Analyse

Macroeconomic effects of the Inflation Reduction Act

DeNederlandscheBank

EUROSYSTEEM

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Executive summary and policy implications

The Inflation Reduction Act (IRA) constitutes the largest green public investment package by the US government thus far. The IRA funnels an estimated total EUR 375 bn towards energy and climate policies. The majority of funds (EUR 313 bn) are investments in green energy and technology until 2031, marking a significant strengthening of US climate policies. On the other side of the Atlantic, European policymakers quickly voiced concerns over the presumed impact of the IRA on European competitiveness and strategic autonomy, with a focus on protectionist elements in the IRA.

The European Commission reacted to the IRA through a proposal for its Green Deal Industrial Plan (GDIP). The plan aims to improve EU competitiveness and support the transition towards climate neutrality. The GDIP includes efforts to simplify and shorten permitting processes for green investments and public procurement. Importantly, it also suggests to loosen state-aid rules and to introduce a new European Sovereignty Fund to finance new initiatives towards reducing emissions. Proposals as set out in the GDIP are currently being discussed by Member States, with the aim of resulting in, amongst others, a Net-Zero Industry Act (NZIA).

Few analyses have been published that assess the macroeconomic impact of the IRA on the European economy. Several institutions and commentors have written insightful reports on potential effects of the IRA on the EU economy.[1] However, these analyses have lacked a model-based assessment of the macroeconomic impact. Regarding effects on the US economy, Moody's has modelled the IRA's impact on output and inflation, yielding deflationary and net positive output effects over the next decade.[2] However, the modelling approach does not include the effects of the IRA on the EU economy.

This analysis seeks to contribute to the policy debate by i) comparing descriptively the IRA's size to Dutch and European funds towards climate policy and ii) assessing the short- to medium-term macroeconomic impact of the IRA on the Netherlands and the EU. In chapter 1, we present a breakdown of IRA funds along several dimensions and compare these to EU and Dutch funds.[3] In chapter 2, we deploy a modified version of the ECB's Euro Area and Global Economy model (EAGLE) to assess the macroeconomic effects of the IRA on American, Euro Area and Dutch trade and GDP. The main results of the analysis are:

The US spends much less on climate policy compared to the EU and the Netherlands.

- Federal public spending on climate and energy through the IRA represents less than a quarter of European investment and less than a sixth of Dutch investment as a % of GDP in the years 2023-2027.
- Compared to Dutch subsidies, those under the IRA are directed more towards proven, existing technologies and less towards developing new ones.
- The IRA lays out a federal climate policy based on subsidies, whereas Dutch and European climate policies are more comprehensive, supplementing subsidies with regulation and carbon pricing. Dutch and European policies are seem more targeted than in the IRA, at the expense of bureaucracy. In principle, the IRA's tax credits are designed to allow for quicker disbursement.

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[1] See e.g. Bruegel (2023).
[2] Moody's (2022)
[3] The EUR 28 bn climate package announced by the Dutch government on the 28th of April 2023 is not included in this analysis.

- The IRA contains protectionist elements, such as bonus subsidies for certain products groups if a minimum threshold of American inputs is used. In the EU, on the other hand, subsidies generally do not contain similar discriminatory clauses.

The model-based results show that the short- to medium-term macroeconomic impact of the IRA is relatively small:

- The climate related spending of the IRA translates into modest effects on GDP in the US.
- These small effects propagate to the Euro Area through trade, and have a limited negative impact on the Euro Area macroeconomy.
- The Netherlands, being a small open economy, is more impacted by the IRA through trade, although the overall effects remain small.

The results should be interpreted with caution. Both our descriptive analyses (in section 1) and model-based results (section 2) rely on assumptions. While the IRA specifically targets strategic sectors that may enjoy higher than average productivity growth in the coming decades, our macroeconomic model does not allow for such distinctions between sectors. The European response is driven at least partly by concerns over firm relocation among a small number of such strategic sectors. Our model cannot account for such dynamics, although it is able to put the overall size of the IRA into a macroeconomic perspective.

From a macroeconomic point of view, our results suggest that there is no need for a far-reaching and sizeable European response to offset potential negative effects from the IRA. The introduction of new subsidies in addition to existing funds bears the risk of ending up in a subsidy race with the US, with potentially negative effects for both the US and Europe. Another intervention proposed by the European Commission, namely loosening state-aid rules, could have negative long-term consequences for the single market and the European economy. First, it may hamper the level playing field and imply more divergence within the Union between member states with and without the fiscal capacity to engage in active industrial policies. In addition to fiscal capacity, divergence may also result from varying degrees of historical relationships between national governments and their business communities. This makes it harder for some countries to promote economic sectors that are deemed productivity enhancing.

Rather than offsetting foreign climate subsidies with its own, the EU should focus on promoting carbon pricing in its global climate-related diplomacy. The global climate effects of the IRA are positive; it has been estimated to lead to a further reduction in US greenhouse gasses of 7 to 8 percentage points by 2030 compared to 2005.[4] Instead of answering future foreign climate investment packages with additional subsidies of its own or a relaxation of state-aid rules, the EU should seek to come to multilateral agreements with other countries to supplement subsidies with regulation and carbon pricing in their climate policy mix. In the absence of such multilateral agreements with other parts of the world, the EU's Carbon Border Adjustment Mechanism

[4] Rhodium Group (2022)

(CBAM) may maintain a level playing field for European producers with the rest of the world on its own internal market.

In addition, the EU should seek to leverage private investments towards financing the green transition. The green and digital transitions will require more than public investment alone. The EU could promote private investment through a further strengthening of the Single Market. Finishing the banking and capital markets union may prove more beneficial to that end than relaxing state-aid rules, which could lead to more fragmentation rather than coordination among national climate policies.

At the same time, policymakers could take more account of the fact that the effects of IRA spending need not be a zero-sum game. In fact, part of the IRA's benefits may actually accrue to European companies producing both in and for the US market. For example, several leading European energy companies have gained a sizeable foothold in the US renewable energy market, including Denmark's Ørsted[5] (10.7 Gigawatts in US), Italy's Enel[6] (9.6 Gigawatts), Spain's Iberdrola[7] and (8 Gigawatts) Germany's RWE[8] (3.1 Gigawatts). The IRA's production subsidies for renewable energy may well boost these European companies' investments in the US renewable energy market, but this does by no means imply they will forego further investment in European clean energy production.

