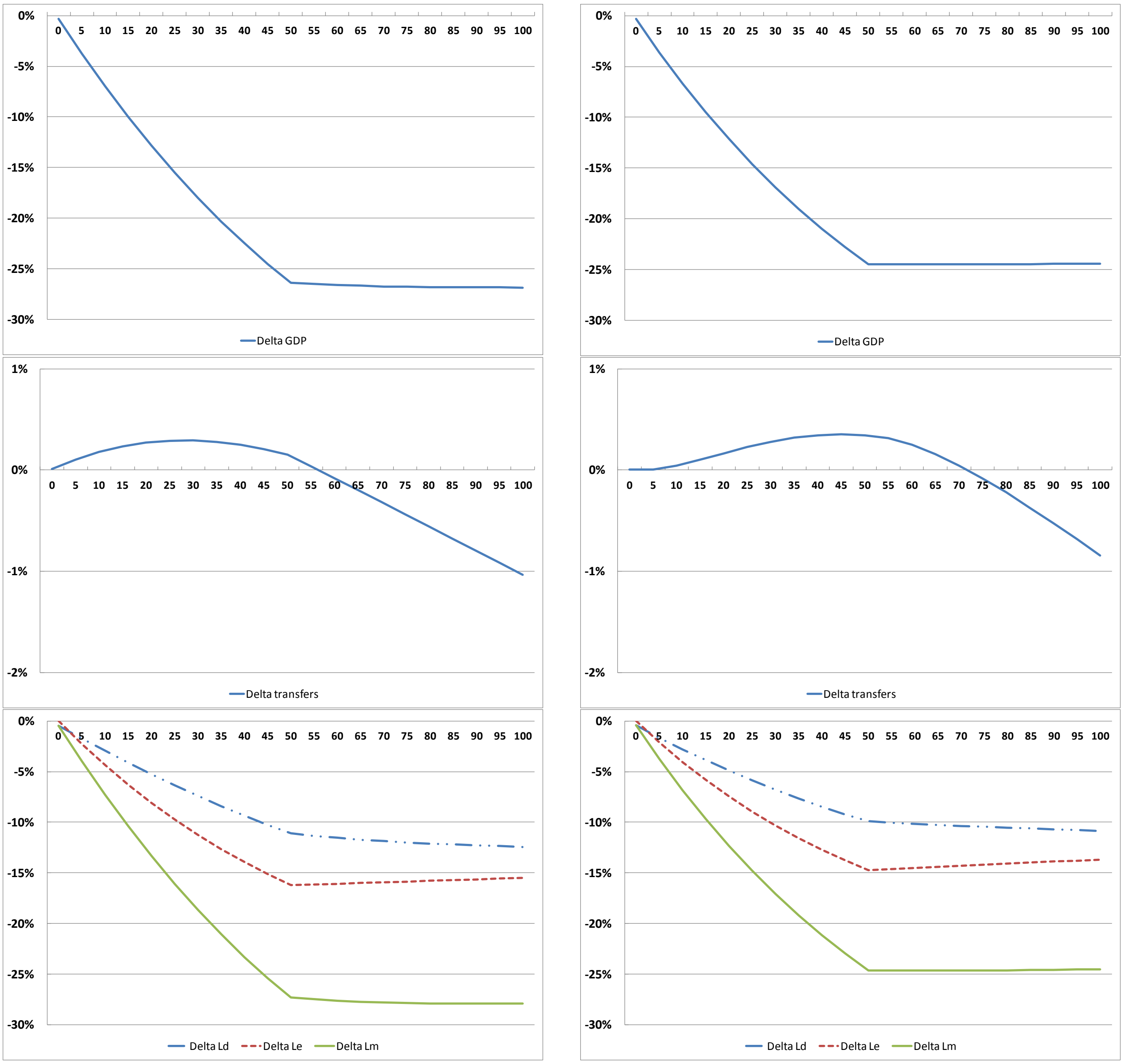
4.2. The waning of export-led model of growth

Relative change compared to baseline

% of GDP without shock or % of employment without shock

Without SWF | With SWF





Notes: transfers denote the public transfers, savings the household's savings, reserves the central bank's reserves, Le the employment in the exporting manufactured sector and Lm total employment.

In the absence of shock, central bank's reserves are increasing, due to current account surpluses and the fixed real exchange rate regime. Negative values of delta reserves do not necessarily mean that central bank's reserves are decreasing, but that reserves accumulation is lower than without shock.

