1 Data appendix

1.1 Benchmark estimations

Tables 1 and 2 show estimation results for equation (2) in the paper.

Table 1: Estimation results of main variables, benchmark specification

	(1) spreads	(2) inv/GDP	(3) CA/GDP	(4) ln(GDP)	(5) ln(cons)	(6) ln(RER)
y_{t-1}	0.622	0.818	0.577	0.807	0.703	0.741
	(0.114)	(0.059)	(0.083)	(0.037)	(0.049)	(0.200)
NPV_t	1.616	4.009	-3.469	0.029	-1.040	-7.596
	(2.879)	(2.534)	(0.640)	(0.535)	(1.072)	(7.769)
NPV_{t-1}	-1.934	4.208	-2.675	3.698	3.007	-12.454
	(3.226)	(2.407)	(1.002)	(1.823)	(2.193)	(14.576)
NPV_{t-2}	2.608	-0.949	-0.594	3.576	-0.700	-10.191
	(4.043)	(0.520)	(0.440)	(1.079)	(1.985)	(20.275)
NPV_{t-3}	2.471	-1.318	-0.112	3.007	-0.229	-10.214
	(5.136)	(0.749)	(0.408)	(0.971)	(1.673)	(17.806)
NPV_{t-4}	6.884	0.021	-0.193	2.904	1.097	-12.294
	(6.305)	(0.274)	(0.478)	(0.792)	(1.659)	(16.665)
NPV_{t-5}	7.347	0.849	-1.298	3.005	0.833	-10.611
	(8.270)	(0.697)	(0.432)	(0.699)	(1.337)	(15.277)
NPV_{t-6}	18.011	0.607	-1.537	3.163	0.039	-11.280
	(9.214)	(0.364)	(0.530)	(0.677)	(1.172)	(13.272)
NPV_{t-7}	12.428	0.028	-1.726	2.604	0.120	-6.809
	(11.364)	(0.519)	(0.674)	(0.618)	(1.189)	(12.179)
NPV_{t-8}	4.954	-0.298	1.455	1.658	-0.458	-8.367
	(7.577)	(0.274)	(0.498)	(0.716)	(0.859)	(10.377)
NPV_{t-9}	-0.435	0.498	-2.242	1.510	-0.618	-3.344
	(1.080)	(0.255)	(0.851)	(0.563)	(0.682)	(8.435)
NPV_{t-10}	0.107	0.155	0.077	1.165	-0.624	-3.108
	(0.852)	(0.579)	(0.442)	(0.648)	(0.873)	(5.120)
N	430	622	660	676	672	653
within R-squared	0.557	0.735	0.426	0.989	0.980	0.787

All columns include country and year fixed effects as well as a constant. All columns control for the interaction of the price of oil with an indicator for recent discoveries. Country specific quadratic trends are included for spreads, log real exchange rate, log GDP, and log consumption. Robust standard errors for panel regressions with cross-sectional dependence are in parenthesis.

The estimated coefficients in Table 1 are used to construct the impulse-response functions for spreads, investment, the current account, GDP, consumption, and the real exchange rate.[1] Table 2 presents the point estimates of the coefficients ξ_s related to the interaction between the natural logarithm of the price of oil $p_{oil,t}$ and the indicator of an oil discovery in $t-s$ for $s = 1\ldots10$.

Table 2: Point estimates of interaction between price of oil and indicators of recent discoveries

	(1) spreads	(2) inv/GDP	(3) CA/GDP	(4) ln(GDP)	(5) ln(cons)	(6) ln(RER)
$p_{oil,t}\mathbb{I}_{disc,i,t-1}$	-0.253	0.000	0.001	0.001	0.003	0.009
	(0.129)	(0.001)	(0.002)	(0.002)	(0.002)	(0.008)
$p_{oil,t}\mathbb{I}_{disc,i,t-2}$	-0.240	0.002	0.000	0.001	0.002	0.018
	(0.169)	(0.001)	(0.001)	(0.001)	(0.001)	(0.011)
$p_{oil,t}\mathbb{I}_{disc,i,t-3}$	-0.143	0.001	0.000	-0.001	0.000	0.008
	(0.250)	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)
$p_{oil,t}\mathbb{I}_{disc,i,t-4}$	-0.376	-0.001	0.001	-0.002	0.002	0.010
	(0.207)	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)
$p_{oil,t}\mathbb{I}_{disc,i,t-5}$	-0.142	0.001	0.001	-0.002	0.000	0.010
	(0.238)	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)
$p_{oil,t}\mathbb{I}_{disc,i,t-6}$	0.245	-0.002	0.004	-0.002	-0.002	0.018
	(0.600)	(0.001)	(0.001)	(0.002)	(0.002)	(0.011)
$p_{oil,t}\mathbb{I}_{disc,i,t-7}$	0.043	-0.001	0.001	-0.001	0.000	0.008
	(0.190)	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)
$p_{oil,t}\mathbb{I}_{disc,i,t-8}$	0.116	0.000	0.000	0.001	0.000	0.006
	(0.162)	(0.001)	(0.001)	(0.001)	(0.001)	(0.012)
$p_{oil,t}\mathbb{I}_{disc,i,t-9}$	0.120	0.000	0.001	0.001	0.000	0.004
	(0.157)	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)
$p_{oil,t}\mathbb{I}_{disc,i,t-10}$	-0.430	0.001	-0.004	0.002	0.000	0.003
	(0.322)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)

