Stockholm School of Economics

Master Thesis in Economics

The 2010 Grexit

A counterfactual analysis using a Global VAR

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Abstract

The issue whether Greece should leave the euro is important for both Greece and the rest of Europe. As the wrong policy might be very costly it is important that the issue is carefully examined. This thesis analyses a counterfactual scenario where Greece leaves the eurozone. The Global VAR framework is extended to model a currency union by jointly conditioning the exchange rates and short-term interest rates of the eurozone economies. With this extension the Global VAR makes promising forecasts, and might be a useful practice to improve the forecasts of the model. With the framework the effects of a Grexit are analysed. The result is much in line with the expectations for most variables, but not convincing regarding the exchange rate as the model forecasts an appreciating Greek currency.

Keywords: Global VAR, GVAR, counterfactual analysis, Greece leaving the eurozone, Grexit

JEL Classification: C32, C35, C53, E17, F15, F42, F47

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1 Introduction

When the euro was introduced in 1999, Greece did not comply with the convergence criteria stated in the Maastricht Treaty, as the Greek deficit, debt, and inflation numbers were too high. Two years later the Greek economy still did not fulfil the requirements, but after having reported false figures, Greece was accepted as a member of the euro area. After entering, Greece saw interest rates drop to German levels, this spurring lending and deficits to grow even further. The increasing government deficit was still misreported to Eurostat, and once this was unveiled in 2009 the European sovereign debt crisis emerged. Greece has since then remained within the Eurozone and has seen its government debt increase, GDP slow down, and unemployment triple.

The purpose of this thesis is to model a counterfactual scenario where Greece withdraws from the eurozone. Method-wise a Global VAR model is utilized, which makes it possible to estimate effects both within and between countries. The model is then used to perform a counterfactual analysis for the period after an assumed Greek exit from the eurozone in the first quarter of 2010. Theory and method are inspired by M. H. Pesaran et al. (2007), which examines scenarios in which the UK or Sweden joins the eurozone in 1999.

There are several motivations for this thesis. One is that there are a plethora of opinions on which policies Greece should implement, as if to leave the euro or not. There are however a lack of quantitative and model based studies that examines the effects of different policies regarding the Greek participation in the eurozone. After researching the topic I could not find any academic study of this specific question. As the wrong policy potentially could be very costly there are good reasons to examine the effects of different policy decisions. As the policy issue is global there are also good reasons to use a model that can fetch the cross country effects.

The contribution of the thesis is twofold: (i) to study the topic of a counterfactual Grexit using a model approach , and (ii) the simulation of the eurozone by restricting the exchange rate and short-term interest rates of the included eurozone members, and doing so in a disaggregated setting.

M. H. Pesaran et al. (2007) does this with two entities by aggregating all the eurozone countries to one economy.

The thesis is structured as follows: Section two gives a brief economic background since the 1960s and summarizes the events of the crisis and its consequences on the Greek economy. Section three presents theory about optimum currency areas and how that relates to the eurozone and the economic situation of Greece. Moreover are other studies with estimated effects of a Grexit presented. In section four the counterfactual approach of the thesis is presented and the strengths and weaknesses of the method are discussed. The fifth section explains the Global VAR model and the sixth section how it is specified for this study. In the seventh section the scenario forecasts are specified and discussed. In the eighth section the results are presented and interpreted. In the ninth and last section the findings are discussed and evaluated.

2 Background

This section gives a brief economic background of Greek economic developments and summarizes the events of the crisis. Most of the numbers mentioned in this section are referenced in figure 1.

Before the euro

After the military junta was removed in 1974 the Greek economy faced a period of large deficits, high inflation and interest rates, and a depreciating currency. The GDP growth was high in nominal terms but staggering in real terms due to the high inflation. The poor macroeconomic performance continued throughout the 1980s and early 1990s, and the Greek sovereign debt rose from about 20 per cent of GDP to close to 100. As a result of this the Greek drachma, that previously had been pegged to the US dollar, would to become continuously devalued, a policy named *the sliding drachma* (Lazaretou 2003).