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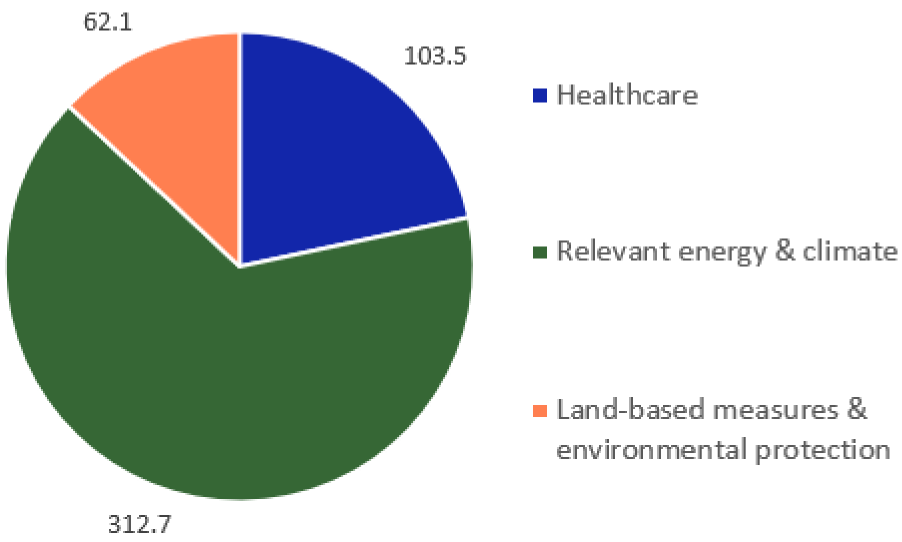
[5] Orsted (2023) Annual report 2022
[6] United States | Enel Green Power
[7] Iberdrola in the United States - Iberdrola
[8] RWE (2023) Annual report 2022

1. Breaking down the IRA

The IRA comprises a package of federal government spending, budget cuts, and tax increases until the end of 2031. Most parts of IRA spending (around EUR 375 bn until the end of 2031) are devoted to climate policy, with the second large component comprising healthcare spending (about EUR 103 bn), see Figure 1. The increased spending by the government will be fully covered by higher revenues. The largest portion of the increase in tax revenues are expected from an increase in the minimum corporate tax to 15% and by improving tax collection by the Internal Revenue Service. Taken altogether, the Congressional Budget Office expects the IRA to reduce the federal government's deficit by EUR 228 bn until the end of 2031. Given the size and its potential impact, we will focus only on the IRA's spending towards energy and climate policies in the remainder of this Analysis.[9] We refer only to those expenditures when mentioning the IRA.

Figure 1 – IRA spending by component
EUR bn



Source: Own calculations based on Congressional Budget Office. See appendix 2 for more details.

The overall size

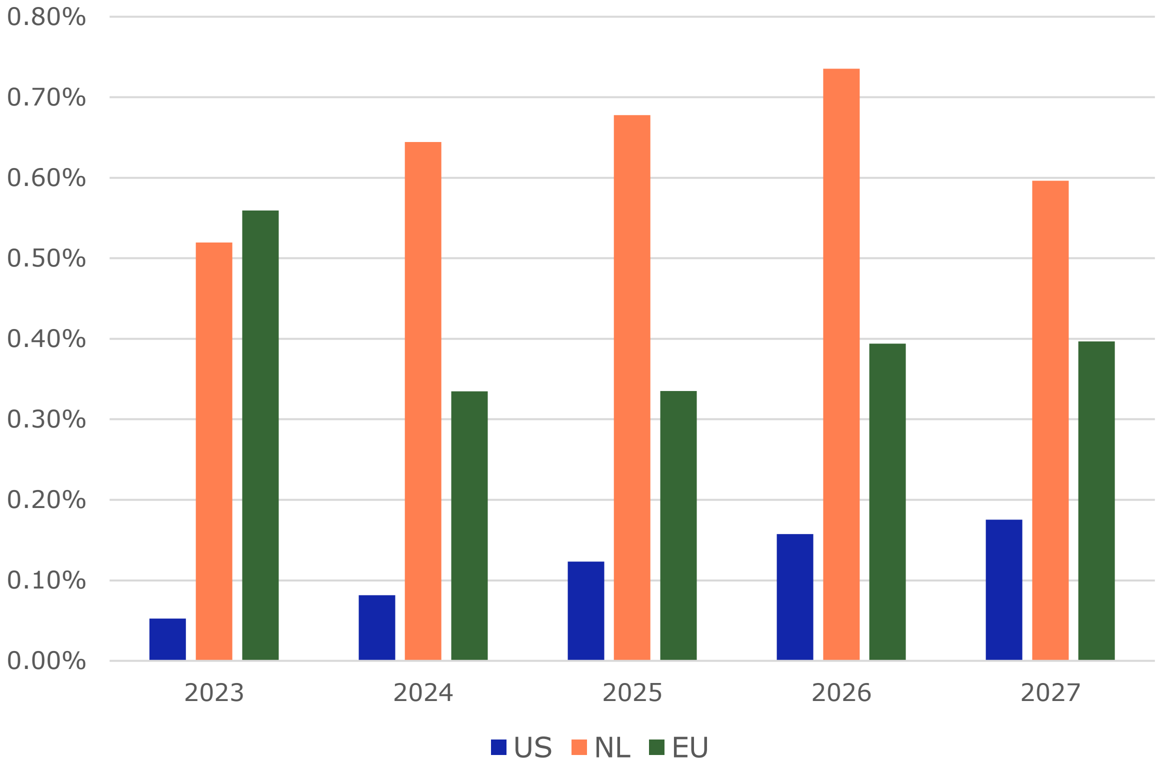
Compared to European and Dutch funds, the IRA's expenditure on climate policies appears relatively modest. Under the IRA, the federal government will spend an estimated EUR 375 bn over the next eight years EUR 144 bn of that will be spent in the period of 2023-2027, the years for which European budgeting practices allow for a comparison. In figure 1, we compare the planned expenditure under the IRA to similar funds in the EU and the Netherlands (see annex 1 for a background on this comparison). Dutch planned public spending towards emission reduction in the coming five years is about 6 times higher than estimated US spending under the IRA,

[9] In Chapter 2, we also consider the increase in the corporate tax to finance the IRA's climate policy spending.

relative to GDP[10]. Up until 2027, Dutch spending on the climate transition is estimated to peak in 2026 at about 0.7% of GDP, vastly outnumbering the estimated 0.15% of GDP in the US in 2027. The EU level of public spending is expected to be about 4 times higher than that of the US under the IRA. Note that estimates for the IRA spending are more uncertain than EU and Dutch spending, as many of the IRA tax credits are open ended arrangements: in theory, the amount of tax credits to be disbursed is uncapped.[11] Because IRA's expenditures on climate policies are modest, the direct macroeconomic consequences are expected to be of limited magnitude too, as we shall see in Chapter 2.

Figure 2 – IRA, Dutch and EU green public investment

% of GDP



Source: Own calculations based on Congressional Budget Office, The White House, Miljoenennota's, European Council (FitFor55), Multiannual Financial Framework 2021-2027 and NextGenerationEU. See appendix 2 for more details.