Robust standard errors for panel regressions with cross-sectional dependence are in parenthesis.

Note that the coefficients in column (1) are three orders of magnitude larger than those in columns (2) through (5). Similarly, the coefficients in column (6) are also much larger than those in columns (2) through (5). As discussed in the following section, this difference shows how the inclusion of these control variables is relevant for the estimation of the effect of oil discoveries on spreads and the real exchange rate but not for their effect on the rest of the variables.

[1] Appendix 1.3 shows the details about the estimation of the shares of investment in different sectors.

1.2 Estimations without interaction control variables

Table 3 shows the estimation results for the following regression:

$$y_{i,t} = \rho y_{i,t-1} + \sum_{s=0}^{10} \psi_s NPV_{i,t-s} + \alpha_i + \mu_t + \varepsilon_{i,t}$$

Table 3: Estimation results of main variables, no interaction term

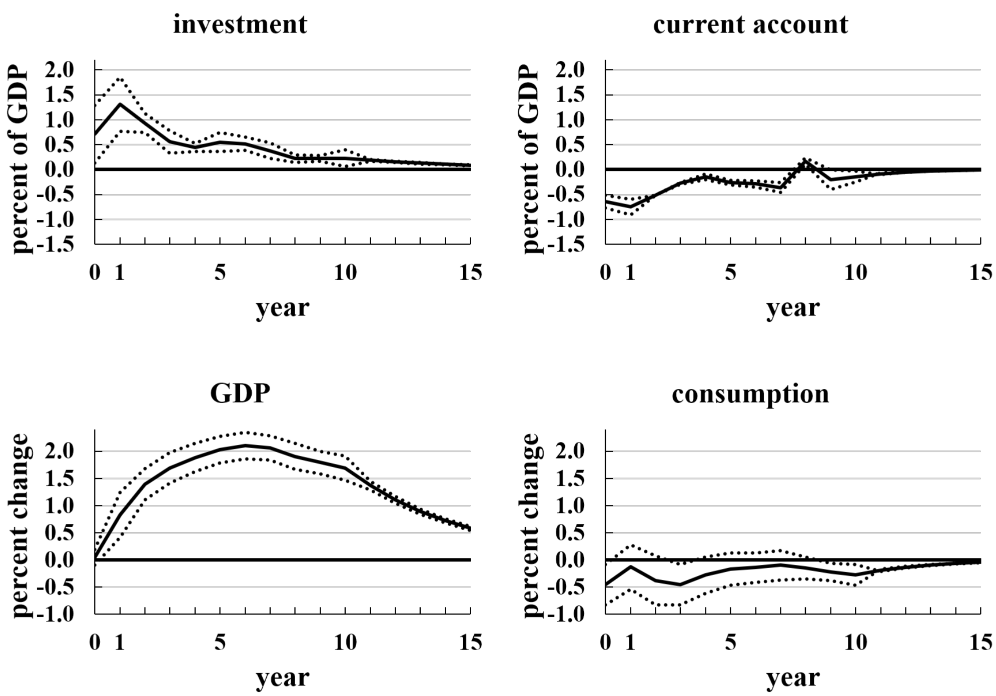
	(1) spreads	(2) inv/GDP	(3) CA/GDP	(4) ln(GDP)	(5) ln(cons)	(6) ln(RER)
y_{t-1}	0.621	0.820	0.582	0.807	0.701	0.744
	(0.118)	(0.060)	(0.084)	(0.036)	(0.050)	(0.197)
NPV_t	-1.491	3.937	-3.600	0.262	-1.078	-8.304
	(2.799)	(2.479)	(0.551)	(0.620)	(1.030)	(7.972)
NPV_{t-1}	-7.769	4.050	-2.082	4.394	0.996	-6.185
	(4.155)	(2.110)	(0.962)	(1.780)	(1.921)	(10.852)
NPV_{t-2}	-6.075	-0.776	-0.437	3.995	-1.465	-2.295
	(4.680)	(0.410)	(0.357)	(1.066)	(2.013)	(15.110)
NPV_{t-3}	-5.349	-1.176	0.135	3.183	-0.900	-3.170
	(4.502)	(0.646)	(0.311)	(0.947)	(1.733)	(13.035)
NPV_{t-4}	-3.212	-0.044	0.066	2.878	0.264	-5.286
	(5.341)	(0.157)	(0.374)	(0.781)	(1.597)	(12.029)
NPV_{t-5}	-1.386	1.022	-0.992	2.833	0.228	-3.368
	(6.427)	(0.682)	(0.267)	(0.671)	(1.382)	(10.805)
NPV_{t-6}	25.514	0.363	-0.756	2.574	-0.079	-4.525
	(13.036)	(0.398)	(0.390)	(0.657)	(1.219)	(9.186)
NPV_{t-7}	15.521	-0.243	-1.071	2.045	0.038	-0.994
	(7.267)	(0.491)	(0.569)	(0.546)	(1.223)	(8.519)
NPV_{t-8}	4.411	-0.498	2.107	1.330	-0.469	-3.264
	(6.384)	(0.190)	(0.434)	(0.629)	(0.913)	(6.231)
NPV_{t-9}	-0.975	0.245	-1.665	1.421	-0.616	0.151
	(1.131)	(0.171)	(0.763)	(0.519)	(0.743)	(5.719)
NPV_{t-10}	-0.457	0.237	-0.147	1.353	-0.652	-1.228
	(0.522)	(0.634)	(0.567)	(0.617)	(0.866)	(3.235)
N	430	622	660	676	672	653
within R-squared	0.545	0.731	0.414	0.989	0.980	0.786