However, the Greek economy was about to dramatically improve. In 1991

Greece had signed the Maastricht Treaty and was aspiring to become an EMU member and adopt the future European common currency, the euro. The treaty included convergence criteria with the purpose to induce the aspiring countries to maintain sound economic policies regarding inflation, public finances (budget deficit and debt), exchange rate, and interest rates. Greece succeeded to dramatically improve in some of these aspects, though not to completely comply with the criteria.

From 1991 until 1999 inflation rates went from 20 per cent to the required 3 per cent. The public debt of 88 per cent of GDP was above the stated 60 per cent, but Greece had succeeded to stabilize the debt that before had been growing steadily from 21 per cent of GDP in 1980 (IMF 2015d).

The budget deficit was reduced from 10 per cent of GDP to a reported figure just under the 3 per cent required to comply with the criteria. Later this figure would be revised to just above the 3 per cent threshold. Reports of the 2004 Greek Financial audit of the Greek public finances have shown that the public finances of Greece during the qualification period where not as sound as reported (Eurostat 2004), but also the revised numbers were a substantial improvement compared to the Greek situation in the early 1990s.

Despite the lowered inflation during this period, the Greek drachma continued to weaken. As inflation had lowered also in other countries, the Greek improvements could not accommodate the difference in inflation rates to stabilize the drachma, which continued to depreciate until its exchange rate towards the euro was fixed in the middle of year 2000.

Inside the euro

Greece qualified as a member of the EMU and in the beginning of 2001 the euro was introduced as the official currency. After entering the eurozone Greece experienced a period of high economic growth. In the same period higher unit labour costs and reduced competitiveness made Greek exports less attractive, and the trade deficit increased (see figure 2). Coinciding with this the government spending increased rapidly, resulting in large budget deficits. Previously, under the sliding drachma regime Greek officials would have the

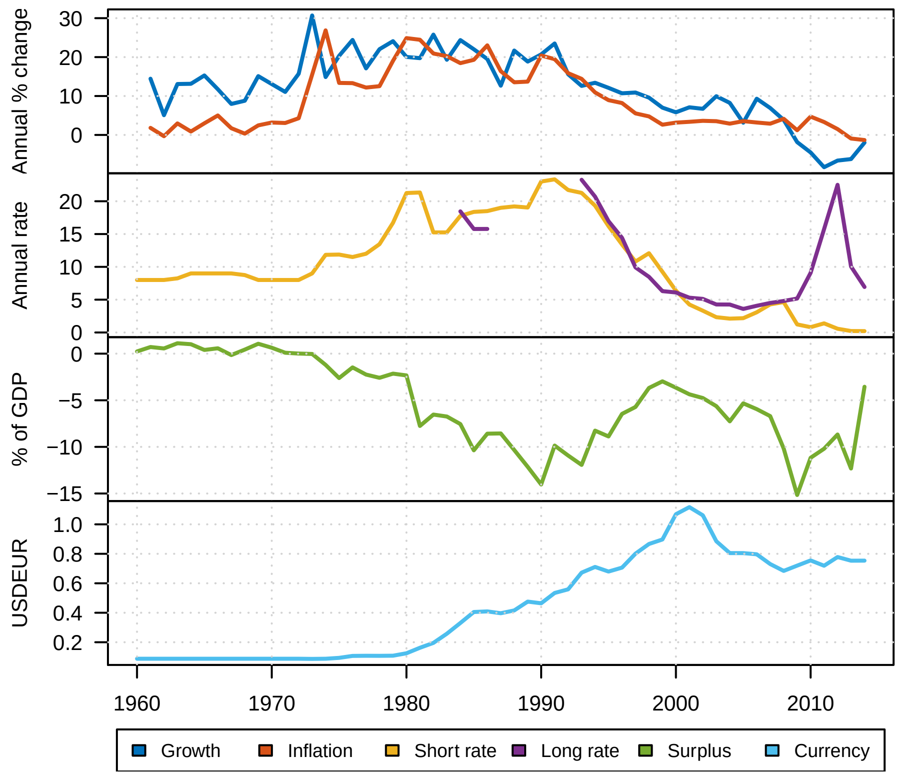

Figure 1: Greek economic data – Annual series from IMF, OECD and the World Bank. See appendix A.