An important difference with federal climate policy in the US, is that subsidies are accompanied by carbon pricing instruments in the EU and in the Netherlands. Roughly 40% of European emissions fall under the scope of the EU Emission Trade System (ETS). Currently, the carbon price under the ETS sits at around €90 per metric ton. The EU's fit-for-55 package will expand the ETS to cover roughly 80 percent of emissions in

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[10] Note that the numbers in figure 1 include spending on greening the Dutch economy both from European and Dutch national funds, whereas the IRA only includes federal funds. This means that for some states, actual spending on the green transition may be higher because of state-level investment packages, especially e.g. California. Due to data and time limitations, we're currently unable to include these additional US funds in the figures.

[11] In practice, however, it is likely capped by the US debt ceiling.

the EU[12]. This is topped by national initiatives, including both explicit pricing (such as the Dutch national levies for industry and greenhouse sectors) and implicit pricing such as energy taxation. Such forms of carbon pricing are not in place at the federal level in the US but have been implemented in states such as California and Oregon. Overall, 6.4% of emissions are covered by an explicit carbon price in the US.[13]

The size of the IRA seems limited when compared to previous US spending programmes. As mentioned, the US will spend an estimated EUR 375 bn towards climate policies and energy under the IRA until the end of 2031. The total expenditures to counter the Covid crisis passed by the US Congress in 2020 alone, at roughly EUR 3100 bn, are more than 8 times higher than total estimated IRA spending until 2031.[14] In terms of tax revenues, the IRA is not featured among the most sizeable federal packages. Moody's shows that when placed alongside previous US public expenditure and taxation acts, 27 acts achieved a larger annual revenue increase, as a share of GDP, than the IRA since the First World War.[15]

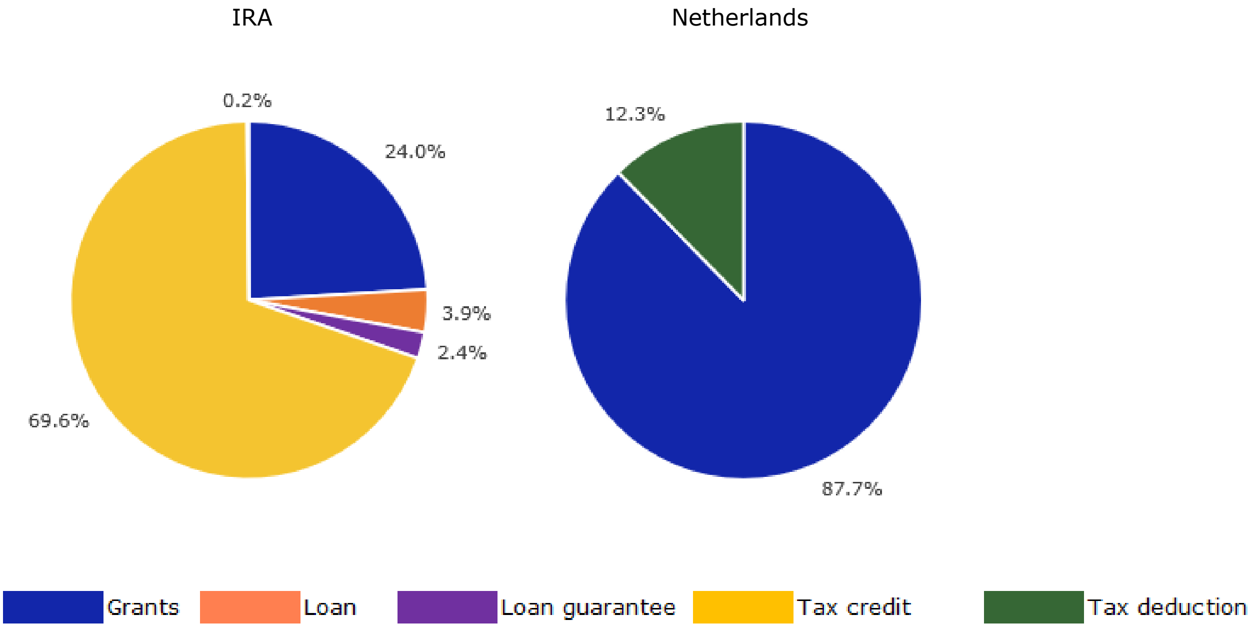
The means

The IRA distinguishes itself by mostly distributing funds in the form of tax credits. In contrast, European and Dutch climate spending relies mainly on grants. Figure 1 provides a breakdown of estimated means for the IRA and Dutch spending on emission reduction. A major difference is that the IRA's tax credits are open-ended, whereas Dutch and EU subsidies generally disburse a predetermined amount of funds over a fixed period of time. It is difficult at this time to compare the effectiveness and efficiency of these different means of distributing funds, as the IRA's specifics are still being worked out. In general, there may be a trade-off between how easy it is for firms and consumers to access the funds (and thereby also how level the playing field is between firms for accessing subsidies) and how targeted they are towards their policy objective. The IRA's tax credits are designed to be quicker in their disbursement but are less targeted than European subsidies.

[12] The European policy programme Fit-for-55 includes proposals to expand the ETS to the maritime transport sector, and start an 'ETS-2' for emissions in road transport and from buildings.
[13] OECD (2022)
[14] In this comparison we included the CARES Act (at EUR 1930 bn), the Paycheck protection Program (at EUR 424 bn), followed by another EUR 790 bn bill in December 2021. We used the average 2020 USD/EUR exchange rate to convert the packages to EUR.
[15] Moody's (2022)