All columns include country and year fixed effects as well as a constant. Country specific quadratic trends are included for spreads, log real exchange rate, log GDP, and log consumption. Robust standard errors for panel regressions with cross-sectional dependence are in parenthesis.

That is, equation 2 without controlling for the interaction between the price of oil and indicators for recent discoveries. Comparing the results shown in Table 3 with those from Table 1 it is clear that the interaction controls are of very little consequence for all regressions except for those regarding spreads and the real exchange rate.

To illustrate this point even further, Figures 1, 2, and 3 show the impulse-response functions constructed with the point estimates from Table 3.

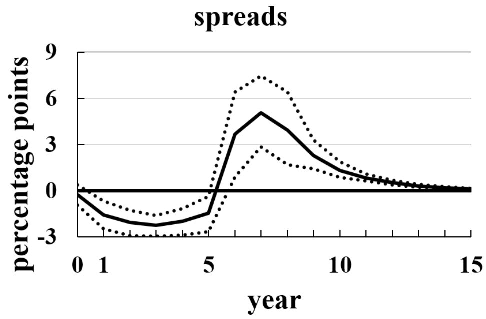
Figure 1: Impact of giant oil discoveries on macroeconomic aggregates



Impulse response to an oil discovery with net present value equal to 18 percent of GDP. The dotted lines indicate 90 percent confidence intervals.

As is clear from comparing Figure 1 above with Figure 2 in the paper, the impulse-response functions of investment, the current account, GDP, and consumption remain virtually unchanged if we exclude the interaction controls. By comparing Figure 2 below with Figure 3 in the paper, we can observe that the impact of oil discoveries on the dynamics of spreads is sensitive to the inclusion of these interaction controls.

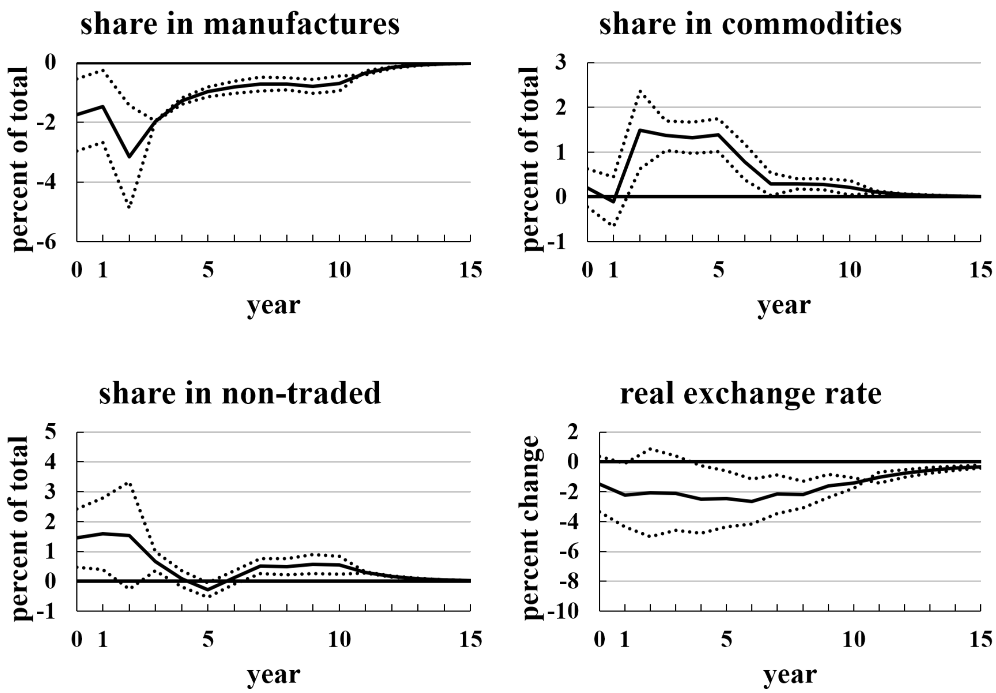
Figure 2: Impact of giant oil discoveries on spreads