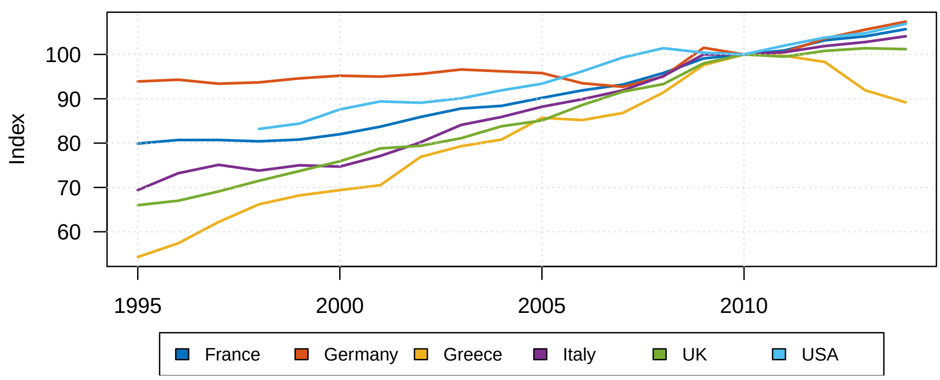

Figure 2: Unit labour cost – Annual series from OECD. See appendix A.

option to devalue the drachma and in this way reduce the deficit and improve competitiveness. While the common currency had deprived Greece of its devaluation tool it had provided something else: low interest rates. In 1994 and the years before Greek bond rates were above 20 per cent, while being at German levels below 5 per cent after the entry in 2001 and up until the financial crisis. This helped Greece to finance its deficits. During this period the misreporting continued. Each year in the period 2005 to 2009 Eurostat noted reservations to the reported fiscal figures of Greece, and to improve the reliability of those figures more than 10 delegations were sent to Athens since 2004 (European Commission 2010). To convey a favourable image of its public finances Greece engaged American investment banks that helped the Greek government to with financial arrangements to hide the full extent of the Greek deficit and debt (Balzli 2010; Story et al. 2010). Greece was not alone in pursuing those practices, but would eventually be the country within the eurozone to suffer the hardest ordeal during the forthcoming crisis.

Budget crisis and austerity measures

In 2009, Greece started to be seriously affected by the financial crisis of 2007–2008. In October 2009 the finance minister George Papaconstantinou of the newly elected government revealed that the budget deficit was expected to reach about 12.5 per cent of GDP. This was far above the 6 to 8 per cent projected by the former government, but not unexpected (Hope 2009; Barber 2009). This was followed by a series of downgrades by the credit rating agencies (Associated Press 2009).

In January 2010 finance minister Papaconstantinou published the *Hellenic Stability and Growth Programme* to address the economic challenges that Greece faced (Ministry of Finance 2010). The program contained a reform program to improve the public finances by cutting government expenditures as salaries, and increase taxes. The reforms were passed into legislation by the Greek parliament by three austerity packages in February, March, and May (H. Smith 2010; Hope 2010b).

Due to the economic difficulties the yield of the Greek government bonds increased during the spring of 2010 (Sithole-Matarise 2010), but Greece could still issue bonds in early March, though the high rates made it costly (Hope 2010a; Oakley 2010). Because of the bad outlook for Greece its credit ratings were downgraded to junk status in April, and because of this not a viable option for institutional investors, thus increasing the yield even more (Wachman and Fletcher 2010). By then Prime Minister George Papandreou had already formally requested a bailout (Kitsantonis and Saltmarsh 2010).