Figure 3 Composition of subsidies until 2027

Percentage



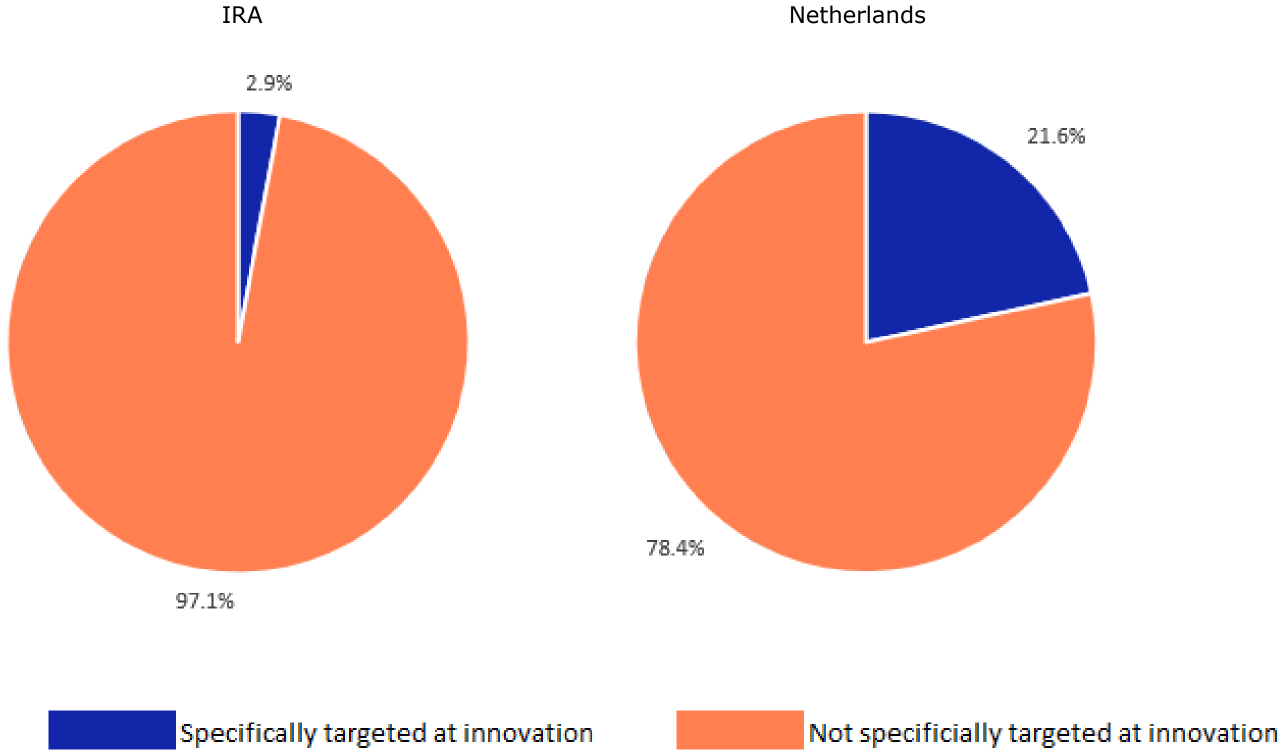
Source: Own calculations based on Congressional Budget Office, The White House, Rijksoverheid. See appendix 2 for more details.

The IRA mainly subsidises developments in proven technologies, while EU and Dutch funds allocate a sizeable part to new technologies. The size of the "horizon Europe" programme alone is equivalent to a quarter of overall spending towards climate policies in scope under the IRA[16]. The Dutch Climate Fund (at a total size of EUR 35 bn) alone will spend EUR 5.7 bn on subsidies for innovative technologies until 2027, while the Dutch government dedicates another EUR 1.6bn to the IPCEI Green Hydrogen project. These two components of the Dutch package account for 24% of all Dutch spending on greening the economy, substantially more than the 2.9% of spending towards innovation under the IRA. Note that "mature technology" includes sectors such as battery production, where innovation is still expected to occur. We have defined innovation as funds that are explicitly directed at research and development of technologies that are not readily available yet, such as green hydrogen.

[16] "Horizone Europe" is the EU's funding programme with a total budget of EUR 95.5 bn, aimed at research towards climate change, sustainable development goals, EU competitiveness and growth. For more, see Horizon Europe (europa.eu)

Figure 4 Breakdown of innovation spending

In %



Source: Own calculations based on Congressional Budget Office, The White House, Rijksoverheid. See appendix 2 for more details.

The IRA contains *local content requirements*, discriminating between domestic and foreign producers. Certain "buy American" clauses provide a bonus to production or investment subsidies for firms in the US on the condition that at least 30-50% of inputs are US manufactured. The EU considers these clauses distortionary to free trade and to be in violation of WTO rules[17]. Based on the CBO's estimates, the bonuses will amount to a maximum of EUR 26.7 bn up until the end of 2031. Dutch and EU production subsidies do not feature discriminatory requirements[18].

[17] EU accuses US of breaking WTO rules with green energy incentives | Financial Times (ft.com)

[18] The EU is setting up a Carbon Border Adjustment Mechanism to ensure a level playing field between EU and non-EU producers when it comes to carbon emission reduction. This mechanism, however, is not designed to favor EU goods over non-EU goods, but rather to offset the effect on European firms of a lack of carbon pricing on certain products in other parts of the world.

Which sectors benefit?

A large share of the IRA is devoted to clean energy production subsidies. Figure 5 shows the breakdown of the IRA and Dutch green public spending. The two largest provisions in the IRA are investment and production tax credits for renewable energy. These two provisions alone account for EUR 98 bn or roughly 38% of the total IRA spending in scope of this Analysis. An additional three clean energy production provisions bring the total to EUR 151 billion or 48% of relevant IRA spending. Although these subsidies comprise a relatively large part of the IRA, the US lags EU green energy production subsidies. [19] [20] In the IRA's sectoral allocation, other sectors follow energy production at a large distance. For example the IRA provisions towards the built environment (at EUR 21 bn) are substantially smaller than those for clean energy production.

Dutch spending on the climate transition of its energy intensive industries is three to four times larger than under the IRA. Debates about competitiveness in the Netherlands often centre on its energy intensive industry, which produces for a global market and is thus directly affected by regulatory regimes in other countries. However, estimated spending under the IRA provides less incentives for industry than Dutch climate policy programs (such as the SDE++ and individual agreements with large emitters).

Consumption subsidies for electric vehicles seem only slightly higher under the IRA than the average of EU member states' consumption subsidies. The US will provide consumer subsidies of EUR 7.200 per new car.[21] Bruegel estimates that on average, EU member states' subsidies amount to about EUR 6.000 per vehicle.[22] Electric vehicle subsidies are one of the focal points in recent media coverage and political discussions on the IRA, while in fact federal consumption subsidies do not differ substantially between the EU and US and comprise a relatively modest share of total green public spending. However, , the electric vehicle industry will also profit from production subsidies, which are not included in the numbers mentioned above. For example, these numbers do not include US state-level incentives for electric car manufacturers, which are said to amount to billions of USD.[23] It is beyond the scope of this Analysis to grasp the full extent of the balance between EU and US production and consumption subsidies for electric vehicles. It therefore remains unclear what the effect may be on the potential relocation decisions of the EU automobile industry.

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[19] The US also lags Europe when it comes to electricity production from renewable sources. In the US, renewables account for about 12% of total US primary energy consumption (US Energy Information Administration). In the EU, they made up 37.5% of gross electricity consumption . In the US, renewables account for about 12% of total US primary energy consumption in 2021 (US Energy Information Administration). In the same year, they made up 37.5% of gross electricity consumption in the EU (European Commission).