Impulse response to an oil discovery with net present value equal to 18 percent of GDP. The dotted lines indicate 90 percent confidence intervals.

In both cases, with and without the interaction controls, the change in spreads peaks in the seventh year after a discovery at around 5 percentage points. However, in the benchmark specification spreads steadily increase in the years following a discovery, while in the specification that excludes the interaction controls spreads first decrease during the first five years and then increase. These differences are expected considering the sign of the coefficients reported in column (1) of Table 2. These coefficients are negative for $p_{oil,t}\mathbb{I}_{disc,i,t-s}$ for $s = 1...5$, which implies that the coefficients of $NPV_{i,t-s}$ for $s = 1...5$ are biased downward when the interaction terms are omitted.

Figure 3: Impact of giant oil discoveries on sectoral investment and the RER



Impulse response to an oil discovery with net present value equal to 18 percent of GDP. The dotted lines indicate 90 percent confidence intervals.

Figure 3 presents the impulse-response functions of the real exchange rate and the shares of total investment that go into manufacturing, commodities, and non-traded sectors for the estimations that do not consider the interaction controls. As is clear by comparing Figure 3 above with Figure 4 in the paper, only the response of the real exchange rate is affected by the omission.[2] Given the sign of the coefficients reported in column (6) of Table 2, the coefficients of $NPV_{i,t-s}$ for $s = 1 \ldots 10$ are biased upward when the interaction terms are omitted.

1.3 The effect of oil discoveries on investment shares by sector

This Section provides details on the estimation of the effect of oil discoveries on the share of total investment in manufactures, commodities, and non-traded sectors. These estimates consider 47

[2]Note how the coefficients in column (6) of Table 2 are much larger than the coefficients reported in Table 6.

countries for which sectoral investment data for the period 1993–2012 are available.[3]

The data of investment by sector are from the National Accounts Official Country Data collected by the United Nations following the International Standard Industrial Clasification, Revision 3 (ISIC Rev. 3). It considers investment per country for 11 sub-items. Table 4 summarizes the sub-items and how I classify them into non-traded, manufacturing, and commodities.

Table 4: Industry classification

sub-item	clasification
Agriculture, hunting, forestry; fishing (A+B)	commodities
Mining and quarrying (C)	commodities
Manufacturing (D)	manufacturing
Electricity, gas and water supply (E)	non-traded
Construction (F)	non-traded
Wholesale retail; hotels and restaurants (G+H)	non-traded
Transport, storage and communications (I)	non-traded
Financial intermediation; real estate (J+K)	non-traded
Public administration; compulsory social security (L)	non-traded
Education; health and social work; other (M+N+O)	non-traded
Private households with employed persons (P)	non-traded

Tables 5 and 6 show the estimation results for equation (2) in the paper. The estimated coefficients in Table 5 are used to construct the impulse-response functions for the shares of total investment that go into manufacturing, commodities, and non-traded sectors reported in Figure 4 in the paper.

[3]These countries are Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Botswana, Canada, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kuwait, Latvia, Lithuania, Luxembourg, Malta, Mauritius, Mexico, Namibia, Netherlands, New Zealand, Norway, Oman, Pakistan, Poland, Portugal, Qatar, Saudi Arabia, Slovenia, South Africa, Spain, Sweden, Syrian Arab Republic, Tunisia, Ukraine, United Arab Emirates, United Kingdom, United States, and Uruguay.