At this time it was obvious that Greece was not able to sustainable service its debt. This was worrying for the other EMU and EU countries as a Greek economic meltdown could have Greece default on its sovereign debt, and to exit the eurozone. Such an event could, with the Bankruptcy of Lehman Brothers in mind, have huge economic consequences, but also spur doubts about the stability of the currency union.

Thus there were incentives to help Greece in its economic hardship, and on 2 May the first bailout programme was launched by ECB, EC, and the IMF (IMF 2010). In addition to a €110 billion financing plan the programme contained demands for economic and structural reforms to reduce government expenditures and improve competitiveness. Since 2010 and until the writing of this thesis several programmes of this kind have been launched, received with public anger among the Greeks, that ended in demonstrations and strikes. One referendum on the economic terms of the programmes was announced in 2011 and later cancelled, shortly followed by the prime minister's resignation. Since the crisis began Greece has been in struggle. At the same time as the GDP has been in decline, there has been a steep increase of the government debt, and the unemployment has tripled.

3 Theory and previous research

The issue of whether the eurozone is an optimum currency area (OCA) is a useful perspective when deliberating on the effects of a complete or partial breakup. In Mundell (1961) it is argued that if countries or regions that share the same currency face asymmetric shocks, they do not compose an OCA. This would result in different real economy outcomes, such as high demand and inflation in one country, and low demand and unemployment in others. With a flexible currency the asymmetries could be accommodated by a change in the exchange rates, but this is not feasible within a currency union.

In the case with flexible prices and a high degree of factor mobility between the countries within a currency union, the asymmetries could be accommodated by factor redistribution. A currency union can also in itself improve the economic efficiency in the long term, as it brings a commitment to not accommodate by exchange rates and thus induce a greater degree of factor mobility between the included countries. Mundell and other proponents of a European currency as Scitovsky (1958) refer to the long term benefits of a currency union. Eichengreen (1997) criticises this view arguing that structural accommodation by factor reallocation is a slow process and that individual monetary policy and flexible exchange rates are more powerful. Meade (1957) argues that there are too many barriers such as Europe's many languages to have sufficient labour mobility to form a single currency area.

When addressing the research question of this thesis from an empirical perspective we can ask whether the eurozone is an OPA, or more specifically; if the Greek economy is well fitted in the EMU framework with regards to e.g. monetary policy, and what could have been the consequences if Greece had left in 2010.

In hindsight for the period 2010–2013 we can observe that the economic outcomes within the eurozone have been asymmetric as described by Mundell (1961) with northern countries as Germany exhibiting strong growth and a large trade surplus, and southern economies as Italy and Spain in the south with a much more dampened economic outcome ("Northern lights, southern cross" 2011; "North and south" 2012). Greece has been in recession for the entire period with high unemployment. Eichengreen (1997) would argue that this has been unnecessary and that Greece outside the eurozone could have performed much better. Mundell (1961) and Mundell (1969) would have admitted that this is the case, but that in the long term Greece would benefit as it would need to adapt by reforming its economy. What is long term is however ambiguous, and Greece have not had any major turnaround during the studied period, and it might be the case that the outcome would have been better outside the euro.

But the event of never entering the euro might yield different results than exiting the euro. Eichengreen (2007) discusses the political and economic consequences of a country leaving the eurozone, and argues that it is dependent on which country that leaves. A country like Greece might consider to exit and introduce the drachma to be able to conduct its own monetary policy and to improve its competitiveness. This gain might though be outweighed by higher inflation. Greece would also face higher interest rate spreads and debt-serving costs. This would make it possible for Greece to redenominate its debt to drachma, triggering a default. Greece would have to consider the political effects of these actions. The regained competitiveness would be at the expense of the remaining countries, and a Greek default event might be costly for European banks owning Greek government bonds. It is not unlikely that this would make Greece to be considered a second-tier in the European community and there might be policies as compensatory tariffs enacted to retaliate and deter other member states from exiting.