Both public and private savings increase first, and then decline.[14] Public transfers to households follow the same path, so that this first limits the losses of revenues for households. Employment in the exporting sector is directly affected by the shock. The associated losses of revenues imply that consumption decreases, so that employment in the domestic sector also decreases. GDP is continuously affected during the shock, and then stabilizes at lower values.

Thanks to higher returns (than the central bank) and its role of reallocation to constrained households, a SWF allows limiting relative losses in terms of GDP and consumption. Since profits realized in the export manufactured sector are directly redistributed to households, the SWF's resources are not (directly) affected by the shock. Hence it acts as a buffer.

Along the same line, relative employment losses are slightly more limited with a SWF, because of higher returns on SWF assets.[15] In brief, this means that a SWF can allow supporting households' revenues (in particular for constrained households), hence consumption, in the long term, and in turn, employment in the domestic good sector. Interestingly, this reallocation effect differs from the case of a shock on oil exports.

[14] In a first time, optimizing households increase their savings in order to limit their loss of consumption, whereas central bank's reserves also increase, because imports of manufactured goods and investment decrease in higher proportions than the decrease in exports, leading to increased asset accumulation in order to maintain the real exchange rate constant (see the equation of the balance of payments). When the shock is over, lower export values lead to lower reserves accumulation.

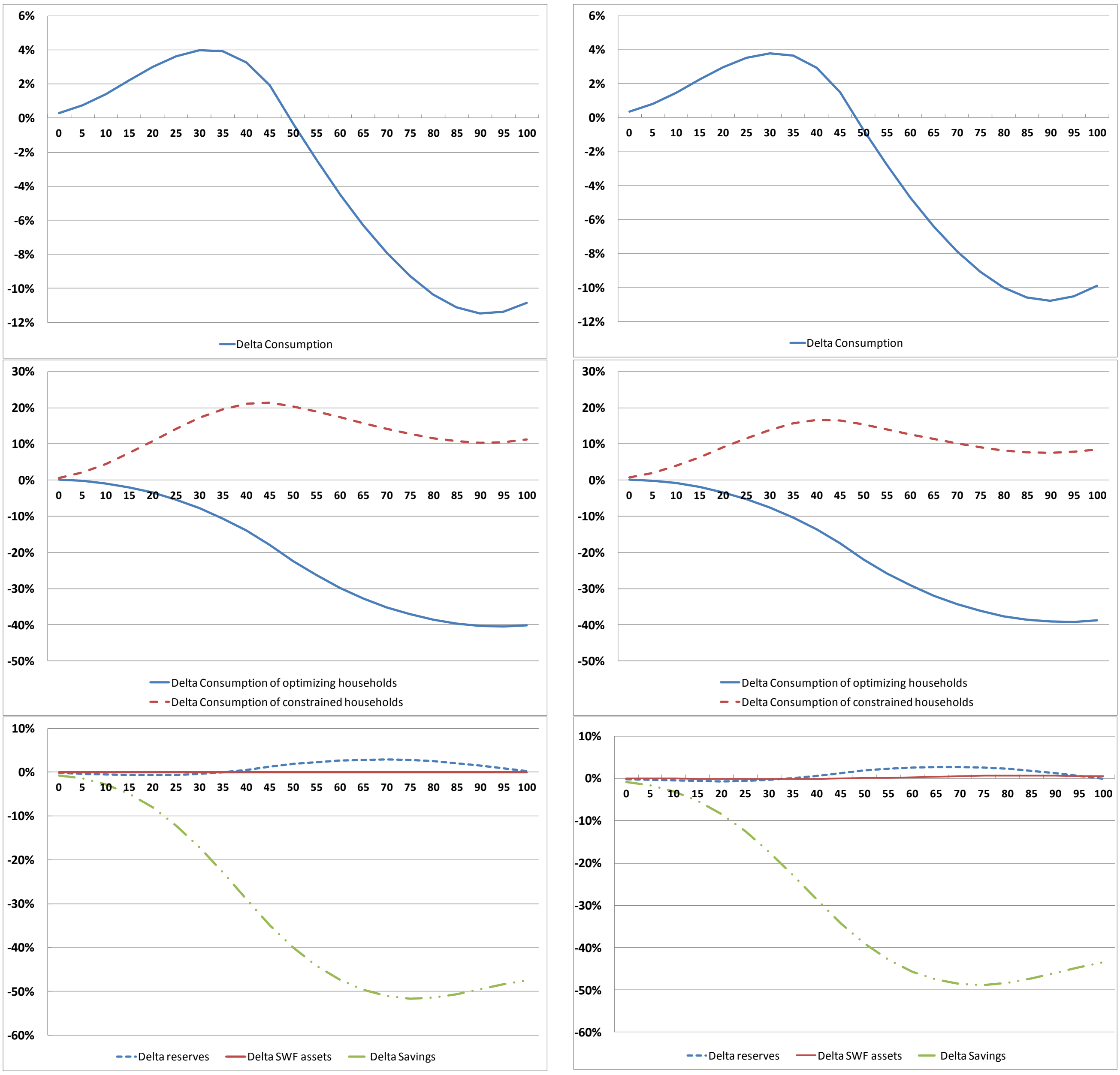
[15] Furthermore, employment levels in absolute terms are somewhat higher with a SWF than without (thanks, similarly to the explanation given in the paragraph, to higher returns and support of household's revenues, hence, consumption). This also leads to lower relative losses in the presence of a SWF.