Table 5: Estimation results of investment shares, benchmark specification

	(1) non-traded	(2) manufacturing	(3) commodities
y_{t-1}	0.545	0.499	0.520
	(0.037)	(0.071)	(0.113)
NPV_t	9.306	-10.222	0.475
	(4.895)	(5.570)	(1.949)
NPV_{t-1}	6.289	-4.746	-1.529
	(5.362)	(6.327)	(1.772)
NPV_{t-2}	6.789	-15.227	7.059
	(8.062)	(10.547)	(5.725)
NPV_{t-3}	-0.594	-2.491	3.065
	(1.214)	(1.212)	(0.435)
NPV_{t-4}	-1.577	-1.854	3.431
	(1.180)	(1.248)	(0.604)
NPV_{t-5}	-1.822	-1.883	3.758
	(1.153)	(1.247)	(0.788)
NPV_{t-6}	1.887	-1.884	0.072
	(1.128)	(1.250)	(0.850)
NPV_{t-7}	2.983	-2.014	-0.967
	(1.151)	(1.214)	(0.534)
NPV_{t-8}	1.511	-1.984	0.407
	(1.232)	(1.235)	(0.319)
NPV_{t-9}	1.763	-1.827	0.014
	(1.445)	(1.394)	(0.407)
NPV_{t-10}	1.528	-1.750	0.152
	(1.272)	(1.261)	(0.564)
N	569	569	569
within R-squared	0.522	0.414	0.461

All columns include country and year fixed effects as well as a constant. All columns control for the interaction of the price of oil with an indicator for recent discoveries. Robust standard errors for panel regressions with cross-sectional dependence are in parenthesis.

Table 6 presents the point estimates of the coefficients ξ_s of the interaction between the natural logarithm of the price of oil $p_{oil,t}$ and the indicator of an oil discovery in $t-s$ for $s = 1 \ldots 10$.

Table 6: Point estimates of interaction between price of oil and indicators of recent discoveries

	(1) non-traded	(2) manufacturing	(3) commodities
$p_{oil,t}\mathbb{I}_{disc,i,t-1}$	-0.002	0.002	0.000
	(0.003)	(0.002)	(0.002)
$p_{oil,t}\mathbb{I}_{disc,i,t-2}$	-0.001	0.001	0.000
	(0.001)	(0.002)	(0.002)
$p_{oil,t}\mathbb{I}_{disc,i,t-3}$	-0.002	0.003	-0.001
	(0.003)	(0.001)	(0.003)
$p_{oil,t}\mathbb{I}_{disc,i,t-4}$	0.002	0.001	-0.003
	(0.002)	(0.001)	(0.001)
$p_{oil,t}\mathbb{I}_{disc,i,t-5}$	0.002	0.000	-0.001
	(0.002)	(0.002)	(0.002)
$p_{oil,t}\mathbb{I}_{disc,i,t-6}$	-0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)
$p_{oil,t}\mathbb{I}_{disc,i,t-7}$	-0.003	0.003	0.001
	(0.002)	(0.004)	(0.002)
$p_{oil,t}\mathbb{I}_{disc,i,t-8}$	-0.001	0.000	0.002
	(0.002)	(0.002)	(0.001)
$p_{oil,t}\mathbb{I}_{disc,i,t-9}$	0.001	-0.005	0.004
	(0.002)	(0.001)	(0.001)
$p_{oil,t}\mathbb{I}_{disc,i,t-10}$	-0.001	0.001	0.000
	(0.001)	(0.001)	(0.002)

Robust standard errors for panel regressions with cross-sectional dependence are in parenthesis.

Finally, Table 7 shows the estimation results for the following regression:

$$y_{i,t} = \rho y_{i,t-1} + \sum_{s=0}^{10} \psi_s NPV_{i,t-s} + \alpha_i + \mu_t + \varepsilon_{i,t}$$

that is the same as equation (2) but without controlling for the interaction between the price of oil and indicators for recent discoveries.

Table 7: Estimation results of investment shares, no interaction term

	(1) non-traded	(2) manufacturing	(3) commodities
y_{t-1}	0.551	0.496	0.533
	(0.036)	(0.069)	(0.112)
NPV_t	8.047	-9.735	1.098
	(4.220)	(5.216)	(1.844)
NPV_{t-1}	4.418	-3.351	-1.191
	(4.909)	(5.912)	(2.252)
NPV_{t-2}	3.654	-13.469	8.607
	(7.419)	(7.988)	(3.840)
NPV_{t-3}	-0.958	-2.228	3.184
	(1.087)	(1.254)	(0.483)
NPV_{t-4}	-1.598	-1.734	3.280
	(1.052)	(1.233)	(0.638)
NPV_{t-5}	-1.868	-1.909	3.765
	(1.024)	(1.234)	(0.763)
NPV_{t-6}	1.614	-1.871	0.264
	(1.009)	(1.247)	(0.874)
NPV_{t-7}	2.437	-1.734	-0.744
	(1.057)	(1.302)	(0.618)
NPV_{t-8}	1.175	-2.000	0.757
	(1.055)	(1.166)	(0.326)
NPV_{t-9}	1.683	-2.453	0.720
	(1.251)	(1.298)	(0.367)
NPV_{t-10}	1.268	-1.705	0.318
	(1.178)	(1.396)	(0.526)
N	569	569	569
within R-squared	0.514	0.398	0.449

All regressions include country and year fixed effects as well as a constant. Robust standard errors for panel regressions with cross-sectional dependence are in parenthesis.