For this thesis I have extensively searched the literature for estimated macroeconomic effects of a Grexit. To the best of my knowledge, there are no model-based approaches to estimate the effects of a Grexit, neither forecast projections nor counterfactual scenarios. IMF projected in 2012 that a Grexit would have an introduced Greek currency devalue by 50 per cent and cause a decline of output by 10 per cent over the first year (von Hoffman 2012). Roubini (2011b) and Roubini (2011a) argues that Greek real GDP would fall sharply and over time drop about 30 per cent in euro terms, regardless if Greece stayed within the eurozone or not, but that staying would prolong this period. He does also estimate the new drachma to depreciate by about 30 per cent. Feldstein (2012) also foresees a depreciated currency, and argues that this would boost Greek output but without specifying any figures. Buiter (2011) and Åslund (2012) depict a more dire outcome where a new drachma would plummet, by 65 per cent according to Buiter (2011) and by 75 to 80 per cent according to Åslund (2012). It is further argued that this will make wages and prices to soar and by this restore the uncompetitive status, thus making production output to rapidly decline.

To summarize: the expected outcome for Greece leaving the eurozone would be higher interest rates, a depreciating currency, and a fall in output.

4 The counterfactual approach

The advantage of the Global VAR is that it can estimate and simulate multiple countries, but as any model it has both strengths and weaknesses. The reason why it became the choice of this thesis is that it makes it possible to simultaneously and dynamically simulate a currency union in a global setting.

The Global VAR is not structural. As the model includes multiple countries, the decomposition of the covariance matrix is extremely difficult, if not impossible. As the event that is to be simulated in this thesis is indeed a very large economic shock in econometric terms, the empirical setting is vulnerable to the Lucas critique. We cannot be sure that the economic properties of Greece, as so for rest of the eurozone, are the same before and after a Grexit. But neither can we be sure that the economic structure would change, even less so on an aggregate level. A structural model would also be able to produce an economic interpretation of the developments.

Another feature is that the model is linear. As the eurozone is simulated using the models endogenous exchange rate and short term interest rate, one could argue that a Grexit is a fat-tail event that would cause extreme financial effects that the linear model does not fetch. The way the eurozone is modelled also does not for other counties to follow Greece and exit the eurozone.

Despite some potential limitations of the GVAR model, I still think that this application is very interesting and that the model can contribute to a topic that has not been much addressed using economic models.

5 The global vector autoregression model

Model description

The global vector autoregression (e.g. global VAR or GVAR) model framework was introduced by M. H. Pesaran et al. (2004) and further examined and developed by Dees et al. (2007). L. V. Smith and Galesi (2014) summarize the advantages of the GVAR model as follows: (i) allows for interdependence at a variety of levels (national and international) in a transparent way that can be empirically evaluated, (ii) allows for long-run relationships consistent with the theory and short-run relationships that are consistent with the data, and (iii) provides a coherent, theory-consistent solution to the curse of dimensionality in global modelling.

The GVAR combines individual VAR-models, estimated in a vector error-correction model (VECM) setting, into a global model. This makes it possible to study cross country effects of a large number of individual country models that would have too many unknown parameters to estimate if they were included into an unrestricted VAR-model. The individual country models are denoted VARX*, where the X stands for the inclusion of foreign variables. A foreign variable is a weighted sum of the corresponding domestic variable present in all of the other VARX*-models. The weights used for one country should well mirror the effect brought upon it by the domestic variables of the other countries. Trade flow data might be a good proxy of how the demand of one country channels to its trade partners, and might thus be well suited to to create weights for GDP. For financial variables measures of financial inter-linkages might be better, such as cross country financial flows or debt. An essential assumption to estimate the model is that the foreign variables are weakly exogenous in all of the individual country models. When a variable is weakly exogenous in an error-correction model, it is not affected if the model deviates from its long-run equilibrium; instead the other variables that are not weakly exogenous are affected. Another assumption is that the idiosyncratic shocks of the individual country models are cross-sectionally weakly correlated; this means that the cross-sectional correlation of idiosyncratic shocks approach zero when the number of countries increases. These assumptions make it possible to estimate the individual country models separately before they are combined to solve the global model. If the variables where not weakly exogenous they would have to be included as endogenous, and the coefficients of the models would be estimated without any data from the other countries. Optionally global variables can be included in the VARX*. As the name global variable implies these are not country specific and can be used for variables with a common value for all countries, such as commodity prices.