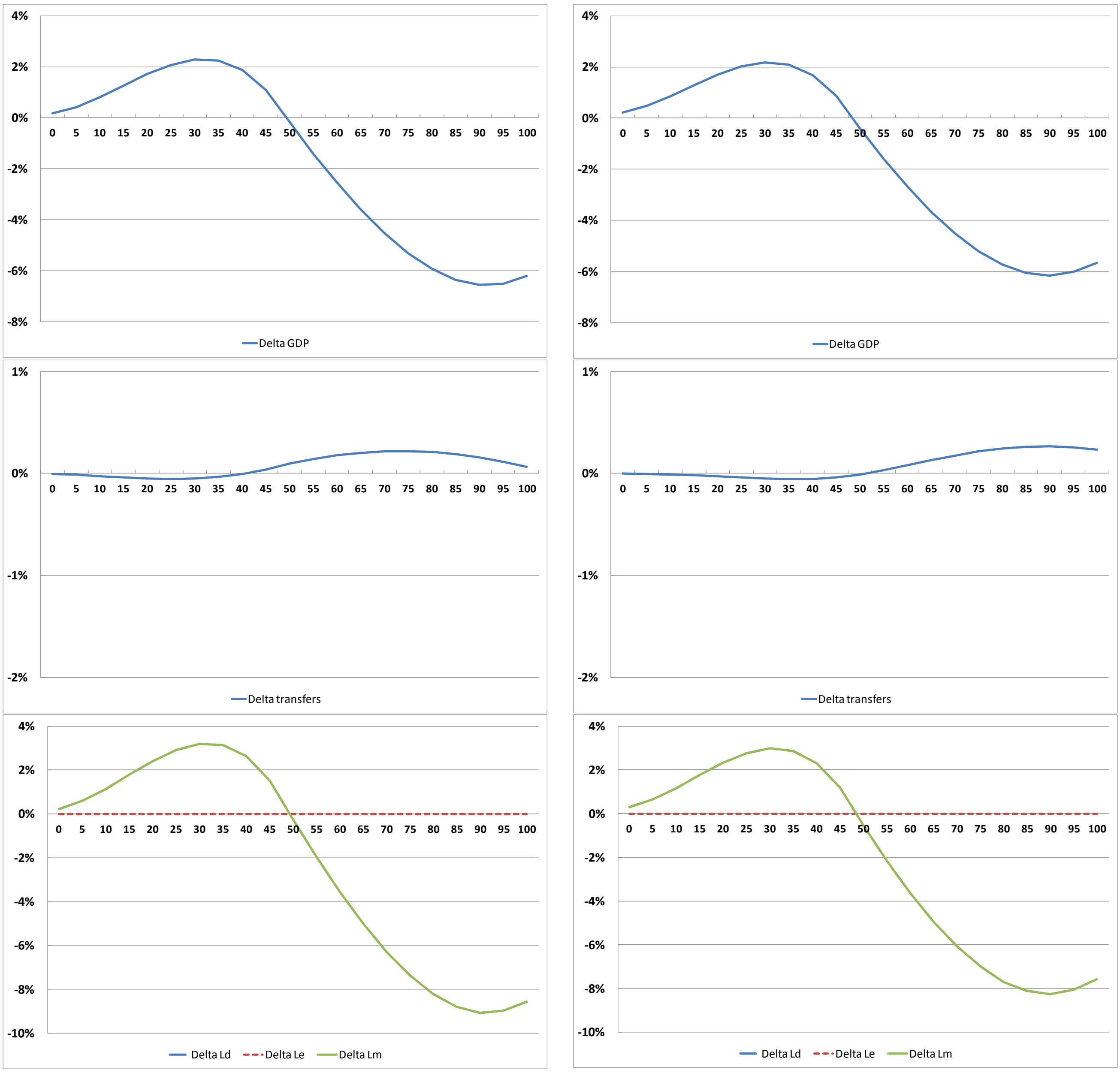
4.3. The ageing process

Relative change compared to baseline

% of GDP without shock or % of employment without shock

Without SWF | With SWF





Notes: transfers denote the public transfers, savings the household's savings, reserves the central bank's reserves, Le the employment in the exporting manufactured sector and Lm total employment.