2 Decentralized economy

This Appendix shows how the allocations from the economy in Section 3 in the paper can be decentralized by an economy with a representative household, a government, and competitive firms. First I lay out the environment and then I prove an equivalence result that is akin to a first welfare theorem.

2.1 Environment

Final Good.—There is a competitive firm that assembles the final non-traded good Y_t from the intermediate non-traded good $c_{N,t}$, manufactures $c_{M,t}$, and oil $c_{oil,t}$ and sells it to the representative household at price P_t. The firm has access to the technology:

$$Y_t = f^Y\left(c_{N,t}, c_{M,t}, c_{oil,t}\right) = \left[\omega_N^{\frac{1}{\eta}}\left(c_{N,t}\right)^{\frac{\eta-1}{\eta}} + \omega_M^{\frac{1}{\eta}}\left(c_{M,t}\right)^{\frac{\eta-1}{\eta}} + \omega_{oil}^{\frac{1}{\eta}}\left(c_{oil,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

where η is the elasticity of substitution and ω_i are the weights of each intermediate good i in the production of the final good. The firm purchases manufactures and oil in international markets at prices p_M and $p_{oil,t}$ and purchases the intermediate non-traded good at price $p_{N,t}$ from a domestic producer. Cost minimization implies the demands for intermediate goods are:

$$c_{N,t} = \left(\frac{P_t}{p_{N,t}}\right)^{\eta} Y_t \omega_N$$
$$c_{M,t} = \left(\frac{P_t}{p_{M,t}}\right)^{\eta} Y_t \omega_M$$
$$c_{oil,t} = \left(\frac{P_t}{p_{oil,t}}\right)^{\eta} Y_t \omega_{oil}$$

and since the firm is competitive the price of the final good equals its marginal cost:

$$P_t = \left[\omega_N\left(p_{N,t}\right)^{1-\eta} + \omega_M\left(p_{M,t}\right)^{1-\eta} + \omega_{oil}\left(p_{oil_t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

Intermediate Goods.—Manufactures $y_{M,t}$, oil $y_{oil,t}$, and the intermediate non-traded good $y_{N,t}$

are produced by competitive firms with access to technologies:

$$y_{N,t} = f^N(z_t, k_{N,t}) = z_t k_{N,t}^{\alpha_N}$$
$$y_{M,t} = f^M(z_t, k_{M,t}) = z_t k_{M,t}^{\alpha_M}$$
$$y_{oil,t} = f^{oil}(z_t, k_{oil,t}, n_t) = z_t k_{oil,t}^{\alpha_{oil}} n_t^{\zeta}$$

. Each period, these firms rent general capital $k_{N,t}$ and $k_{M,t}$ and capital for oil extraction $k_{oil,t}$ from the household in exchange for rental rates r_t and $r_{oil,t}$. The manufacturing and oil firms sell their product in international markets at prices $p_{M,t}$ and $p_{oil,t}$ and the non-traded firm sells its product to the domestic final good firm at price $p_{N,t}$. The representative household owns all the firms and gets the profits from the firms.

Households.—There is a representative household with preferences over consumption c_t represented by:

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty} \beta^t u(c_t)\right]$$

where $u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$ and β is the discount factor. The household owns all the firms and faces a budget constraint and laws of motion for capital:

$$c_t + (1+\tau_{i,t})\, i_{k,t} + (1+\tau_{i_{oil},t})\, i_{k_{oil},t} \leq \frac{r_t}{P_t} k_t + \frac{r_{oil,t}}{P_t} k_{oil,t} + \frac{\pi_t^N + \pi_t^M + \pi_t^{oil}}{P_t} + m_t + T_t$$
$$k_{t+1} = (1-\delta)\, k_t + i_{k,t} - \Psi(k_{t+1}, k_t)$$
$$k_{oil,t+1} = (1-\delta)\, k_{oil,t} + i_{k_{oil},t} - \Psi_{oil}(k_{oil,t+1}, k_{oil,t})$$

where $\tau_{i,t}$ and $\tau_{i_{oil},t}$ are distortionary taxes, T_t are transfers from the government, m_t is a small transitory income shock, and π_t^N, π_t^M and π_t^{oil} are profits from the intermediate goods firms. The household takes taxes and prices as given and maximizes its lifetime utility subject to its budget constraint and the laws of motion of capital.