Assume there are $N+1$ countries indexed $i = 0, 1, 2, \ldots, N$. The country with the index $i = 0$ is the base country of the model. The exchange rate of the other countries will be relative to the currency of the base country, and if global variables are included they will be considered endogenous for the base country. Thus it is recommended that the base country is not a small open economy, but instead one with large domestic demand, preferably the United States.

The general VARX*(p, q) model can then be written as

$$\mathbf{x}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i t + \sum_{k=1}^{p} \mathbf{\Phi}_{i,k}\mathbf{x}_{i,t-k} + \sum_{l=0}^{q} \mathbf{\Lambda}_{i,l}\mathbf{x}^*_{i,t-l} + \mathbf{u}_{i,t} \tag{1}$$

where p is the lag order of the endogenous domestic variables in the $\mathbf{x}_{i,t}$ vector, and q is the lag order of the exogenous foreign variables in $\mathbf{x}^*_{i,t}$. As previously mentioned the foreign variables are calculated using weights, $\mathbf{x}^*_{i,t} = \sum_{j=0}^{N} w_{i,j}\mathbf{x}_{j,t}$ with $w_{i,i} = 0$. The length of these vectors equals the amount of corresponding variables. $\mathbf{\Phi}_{i,k}$ and $\mathbf{\Lambda}_{i,l}$ are the coefficient matrices of the associated variable vectors. Their rows amount to the number of endogenous variables in $\mathbf{x}_{i,t}$, and their columns amount to the number of variables in the corresponding variable vector ($\mathbf{x}_{i,t-k}$ and $\mathbf{x}^*_{i,t-l}$). $\boldsymbol{\alpha}_i$ and $\boldsymbol{\beta}_i$ are vectors for the intercept and the deterministic time trend. $\mathbf{u}_{i,t}$ is a vector with idiosyncratic shocks, $iid(\mathbf{0}, \mathbf{\Sigma}_{i,i})$. The global variables must be included as endogenous variables for one country as previously mentioned, otherwise that cannot be forecast and other countries that have it included as a exogenous variable will break down. The VECMX*(p, q) model, which is the error-correcting representation of the VARX*(p, q) model is written as

$$\begin{aligned}\Delta \mathbf{x}_{i,t} &= \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i t + \boldsymbol{\Pi}_i \mathbf{x}_{i,t-1} + \sum_{k=1}^{p-1} \boldsymbol{\Gamma}_{i,k} \Delta \mathbf{x}_{i,t-k} + \boldsymbol{\Lambda}_{i,0} \Delta \mathbf{x}^*_{i,t} \\ &\quad + \sum_{l=0}^{q} \boldsymbol{\Lambda}_{i,l} \mathbf{x}^*_{i,t-1} + \sum_{l=0}^{q-1} \mathbf{E}_{i,l} \boldsymbol{\Delta} \mathbf{x}^*_{i,t-l} + \mathbf{u}_{i,t} \\ \boldsymbol{\Pi} &= \sum_{k=1}^{p} \boldsymbol{\Phi}_{i,k} - \mathbf{I}_k \qquad \boldsymbol{\Gamma}_n = - \sum_{o=n+1}^{p} \boldsymbol{\Phi}_{i,o} \qquad \mathbf{E}_n = - \sum_{r=n+1}^{q} \boldsymbol{\Lambda}_{i,r}\end{aligned} \tag{2}$$

where the coefficient matrices and variables are the same as in the VARX* representation that later is used when the global model is solved. From the general VECMX*(p, q) model we derive the simpler VECMX*(1, 1) model in equation 3 for a more convenient illustration.