The IRFs representing delta Ld and delta Lm are the same, as employment in the export manufacturing sector is not affected.

Relatively curiously, consumption, GDP and employment first slightly increase, and then decrease. These increases in the short run are the results of higher labour supply and consumption of constrained households (despite the decrease in numbers of active households), whereas consumption and labour supply of optimizing households decrease.

In the shock modelled, exports remain constant and act as a buffer. Firstly, whereas the labour force declines, employment in the export manufacturing sector remains at similar levels, supporting the individual labour supply of active constrained households, and hence their labour income. In turn, this supports consumption, and employment in the domestic good sector. Secondly, total profit in the exporting goods sector remains the same. As population decreases, the profit distributed to an individual household increases, which supports individual consumption and employment. Thirdly, in a first time, total employment increases whereas labour force decreases, contributing to increased average wage. This leads to higher pensions provided to retirees, supporting also consumption and employment.

Then, labour supply of both types of households decreases, leading to lower total employment levels. Compared with initial levels (without shock), labour supply (and consumption) of constrained households remain higher, whereas labour supply (and consumption) of optimizing households is much lower, leading to lower aggregates. Households' savings decrease from the beginning of the shock and then stabilize when the shock is over.

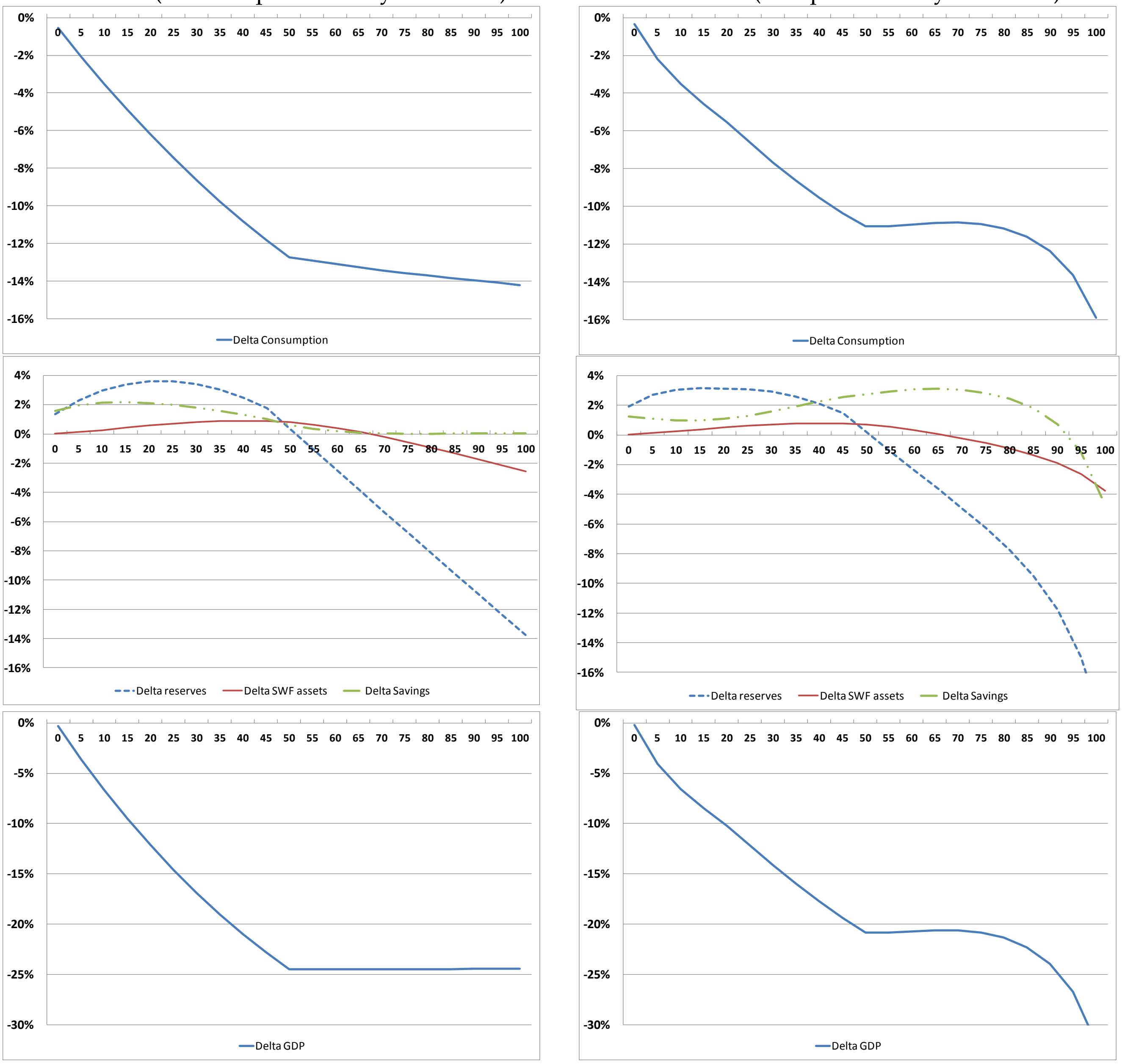
Over the long term, the SWF allows limiting consumption, GDP and employment losses, by supporting the level of public transfers to households. The decrease (respectively increase) in optimizing (respectively constrained) households' consumption and labour supply are more limited with a SWF than without.