Government.—There is a benevolent government that can issue long term debt in international financial markets and lacks commitment to repay. The law of motion for debt is:

$$b_{t+1} = (1-\gamma)\, b_t + i_{b,t}$$

where γ is the fraction of debt that matures each period, b_t is the stock of debt in period t and $i_{b,t}$ is new debt issuances. At the beginning of each period the government chooses whether to default or not. If the government defaults then productivity in the economy is $\tilde{z}_t = z_t - \max\left\{d_0 z_t + d_1 z_t^2\right\}$. After default, the government is excluded from financial markets and is readmitted with probability θ. If the government repays then it can issue new debt. Regardless of default or repayment, the government has access to distortionary taxes $\tau_{i,t}$ and $\tau_{i_{oil},t}$ and lump-sum transfers T_t to influence the decisions of the households. The government maximizes the representative household's utility subject to its budget constraint and to an implementability constraint that restricts the allocations that the government chooses for the household to be a solution to the household's problem given the taxes. If the government is in good financial standing then its budget constraint is:

$$P_t \tau_{i,t} i_{k,t} + P_t \tau_{i_{oil},t} i_{k_{oil},t} + q_t\left(s_t, k_{t+1}, k_{oil,t+1}, b_{t+1}\right)\left[b_{t+1} - (1-\gamma)\, b_t\right] = P_t T_t + \left[\gamma + (1-\gamma)\,\kappa\right] b_t$$

where $(1-\gamma)\,\kappa b_t$ are the coupon payments for the outstanding debt. If the government decides to default then its budget constraint is:

$$P_t \tau_{i,t} i_{k,t} + P_t \tau_{i_{oil},t} i_{k_{oil},t} = P_t T_t$$

and gets readmitted to financial markets with probability θ and zero debt.

2.2 Equivalence result

In this subsection I prove that the allocations that characterize the equilibrium of the economy in Section 3 in the paper can be decentralized by the market economy described above. I do this in two steps: first, I show that, given the state and the dynamic decisions, the static allocations in each period are the same. Then I show that the dynamic problems are the same.

2.2.1 Recursive problems

The recursive formulation of the problem of the government in Section 3 is:

$$V\left(s, m, k, k_{oil}, b\right) = \max_{d \in \{0,1\}} \left\{[1-d]\, V^P\left(s, m, k, k_{oil}, b\right) + d V^D\left(s, k, k_{oil}\right)\right\}$$

where the value in repayment can be written as:

$$
\begin{aligned}
V^{P}(s,m,k,b) = & \max_{\left\{k',b',l,\overrightarrow{C},\overrightarrow{L},\overrightarrow{K},\overrightarrow{X}\right\}} \left\{u(c)+\beta\mathbb{E}\left[V\left(s',m',k',b'\right)\right]\right\} \\
s.t. \qquad & c+i_k+i_{k_{oil}} \leq F(s,k,k_{oil},X)+(1-\delta)k+m \\
& k' = (1-\delta)k+i_k-\Psi\left(k',k\right) \\
& k'_{oil} = (1-\delta)k_{oil}+i_{k_{oil}}-\Psi_{oil}\left(k'_{oil},k_{oil}\right) \\
& X = q\left(s,k',b'\right)\left[b'-(1-\gamma)b\right]-\left[\gamma+\kappa(1-\gamma)\right]b
\end{aligned}
$$

and the value in default can be written as:

$$
\begin{aligned}
V^{D}(s,k) = & \max_{\left\{k',l,\overrightarrow{C},\overrightarrow{L},\overrightarrow{K},\overrightarrow{X}\right\}} \left\{u(c)+\beta\mathbb{E}\left[\theta V\left(s',m',k',0\right)+(1-\theta)V^{D}\left(s',k'\right)\right]\right\} \\
s.t. \qquad & c+i_k+i_{k_{oil}} \leq F^{D}(s,k,k_{oil})+(1-\delta)k-\bar{m} \\
& k' = (1-\delta)k+i_k-\Psi\left(k',k\right) \\
& k'_{oil} = (1-\delta)k_{oil}+i_{k_{oil}}-\Psi_{oil}\left(k'_{oil},k_{oil}\right)
\end{aligned}
$$

where $F(s,k,k_{oil},X)$ and $F^{D}(s,k,k_{oil})$ summarize all the static allocations given the state and the choices of $\left(k',k'_{oil},b'\right)$. In repayment F is defined as:

$$
\begin{aligned}
F(s,k,k_{oil},X) = & \max_{c_N,c_M,c_{oil},k_N,k_M,k_{oil},x_{oil},x_M} f^{Y}(c_N,c_M,c_{oil}) \\
s.t. \qquad & c_N = f^{N}(z,k_N) \\
& c_M = f^{M}(z,k_M)-x_M \\
& c_{oil} = f^{oil}(z,k_{oil},n)-x_{oil} \\
& X = p_M x_M+p_{oil}x_{oil} \\
& k = k_N+k_M
\end{aligned}
$$

and in default F^D is defined as:

$$
\begin{aligned}
F^D(s,k,k_{oil}) = & \max_{c_N,c_M,c_{oil},k_N,k_M,k_{oil},x_{oil},x_M} f^Y(c_N,c_M,c_{oil}) \\
s.t. \qquad & c_N = f^N(\tilde{z},k_N) \\
& c_M = f^M(\tilde{z},k_M) - x_M \\
& c_{oil} = f^{oil}(\tilde{z},k_{oil},n) - x_{oil} \\
& 0 = p_M x_M + p_{oil} x_{oil} \\
& k = k_N + k_M
\end{aligned}
$$