$$\Delta \mathbf{x}_{i,t} = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i t + (\boldsymbol{\Phi}_{i,1} - \mathbf{I}_k)\, \mathbf{x}_{i,t-1} + (\boldsymbol{\Lambda}_{i,0} + \boldsymbol{\Lambda}_{i,1})\, \mathbf{x}^*_{i,t-1} + \boldsymbol{\Lambda}_{i,0} \Delta \mathbf{x}^*_{i,t} + \mathbf{u}_{i,t} \tag{3}$$

The VECMX*-model is estimated conditional on the assumption that the $\mathbf{x}^*_{i,t}$ variables being weakly exogenous.

To construct the Global VAR model the country-specific model estimates are first transformed to a VAR representation; the domestic and foreign variables stacked in one vector, $\mathbf{z}_{i,t} = \begin{pmatrix} \mathbf{x}_{i,t} \\ \mathbf{x}^*_{i,t} \end{pmatrix}$. The VARX*(1, 1) can then be written as

$$\begin{aligned}\mathbf{A}_i \mathbf{z}_{i,t} &= \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i t + \mathbf{B}_{i1} \mathbf{z}_{i,t-1} + \mathbf{u}_{it} \\ \mathbf{A}_i &= (\mathbf{I}_k, -\boldsymbol{\Lambda}_{i0}) \quad \mathbf{B}_{i,1} = (\boldsymbol{\Phi}_{i,1}, \boldsymbol{\Lambda}_{i,1})\end{aligned}. \tag{4}$$

As the foreign variables for one country are weighted aggregates of the domestic variables of all the other countries in the global model, thus the $\mathbf{z}_{i,t}$ vector of each country can be written as a linear combination of a vector that contains all the country specific variables, $\mathbf{x}_t = \left(\mathbf{x}'_{1,t}, \mathbf{x}'_{2,t}, \ldots, \mathbf{x}'_{N,t}\right)'$, using the link matrix $\mathbf{W}_i$ for this country. Thus we have $\mathbf{z}_{i,t} = \mathbf{W}_i \mathbf{x}_t$. The link matrix $\mathbf{W}_i$ with size $(k_i + k^*_i) \times k$, in which each of the first k_i rows contains a one at the positions of the domestic variables of country i in the $\mathbf{x}_t$ vector. The next k^*_i rows is used to create the foreign variables and each contains the weights w^v_{ij} at the position for the corresponding variables for the other countries.

The country models can thus be written as function of the $\mathbf{x}_t$ vector,

$$\mathbf{A}_i\mathbf{W}_i\mathbf{x}_t = \boldsymbol{\alpha}_i + \boldsymbol{\beta}_i t + \mathbf{B}_{i1}\mathbf{W}_i\mathbf{x}_{t-1} + \mathbf{u}_{it}. \tag{5}$$

By stacking these individual country models, we have the global model in its structural form

$$\mathbf{G}\mathbf{x}_t = \boldsymbol{\alpha} + \boldsymbol{\beta} t + \mathbf{H}_1\mathbf{x}_{t-1} + \mathbf{u}_t. \tag{6}$$

As $\mathbf{G}$ is known and non-singular, we can from 6 derive the reduced form

$$\begin{gathered}\mathbf{x}_t = \mathbf{a} + \mathbf{b}t + \mathbf{F}_1\mathbf{x}_{t-1} + \mathbf{v}_t \\ \mathbf{a} = \mathbf{G}^{-1}\boldsymbol{\alpha} \quad \mathbf{b} = \mathbf{G}^{-1}\boldsymbol{\beta} \quad \mathbf{F}_1 = \mathbf{G}^{-1}\mathbf{H}_1 \quad \mathbf{v}_t = \mathbf{G}^{-1}\mathbf{u}_t\end{gathered}. \tag{7}$$