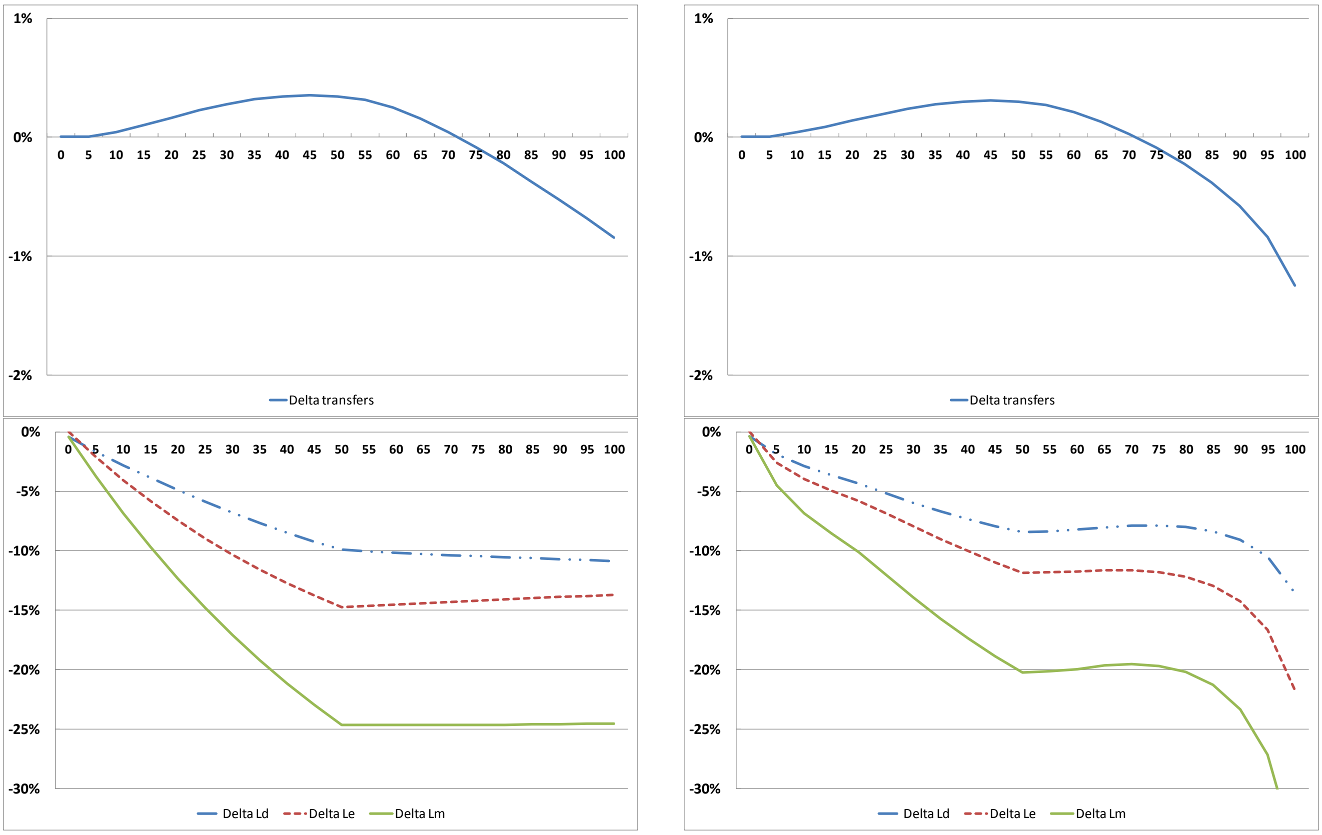
4.4. The waning of export-led model of growth: the impact of productivity increases

Relative change compared to baseline

% of GDP without shock or % of employment without shock

With SWF (without productivity increases) | With SWF (and productivity increases)





Note: transfers denote the public transfers, savings the household's savings, reserves the central bank's reserves, Le the employment in the exporting manufactured sector and Lm total employment.