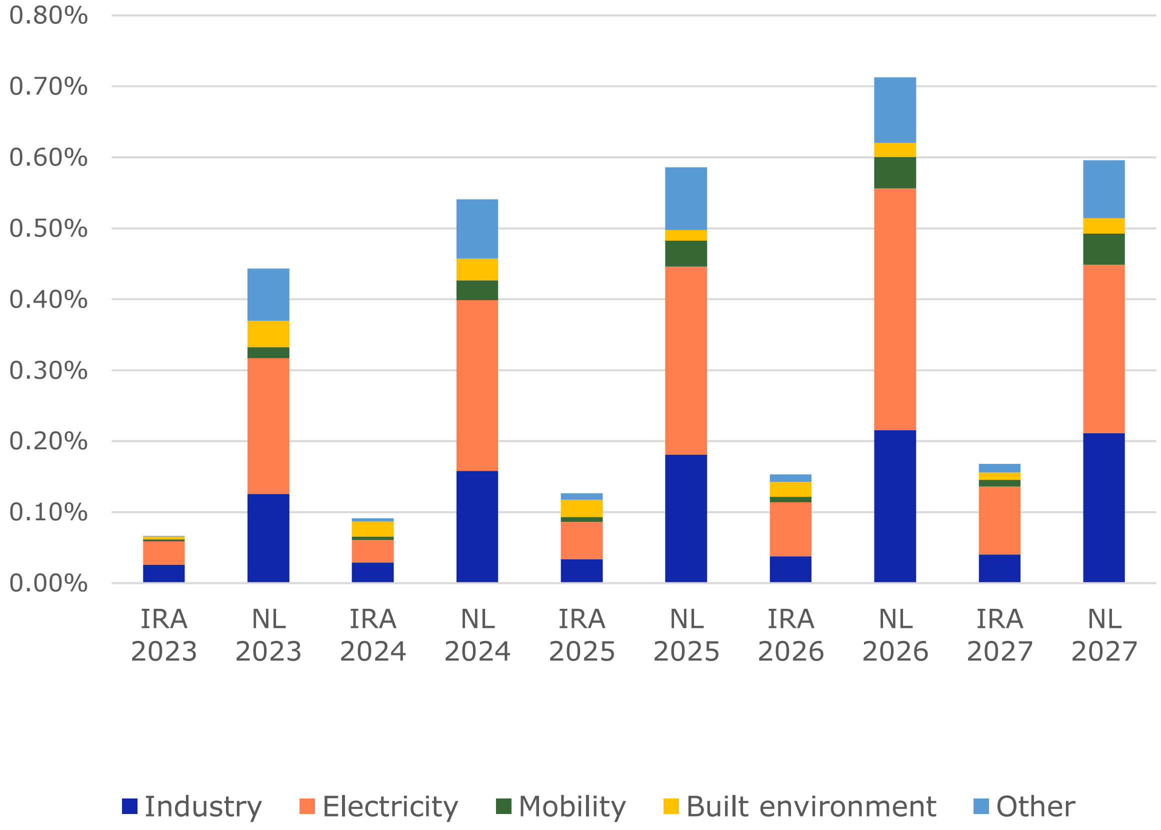
[20] Bruegel (2023)

[21] This amount is the sum of two subsidies: (i) assembly in the US and, (ii) domestically produced batteries. The CBO estimates this provision to amount to EUR 7.2 billion.

[22] Bruegel (2023)

[23] States spend billions on EVs to replace automotive capital Michigan (cnbc.com)

Figure 5 – Sectoral division of IRA and Dutch green public expenditure
% of GDP



Source: Own calculations based on Congressional Budget Office, The White House, Rijksoverheid. Note: This figure shows only the projected spending until 2027, actual IRA spending continues until 2032. See appendix 2 for more details.

2. Macroeconomic impact

2.1 Analysing the macroeconomic impact of the IRA

In this chapter we look at the macroeconomic impact of the IRA in the short- to medium-run. The breakdown of the IRA in the previous chapter provides a starting point for the potential impact of the IRA on the Euro Area and Dutch economies. [24] To complement this descriptive analysis, we make use of a modified version of the Euro Area and Global Economy model (EAGLE), see Box 1 below.[25] We focus on the effects in the short- to medium-run. In the long run, the effects of the IRA will depend on the effectiveness of subsidies to boost productivity growth in the targeted sectors. As sector-specific growth is the core purpose of the IRA, the short- to medium run macro-effects modelled here are secondary effects. Note that the model' results should be interpreted cautiously. Although the model is able to provide us with a rough sense of the magnitude of the IRA's impact on the economy, we should not consider the outcomes in this chapter as point estimates.

The analysis presents the macroeconomic effects in two steps. First, we explore the effect of spending on climate and energy under the IRA without increasing the corporate tax. To this end, we introduce a production subsidy for US producers, at roughly the size of spending under the IRA (in terms of % of GDP). We first exclude the increase in the corporate tax rate to identify the effects of the IRA on output and trade in isolation. We call this 'scenario 1'. Second, in 'scenario 2', we introduce an increase in the US corporate tax that fully finances the production subsidies that are distributed in scenario 1. We do not include spending and revenues under the IRA that are not related to climate policy.[26]

The focus of this analysis is on the impact of the IRA on the economies of the Netherlands and the EA. We also present the impact that the IRA has on the US economy, mostly in order to understand the channels through which the IRA impacts the Netherlands and the Euro Area. We will look at both the overall effect on output and the effect on trade, which is the main channel through which output in the Eurozone and the Netherlands is affected.

Box 1 - On the model used in this Analysis

The results in this chapter are produced by an extended version of the ECB's Euro Area and Global Economy model (EAGLE). EAGLE is a dynamic stochastic general equilibrium large scale model. It features four regions, namely the United States (US), the Netherlands (NL), the rest of the euro area (REA), and the rest of the world (not shown in graphs).

Features

EAGLE provides several features that make it suitable to study the macroeconomic effects of the IRA on the EA and Dutch economy. The model includes the production of intermediate inputs, out of which only a certain

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[24] Although we have considered the EU in Chapter 1 when relating subsidies towards climate policies, EAGLE is calibrated to the Euro Area, which is why we will use that terminology for the remainder of Chapter 2.

[25] European Central Bank (2010)

[26] The IRA also includes a portion on healthcare savings. However, these are not included in the analysis. By excluding this portion, the remaining components roughly equal out and make the package fiscally neutral.

proportion (varying by country) is traded internationally. Those inputs are then transformed into investment and consumption goods.
In scenario 1, as described below, we introduced production subsidies scaled to IRA spending to US goods to mimic the effects of the IRA. In the model, we subsidize the price of domestic intermediate inputs in the US which is financed by issuing debt. In scenario 2, we introduce a matching proxy for a corporate tax in such a way that the subsidy becomes fiscally neutral per year. For a full description of the building blocks of the model, see Appendix 1.