2.2.2 Equivalence for static allocations

In repayment, the first-order conditions that characterize the static allocations in the government problem are:

$$f^Y_{c_N}(c_N,c_M,c_{oil}) = \lambda_{C_N} \tag{1}$$

$$f^Y_{c_M}(c_N,c_M,c_{oil}) = \lambda_{C_M} \tag{2}$$

$$f^Y_{c_{oil}}(c_N,c_M,c_{oil}) = \lambda_{C_{oil}} \tag{3}$$

$$f^N_k(z,k_N) = \frac{\lambda_k}{\lambda_{C_N}} \tag{4}$$

$$f^M_k(z,k_M) = \frac{\lambda_k}{\lambda_{C_M}} \tag{5}$$

$$\lambda_{C_{oil}} = \frac{p_{oil}}{p_M}\lambda_{C_M} \tag{6}$$

$$\lambda_{BoP} = \frac{\lambda_{C_M}}{p_M} \tag{7}$$

where λ_{C_N}, λ_{C_M}, $\lambda_{C_{oil}}$, λ_k, and λ_{BoP} are the multipliers of the market clearing constraints for intermediate goods, for general capital, and for the balance of payments, respectively. Note that equations (6) and (7) already pin down $\lambda_{C_{oil}}$ and λ_{BoP} in terms of λ_{C_M} and the international prices p_M and p_{oil}. Thus, we are left with a system of 5 first-order conditions plus 5 constraints to solve for 7 static allocations c_N, c_M, c_{oil}, k_N, k_M, x_{oil}, and x_M and 3 multipliers λ_{C_N}, λ_{C_M}, and λ_k.

Now, in the market economy the final good firm solves:

$$\min_{c_N, c_M, c_{oil}} p_N c_N + p_M c_M + p_{oil} c_{oil}$$
$$s.t. \quad Y \leq f^Y (c_N, c_M, c_{oil})$$

and the intermediate goods firms solve:

$$\max_{k_N} f^N (z, k_N) - r k_N$$
$$\max_{k_M} f^M (z, k_M) - r k_M$$
$$\max_{k_{oil}} f^{oil} (z, k_{oil}, n) - r_{oil} k_{oil}$$

The 8 static allocations c_N, c_M, c_{oil}, k_N, k_M, k_{oil}, x_{oil} and x_M, 3 endogenous prices p_N, r, and r_{oil}, and the multiplier μ^Y of the constraint in the minimization problem of the final good firm are pinned down by the 6 F.O.C.s of these problems:

$$f^Y_{c_N} (c_N, c_M, c_{oil}) = \frac{p_N}{\mu^Y} \tag{8}$$
$$f^Y_{c_M} (c_N, c_M, c_{oil}) = \frac{p_M}{\mu^Y} \tag{9}$$
$$f^Y_{c_{oil}} (c_N, c_M, c_{oil}) = \frac{p_{oil}}{\mu^Y} \tag{10}$$
$$f^N_k (z, k_N) = r \tag{11}$$
$$f^M_k (z, k_M) = r \tag{12}$$
$$f^{oil}_k (z, k_{oil}) = r_{oil} \tag{13}$$

the balance of payments, the market clearing conditions and the constraint:

$$c_N = f^N(z, k_N)$$

$$c_M = f^M(z, k_M) - x_M$$

$$c_{oil} = f^{oil}(z, k_{oil}, n) - x_{oil}$$

$$X = p_M x_M + p_{oil} x_{oil}$$

$$k_N + k_M = k$$

where, recall, $X = q(s, k', b')[b' - (1-\gamma)b] - [\gamma + \kappa(1-\gamma)]b$, k', and $b'$are given.

Note that r_{oil} is already pinned down by k_{oil}, n, and z in equation (13). Also note that if $\mu^Y = \frac{p_M}{\lambda_{C_M}}$, $p_N = \mu^Y \frac{\lambda_{C_N}}{p_M}$, and $r = \mu^Y \frac{\lambda_k}{p_M}$ then the two systems of equations are the same and, thus, the allocations that satisfy them are the same.

2.2.3 Equivalence for dynamic allocations

Finally, for the dynamic allocations note that the government in the market economy has three instruments τ_k, $\tau_{k_{oil}}$, and T to pin down the households decisions for k, k_{oil}, and c. Thus, with the correct choices of taxes on capital and transfers the two problems are equivalent.