In the absence of shock, central bank's reserves are increasing, due to current account surpluses and the fixed real exchange rate regime. Negative values of delta reserves do not necessarily mean that central bank's reserves are decreasing, but that reserves accumulation is lower than without shock.

We briefly present the possible implications of productivity increases associated with SWF's investments, by analysing the case of a shock on manufactured exports.

On one side (as shown in the first 50 years after the beginning of the shock), productivity increases may further limit the losses in GDP and consumption, because, for a given real exchange rate, the higher the total factor productivity is, the higher the wages are (see equation 23). Indeed, as consumption losses are limited, employment losses can also appear lower with productivity increases than without.

On the other side, when productivity increases become high (as shown in the 50 years following the end of the shock, as the accumulation of assets in the SWF continues, leading to higher total factor productivity), they can lead to further lower labour demand, and possibly to lower labour income (in particular for constrained households), unless real exchange rate (hence real wages) are set at a higher levels. In turn, consumption and GDP may show deeper losses than without productivity increases. These balanced effects raise the question of the adequate level of real exchange rate and wages.

5. Welfare analysis under observed past shocks

In order to compare the cases with and without a SWF, we compute the conditional expected welfare at time zero. For given monetary and fiscal (stabilization fund) policy rules P and for a given shock σ, welfare W_P^{σ} is defined as:

$$W_P^{\sigma} = \sum_{s>0} \beta^{s-t}[k\ln(C_s) + (1-k)\ln(\overline{\Lambda_s} - \Lambda_s)], \text{ where } \overline{\Lambda_s} = \sum_{i=1}^{10} \overline{H^i}.L_s^i$$

Let also W_0 be the welfare level in an economy facing no shocks, and ΔW_P^{σ} is the welfare variation compared to the situation without shock:

$$\Delta W_P^{\sigma} = W_P^{\sigma} - W_0$$

In the absence of shock, W_0 depends on the existence of a SWF. A SWF can significantly improve the welfare. By showing higher returns than central bank's assets, it changes the economic behaviors by providing to households higher revenues and supporting their consumption. This is particularly accurate for constrained households.

This improvement in welfare may be strengthened if there are technology upgrading associated with SWFs' investments. Indeed, firstly, as shown, this can support consumption, and secondly, for given production levels, households can work less, increasing their leisure. However, these effects may be offset by the possible implied losses of revenue, as high increases in total factor productivity may lead to lower the demand for employment, hence labour income, unless the real exchange rate (hence the real wage) is set at a higher level (see part 4.4 above).[16]

When considering respectively the three cases of shocks studied and the cases without SWF, with a SWF and with a SWF and technology upgrading, the IRFs lead to the following results:

[16] Since the exports are exogenous in the model, this however does not take into account possible losses of market shares because of real exchange rate appreciations, or, conversely, possible gains in market shares linked with specialization in higher value added exports.

Table 3: welfare losses in cases of different shocks

Without SWF

	Shock of oil exports	Shock of manuf export	Shock of ageing
ΔW_P^σ	-1.4	-2.4	-2.5
$\Delta W_P^\sigma / W_0$	-2.1%	-3.5%	-3.6%

With SWF

	Shock of oil exports	Shock of manuf export	Shock of ageing
ΔW_P^σ	-1.5	-2.0	-2.4
$\Delta W_P^\sigma / W_0$	-2.0%	-2.8%	-3.3%

With SWF and productivity gains*

	Shock of oil exports	Shock of manuf export	Shock of ageing
ΔW_P^σ	-1.3	-2.1	-1.7
$\Delta W_P^\sigma / W_0$	-1.9%	-3.2%	-2.6%

* in the spirit of Keller (2008) and Branstetter (2001), we set ε=0.15
Source: author's calculation based on IRF.

In the case of shocks, relative welfare losses (compared with welfare at the steady state level) are lower with a SWF than without, because of smoothing and higher returns than central bank's assets. The absolute welfare losses can be relatively high, in particular in the case of a shock on oil exports, since the SWFs' resources are directly affected.[17] The welfare levels with a SWF remains nevertheless above the welfare that would have occurred without SWF.