Limitations
Although the extension of EAGLE model presented in this chapter is useful to identify the macroeconomic transmission of shocks, it has several limitations. The most important ones for our purposes are:

[Only two economic sectors] First, the model merely contains a tradable and non-tradable sector. This prevents us from analyzing the effects of the IRA on the dynamics of specific economic sectors, such as energy intensive or low polluting industries.
[Exogenous productivity growth] Second, as in most general equilibrium models, long term productivity growth is taken as given and does not depend on economic shocks administered to the economy.
[No firm mobility] Third, in the model firms are unable to relocate activities to another region, so we cannot model a potential outflow of firms from the EU to the US and vice versa.
[Limited quantitative inference] Finally, due to the above limitations and calibration of the model, we should not interpret the model results as exact estimates of the IRA's effects. Rather, they provide a rough sense of direction and magnitude of the impact of the IRA on the US, the Eurozone and the Dutch economy.

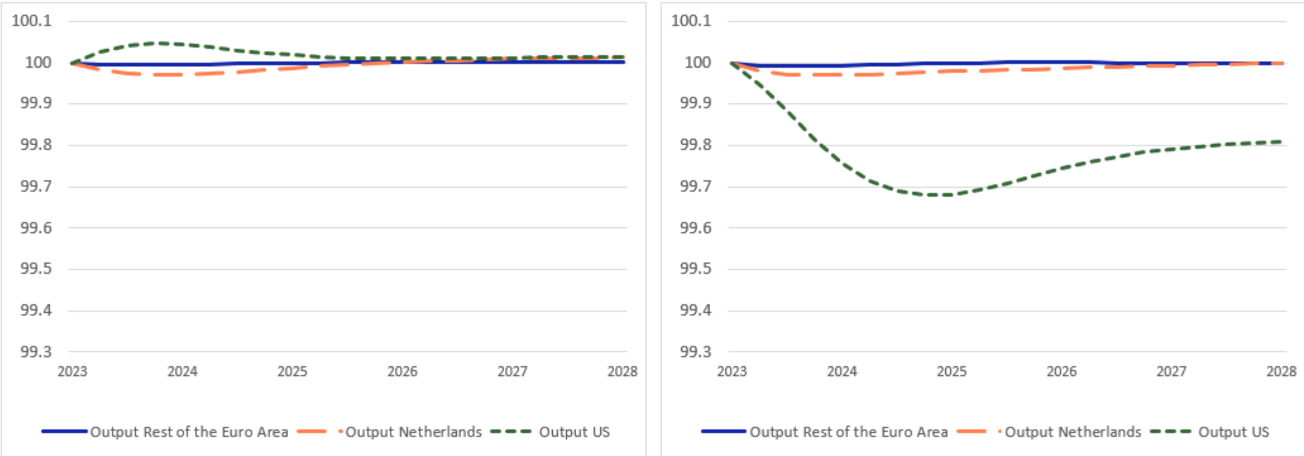
2.2 Output

The model indicates that the impact of the IRA on the US macroeconomy is relatively small As shown in figure 2 in Chapter 1, Annual IRA spending is expected to peak at around 0.17% of GDP in 2027. This translates into a modest response of the economy in the model. In scenario 1, where we isolate the effect of IRA spending, US GDP reacts positively but mildly. The IRA subsidies on domestically produced intermediate goods reduce their relative price, thereby increasing their consumer demand for these goods at the expense of foreign goods. This, in turn increases US output. Increased output in the US raises labour demand and thus wages. As a result, consumption of US households rises. In scenario 2, where we introduce corporate taxes to finance IRA spending, the net effect on GDP is mildly negative. The negative effect of an increase in distortionary corporate taxes on US production outweighs the positive effect of higher consumer demand that results from the price reduction.

The macroeconomic impact of the IRA on the Euro Area and the Dutch GDP is limited. This can be seen in Figure 6. The effects on output in the Euro Area are negligible in both scenarios. The Netherlands is slightly more exposed than the average Euro Area country to the effects of the IRA, because of stronger trade ties with the US, which we will analyse in some more detail below. As mentioned above, the long-run effects depend on productivity growth in the sectors towards which investment is drawn and lie beyond the scope of our analysis.

Figure 6 – GDP in scenarios 1 (left) and 2

Indexed deviation from steady state



2.3 Trade

A modest reduction of Euro Area and Dutch exports is the main driver behind the small decline of output in the Euro Area and the Netherlands under both scenarios. Figure 7 displays the results. In scenario 1, the drop in Euro Area and Dutch exports is driven by the US substituting away from foreign imports. Instead, US demand favours its domestically produced goods, which are subsidized under the IRA. In scenario 2, where the IRA's expenditures are financed by a distortionary corporate tax, the drop in Euro Area and Dutch exports is slightly larger. This is because the negative effect of the corporate tax in the US offsets the benefits of the subsidy, in turn, lowering US demand for goods, which negatively affects Euro Area and Dutch exports to the US.

An interesting yet intuitive result is that Dutch exports respond more strongly to the IRA than exports from the rest of the Euro Area. Figure 8 shows the difference between the trade balance for the Euro Area and Dutch economy. The Netherlands is a small open economy with more trade with the US economy than the Euro Area average. Therefore, Dutch exports respond more strongly to the IRA. The effect on the Dutch trade balance, however, is muted due to trade diversion. Specifically, a decline of Dutch exports to the US is partially offset by a rise in Dutch exports towards the rest of the Euro Area and the rest of the world. This adaptability in trade for the rest of the Euro Area is smaller, which results in a larger negative effect of the IRA on its trade balance in scenario 1. In scenario 2, the effects for the Netherlands are similar, while being more muted for the rest of the Euro Area. The reason is that the corporate tax in the US squeezes supply, putting up inflationary pressures. These tend to appreciate the dollar vis-a-vis the euro. This effect is absent in scenario 1 where the dollar instead depreciates vis-a-vis the euro. This explains why the deterioration in the trade balance of the rest of the Euro Area is slightly milder in scenario 2. The subsidies for domestically produced goods in the US dampen the demand for Euro Area products. The appreciation of the dollar though partially offsets this effect, leading to a milder overall deterioration of the trade balance.