It can be noticed that the resilience to shocks allowed by a SWF, as measured by the difference between the relative welfare losses with a SWF and without SWF, appears here higher in the case of a shock on manufactured exports (0.7%) than in the case of a shock on oil exports (0.1%). This is in part due to the higher part of manufactured exports (hence the deepness of the shock, leading to relatively higher general losses), and to the mode of allocation of profits and surpluses (e.g., the profits are directly redistributed to households, whereas part of the oil revenues go through the SWF first, if it exists).

[17] Absolute welfare losses in the face of an oil shock can even higher with a SWF than without, because the welfare gains of having a SWF were high at the steady state.

6. Concluding remarks

In this paper, we simulate shocks that countries such as China and Russia may face in the future. We have built a general equilibrium, overlapping generations' model calibrated on the cases of China and Russia to assess the impact of the progressive waning of export-led model of growth, of natural resources rents, and the ageing process. We evaluate how the existence of a SWF under a fixed real exchange rate regime modifies the response of the economy to these shocks. To do so, we study the impulse-response functions. We find that a SWF can help improving resilience against shocks. However, the degree of resilience depends on the nature of the shock. In economies facing future end of rents, in the long term, the losses relative to the steady state levels can in some cases be slightly higher with a SWF, whereas losses are limited and smoothed in the short term. This is explained by the fact that the SWF's revenues may be directly affected by the shock, whereas the SWF can be particularly helpful to increase levels of production, consumption, employment and welfare at the steady state. In such cases, and if real wages and real exchange rate are not too low, technology upgrading associated with SWF's investments may be helpful to mitigate these effects. Conversely, in the case of a shock on manufactured exports, the SWF is not directly affected, and the resilience allowed is significantly higher, with lower losses in GDP, employment and consumption, both in the short term and in the long term.

Appendix. Sensitivity analysis

Among the parameters of the model, some are important since their values can greatly affect the steady state and the IRFs of the economy: the share of optimizing households, the world interest rate, the preference for imports χ, the elasticity of substitution between domestic and imported goods ξ^{-1}, and the parameters of the SWF, z_1 and z_2. In this appendix, we first describe how the levels of GDP, consumption (as a % of GDP), employment and welfare are modified at the steady state when these parameters vary around the calibrated values, in a fixed real exchange rate regime, with SWF (but without productivity increases associated with SWFs' investments). We then present how relative losses (relative to the steady state) are modified by the variations of the parameters around the calibrated values, in the face of each type of shock, without and with SWF.

Sensitivity of the quasi-steady state

We first present how the quasi-steady state's values of GDP, consumption, employment and welfare are modified by parameters' variations (see Table A1).

Strikingly, GDP and employment can be significantly affected by variations in real interest rate and preference for imports. In particular, the higher the real interest rate (e.g. 4% instead of 3%), the higher the GDP at steady state is, because more revenues are generated on assets. This also leads to significantly higher consumption levels, and hence to higher employment levels (in order to produce goods that will be consumed). Conversely, the higher the preference for imports is, the lower the GDP at steady state is, because households spend a more important part of their revenues for imported goods. This also leads to lower employment levels (because the domestic good sector has less market shares).

The other variations are much more limited. Interestingly, the higher the proportion of optimizing households is (e.g. 60% instead of 50%), the higher the steady state values of GDP, consumption (as a % GDP), employment and welfare are.

Table A1: Sensitivity analysis of the steady state - percentage change compared to baseline

Variation of ζ (share of optimizing households - initially 50%)

	GDP	Consumption to GDP	Employment	W_0
60%	3.1%	2.8%	4.2%	1.2%
40%	-3.1%	-2.9%	-4.2%	-1.3%

Variation of r (real interest rate - initially 3%)

	GDP	Consumption to GDP	Employment	W_0
4%	35.1%	21.9%	50.5%	1.2%
2%	-17.3%	-18.1%	-25.3%	-1.3%

Variation of χ (preference for imports - initially 0.4)

	GDP	Consumption to GDP	Employment	W_0
0.5	-12.4%	0.6%	-17.0%	1.2%
0.3	14.9%	-0.5%	20.5%	-1.3%

Variation of ξ (inverse of elasticity of substitution between domestic goods and imports, initially 0.75)

	GDP	Consumption to GDP	Employment	W_0
0.9	2.3%	-0.5%	3.1%	1.2%
0.6	-2.2%	0.5%	-3.1%	-1.3%

Variation of k (coefficient of consumption in the utility function – initially 0.8)

	GDP	Consumption to GDP	Employment	W_0
0.9	-1.1%	-1.0%	-1.5%	1.2%
0.7	1.1%	1.0%	1.4%	-1.3%

Variation of γ (output elasticity of capital in the oil sector – initially 0.6)

	GDP	Consumption to GDP	Employment	W_0
0.7	0.0%	0.0%	0.0%	1.2%
0.5	0.0%	0.0%	0.0%	-1.3%

Variation of z_1 (% of SWF's assets redistributed to households per period of 5 years, initially 34%)

	GDP	Consumption to GDP	Employment	W_0
40%	-1.4%	-1.3%	-1.9%	1.2%
30%	1.4%	1.2%	1.9%	-1.3%

Variation of z_2 (% of oil revenues directly distributed to households - initially 40%)

	GDP	Consumption to GDP	Employment	W_0
50%	-0.7%	-0.7%	-1.0%	1.2%
30%	0.7%	0.7%	1.0%	-1.3%

Note: average variations over 100 years.
Source: Author's calculation.

Sensitivity of relative welfare losses in the face of shocks

We now turn to the sensitivity of relative welfare losses, in the case of shock, respectively on oil exports, on manufactured exports and on ageing (see Table A2).

Table A2: Sensitivity analysis of the relative welfare losses in case of shock

Parameter changed	New parameter's value	Existence of a SWF	Shock of oil exports	Shock of manuf export	Shock of ageing
Base model	-	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.8%	-3.3%
Variation of ζ (share of optimizing households - initially 50%)	60%	Without SWF	-1.9%	-3.2%	-3.7%
		With SWF	-1.9%	-2.6%	-3.4%
	40%	Without SWF	-2.2%	-3.8%	-3.4%
		With SWF	-2.2%	-3.0%	-3.2%
Variation of r (real interest rate - initially 3%)	4%	Without SWF	-1.2%	- .1%	-3.8%
		With SWF	-1.1%	-1.4%	-3.5%
	2%	Without SWF	-3.3%	-5.5%	-3.1%
		With SWF	-3.3%	-4.9%	-3.0%
Variation of χ (preference for imports - initially 0.4)	0.5	Without SWF	-2.2%	-3.7%	-3.7%
		With SWF	-2.2%	-3.0%	-3.3%
	0.3	Without SWF	-1.9%	-3.2%	-3.5%
		With SWF	-1.8%	-2.6%	-3.2%
Variation of ξ (inverse of elasticity of substitution between domestic goods and imports, initially 0.75)	0.9	Without SWF	-2.0%	-3.4%	-3.5%
		With SWF	-2.0%	-2.8%	-3.3%
	0.6	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	2.0%	-2.8%	-3.3%
Variation of k (coefficient of consumption in the utility function – initially 0.8)	0.9	Without SWF	-2.1%	-3.6%	-3.5%
		With SWF	-2.1%	-2.9%	-3.2%
	0.7	Without SWF	-2.0%	-3.4%	-3.6%
		With SWF	-2.0%	-2.7%	-3.3%
Variation of γ (output elasticity of capital in the oil sector – initially 0.6)	0.7	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.8%	-3.3%
	0.5	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.8%	-3.3%
Variation of z_1 (% of SWF's assets redistributed to households per period of 5 years, initially 34%)	40%	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.9%	-3.3%
	30%	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.7%	-3.2%
Variation of z_2 (% of oil revenues directly distributed to households - initially 40%)	50%	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.8%	-3.3%
	30%	Without SWF	-2.1%	-3.5%	-3.6%
		With SWF	-2.0%	-2.7%	-3.3%

Note: Statistics show $\Delta W_P^{\sigma} / W_0$ in each reported case; productivity gains associated with SWFs' investments are not taken into account.
Source: Author's calculation.

On the whole, the relative welfare losses appear stable, as welfare levels are modified by parameters' variations in similar proportions at the steady state and in the case of defined shocks. Interestingly, the higher the share of optimizing households is, the lower the relative losses are in the case of oil or manufactured exports shocks. The same conclusion appears for the real exchange rate, which has significant effects.[18] Conversely, the higher the preference for imports is, the lower the relative welfare losses are in the case of oil or manufactured exports shocks. The variations of other parameters around the calibrated values imply fewer variations in relative welfare losses.

[18] It can be noted that the resilience allowed by a SWF (as measured, for a given shock, by difference in relative welfare losses between the case with a SWF and the case without SWF), is weaker when the real interest rate is lower: with lower returns, the SWF has less impact.

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