Figure 7: Exports in scenario 1 (left) and 2

Indexed deviation from steady state

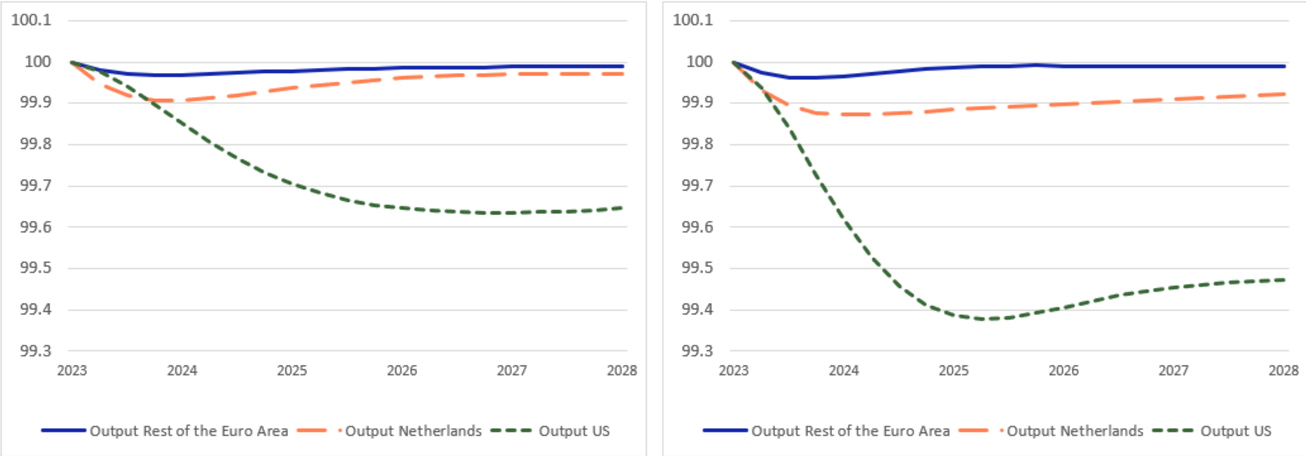
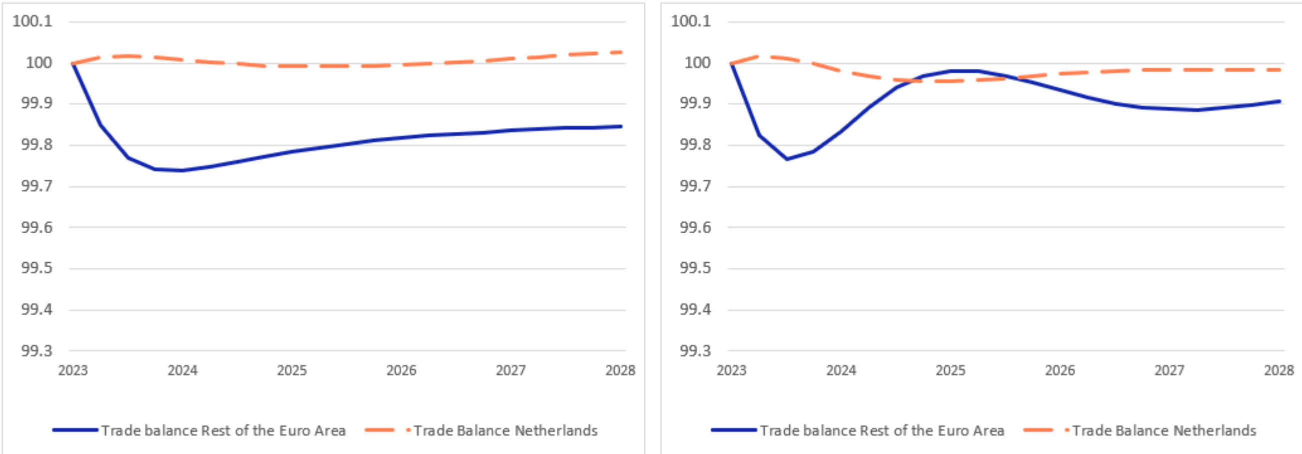


Figure 8: Trade balance in scenario 1 (left) and 2

Indexed deviation from steady state



Appendix 1 – technical appendix to EAGLE

The EAGLE Model – a more detailed description

The EAGLE (Euro Area and Global Economy) model is an open economy DSGE that accounts for international macroeconomic interdependence – within the Economic and Monetary Union, but also globally. It is a large-scale microfounded model that explicitly specifies the behavior of households, firms and monetary and fiscal authorities. It contains 4 regions: the home country (Netherlands), the rest of the Euro area (EA), the US and the rest of the world (RoW). We take RoW as representing China (and other non-EU targets of the US trade offensive).

For more information on the EAGLE model in general, please refer to Gomes, Jacquinot and Pisani (2010), The Eagle, A model for policy analysis of macroeconomic interdependence in the Euro Area.

Additions to EAGLE for this Analysis

The following sections contain a description of the additions to the EAGLE (2012) model in order to include a subsidy to home tradable goods, financed period by period by a production tax. The total expenditure of the subsidy is set exogenously, calibrated with observable data.

Section 1 shows the price subsidy scheme, Section 2 explains the modeling choice for taxing production, and section 3 determines the government budget dynamics. Throughout this document, the same notation as in the original EAGLE (2012) paper is followed.

1. Price subsidy

The subsidy is included directly as a reduction in the price of home tradable goods, used both for investment and production. Thus, the demand functions are as follows:

$$HT_t^C = \nu_{TC} \left(\frac{P_{HT,t}(1 - s_t^h)}{P_{TT^C,t}} \right)^{-\mu_{TC}} TT_t^C \tag{1}$$

$$HT_t^I = \nu_{TI} \left(\frac{P_{HT,t}(1 - s_t^h)}{P_{TT^I,t}} \right)^{-\mu_{TI}} TT_t^I \tag{2}$$

s_t^h is the subsidy rate, which as expressed in the Section 3, is determined period by period by a government that, being fiscally neutral with respect to this subsidy, decides exogenously the size of the total subsidy.

2. Production tax

Firms producing both tradable and non-tradable intermediate goods use the following production function:

$$Y_{N,t}^S(n) = \max\left\{ z_{N,t} K_t^D(n)^{\alpha_N} N_t^D(n)^{1-\alpha_N} - \psi_N, 0 \right\} \tag{3}$$

$$Y_{T,t}^S(h) = \max\left\{ z_{T,t} K_t^D(h)^{\alpha_T} N_t^D(h)^{1-\alpha_T} - \psi_T, 0 \right\} \tag{4}$$

These firms minimize production costs subject to their corresponding production function. The production tax adds to the total input cost for both types of firms, namely:

$$(1+\tau_t^Y)\left(R_t^K K_t^D(h)+(1+\tau_t^{W_f})W_t N^D(h)\right) \tag{5}$$

$$(1+\tau_t^Y)\left(R_t^K K_t^D(n)+(1+\tau_t^{W_f})W_t N^D(n)\right) \tag{6}$$

Where τ_t^Y is a time-varying production tax used to finance the price subsidy for U.S tradable goods. τ_t^Y is endogenous, and is determined by the government period by period in such a way that ensures fiscal neutrality with respect to the subsidy s_t^h. Furthermore, the definition of nominal marginal costs is:

$$MC_{N,t}=\frac{1+\tau_t^Y}{z_t z_{N,t}(\alpha_N)^{\alpha_N}(1-\alpha_N)^{1-\alpha_N}}(R_t^K)^{\alpha_N}\left(\left(1+\tau_t^{W_f}\right)W_t\right)^{1-\alpha_N} \tag{7}$$

$$MC_{N,t}=\frac{1+\tau_t^Y}{z_t z_{T,t}(\alpha_N)^{\alpha_N}(1-\alpha_N)^{1-\alpha_N}}(R_t^K)^{\alpha_N}\left(\left(1+\tau_t^{W_f}\right)W_t\right)^{1-\alpha_N} \tag{8}$$

3. Government

The government has a budget constraint which includes both the subsidy in the expenditure side, and the production tax in the revenue side:

$$P_{G,t}G_t+TR_t+B_t+M_{t-1}+\gamma_t\overline{P_Y Y}=$$

$$=\tau_t^C P_{C,t}C_t+\left(\tau_t^N+\tau_t^{W_h}\right)\frac{1}{s^H}\left(\int_0^{s^H(1-\omega)}W_t(i)N_t(i)di+\int_{s^H(1-\omega)}^{s^H}W_t(j)N_t(j)dj\right)$$
$$+\tau_t^{W_f}W_t N_t+\tau_t^K\left(R_{k,t}u_t-(\Gamma_u(u_t)+\delta)P_{I,t}\right)K_t+\tau_t^D D_t$$
$$+\mathrm{T}_t+R_t^{-1}B_{t+1}+M_t+\tau_t^Y\left(R_t^K K_t^D(n)+(1+\tau_t^{W_f})W_t N^D(n)\right) \tag{9}$$

γ_t is, the proportion of total output ($\overline{P_Y Y}$) that the government spends on the subsidy to home tradable goods in each period. This ratio is a exogenous AR(1) process $\gamma_t=\rho_\gamma\gamma_{t-1}+\epsilon_t^\gamma$, where the zero-mean random shock ϵ_t^γ that can be calibrated using observable data extracted directly from the U.S. treasury to match government expenditure over several periods. The relationship between the subsidy rate s_t^h and the size of the subsidy γ_t is defined as follows:

$$\gamma_t=\frac{s^h\left(P_{HT,t}(HT_t^I+HT_t^C)\right)}{\overline{P_Y Y}} \tag{10}$$

The subsidy rate is set by the government in each period in such a way that it ensures that the exogenous expenditure of the subsidy is satisfied. The subsidy rate also has to satisfy the fiscal neutrality constraint:

$$s_t^h\left(P_{HT,t}(HT_t^I+HT_t^C\right)=\tau_t^Y\left(R_t^K K_t^D(n)+(1+\tau_t^{W_f})W_t N^D(n)\right) \tag{11}$$

Equation (11) ensures that the government finances period by period the home tradable price subsidy with the revenues from the production tax. Thus, the production tax will also be set by the government period by period in order to satisfy simultaneously (10) and (11).

Appendix 2 – Additional information on graphs and calculations

This section provides an overview on some of the assumptions made in the figures that are part of this Analysis. Regarding timelines, estimates for Dutch funds run until 2027, because of availability. Estimates for EU Funds are not available on a provision level the way they are for the IRA and the Dutch funds. Hence we van only provide an indication of total expenditures and not a breakdown of these expenditures. Breakdowns and estimates for the Dutch funds are taken from the Miljoenennota, the yearly Dutch Budget Memorandum. We take these as given and assume that the expenditures, as stated, will be realized. Below are the assumptions per figure.

Figure 1 – IRA spending by component

- Subsidies and expenditures that are earmarked for air quality, forestry, and other environmental protection and restoration are categorised as "land-based measures & environmental protection".
- Subsidies targeted at the production or consumption of renewable energy or products are considered the relevant portion of the IRA.

Figure 2 – IRA, Dutch, and EU green public investment

- For all economies, the GDP figure for 2022 is used as a baseline. We then assume 2% yearly growth.
- For the US we only consider the IRA package.
- For the Dutch funds included in this analysis, see appendix 3
- For the EU funds we based the calculation on the EU's own goal of allocating at least 30% of the multiannual financial framework and Next Generation EU to climate. We assume that this goal will be reached and that all funds will have been distributed.
- There is some overlap in the Dutch and EU funds. For example, between 2023 and 2027 an amount of EUR 970 million allocated towards the *Investering Subsidie Duurzame Energie (ISDE).* This overlaps with the Dutch allocation of the EU's Recovery and Resilience Facility, of which EUR 624 million is allocated for the ISDE.

Figure 3 – Composition of subsidies until 2027

- In the IRA, most provisions are to be distributed through a single form. In some cases however, the provision allows for different forms of subsidies. In this case we categorise the provision according to which form is expected to comprise the largest share.

Figure 4 – Breakdown of innovation spending

- We categorise spending towards innovation there where provisions clearly and explicitly target research and development, or demonstration of technologies that are not readily available yet (e.g. green hydrogen).
- Note that *not specifically targeted at innovation* includes sectors, such as battery production, where innovation is still expect to occur.

Figure 5 – Sectoral division of IRA and Dutch green public expenditure

- For both economies, the GDP figure for 2022 is used as a baseline. We then assume 2% yearly growth.
- The provisions, in both the IRA and in the Netherlands, do not always target one specific sector. Often more than one sector is the beneficiary.
- A distribution per provision has been identified on the basis of descriptions of the provisions and expert judgement.

Appendix 3 – List of Dutch funds included in figures

- Climate fund / *Klimaatfonds*
    - Subsidies for zero emission gas plant / *Subsidieregeling CO2-vrije gas centrales*
    - Construction of nuclear energy plants / *Bouw kerncentrales*
    - Subsidies for early phase upscaling of hydrogen / *Subsidie vroege fase opschaling (waterstof)*
    - Energy infrastructure / *Energie-infrastructuur*
    - Tailored SME agreements, industry and innovation / *Maatwerk industrie/innovatie MKB*
- Climate agreement / *Klimaatakkoord*
    - Subsidies new electric vehicles / *Subsidies nieuwe elektrische autos*
    - Subsidies second-hand electric vehicles / *Subsidies tweedehands elektrische autos*
    - Fiscal EV stimulus package / *Fiscale stimulering EV personenautos*
    - Delivery and freight / *Bestel en vracht*
- Tax deduction for energy investments / *Energie-investerings aftrek (EIA)*
- Demonstration of energy and climate innovations / *Demonstratie energie- en klimaatinnovatie (DEI)*
- Investment subsidy for sustainable energy and energy savings / *Investeringssubsidie duurzame energie en energiebesparing (ISDE)*
- Accelerated climate investments for industry / *Versnelde klimaatinvesteringen industrie (VEKI)*
- IPCEI Hydrogen: 2nd and 3rd rounds / *IPCEI Waterstof: 2e en 3e golven*
- Sustainable energy production and climate transition stimulus + / *Stimulering duurzame energieproductie en klimaattransitie + (SDE +)*
- Sustainable energy production and climate transition stimulus ++ / *Stimulering duurzame energieproductie en klimaattransitie ++ (SDE ++)*
- Fiscal stimulus electric vehicles / *Fiscale stimulering elektrische autos (niet toepassen HADK, stimulering meer richten op particulieren ipv zakelijk)*
- Netting arrangement / *Salderingsregeling*