The fact that the GVAR consists of many country specific models and by that has a large number of variables limits the dynamic analysis of the model. The identification of shocks by Cholesky decomposition is not possible as this requires the variables to be ordered, something that is possible in a smaller model, but not in a GVAR setting with multiple countries. Restricting structural equations would be very useful, but if possible a very complex task with a model as large as the GVAR, and out of scope in this application. Instead the dynamic properties will be examined using the Generalized impulse response function (GIRF) of the model, $\psi_j^g(n) = \frac{1}{\sqrt{\sigma_{ii,ll}}}\mathbf{F}^n\mathbf{G}^{-1}\boldsymbol{\Sigma}\mathfrak{s}_j$, where contemporary shock vector from a shock in variable j, represented by a unit shock in the selection vector $\mathfrak{s}_j$, is determined by the covariance matrix $\boldsymbol{\Sigma}$ (Koop et al. 1996; M. H. Pesaran and Shin 1998; M. H. Pesaran and R. P. Smith 1998). The shock vector is multiplied with $\mathbf{G}^{-1}$ for reduced form representation. $\mathbf{F}$ contains the coefficients of the model. If the model has more than one lag it is preferably written in companion form similar to the idiosyncratic term of equation 10 in the following subsection.

Model forecasts

The unrestricted forecast from the estimated reduced form GVAR is given by $\boldsymbol{\mu}_h = \hat{\mathbf{a}} + \hat{\mathbf{b}}(T+h) + \hat{\mathbf{F}}_{1,t-1}\mathbf{x}_{h-1} + \hat{\mathbf{F}}_{2,t-2}\mathbf{x}_{h-2}$, where $h = 1, 2, \ldots, H$ is the time index for the forecast. Normally a forecast starts after the last time index T of the estimated model such that $h_0 = T$, but this might not be the case in counter factual scenarios as in this thesis where forecasts are in-sample. To distinguish between them we introduce the term T_0 which is the time period before the first forecast, such that $T_0 = h_0$.

When the GVAR model as in the example above has more than one lag, it is convenient to use the companion form of the model,

$$\begin{pmatrix} \mathbf{x}_t \\ \mathbf{x}_{t-1} \end{pmatrix} = \begin{pmatrix} \mathbf{F}_1 & \mathbf{F}_2 \\ \mathbf{I} & \mathbf{0} \end{pmatrix} \begin{pmatrix} \mathbf{x}_{t-1} \\ \mathbf{x}_{t-2} \end{pmatrix} + \begin{pmatrix} \mathbf{a} + \mathbf{b}t \\ \mathbf{0} \end{pmatrix} + \begin{pmatrix} \mathbf{v}_t \\ \mathbf{0} \end{pmatrix} \tag{8}$$

$$\mathbf{X}_t = \mathbf{F}\mathbf{X}_{t-1} + \mathbf{D}_t + \mathbf{V}_t \tag{9}$$

The companion form makes it easy to solve the difference equation to have the future state at time $T_0 + h$ given the initial state at time T_0,

$$\mathbf{X}_{T_0+h} = \mathbf{F}^h \mathbf{X}_{T_0} + \sum_{s=0}^{h-1} \mathbf{F}^s \mathbf{D}_{T_0+h-s} + \sum_{s=0}^{h-1} \mathbf{F}^s \mathbf{V}_{T_0+h-s} \tag{10}$$

where the first term is the effect from the initial state values; the second term is the effect from the deterministic trends of the model. The last term is the non-deterministic effect that comes from the idiosyncratic shock vector. The $\mathbf{X}_{T_0+h}$ of the companion form model contains not only the $\mathbf{x}_{T_0+h}$ result, but also $\mathbf{x}_{T_0+h-1}$. We extract the first k rows with $\mathbf{x}_{T_0+h} = \mathbf{E}_1 \mathbf{X}_{T_0+h}$ where $\mathbf{E}_1 = \begin{pmatrix} \mathbf{I} & \mathbf{0} \end{pmatrix}$, to have the result in standard form. The endogenous point forecast in standard form is thus given by the expression 10 above multiplied with $\mathbf{E}_1$, excluding the idiosyncratic term

$$\boldsymbol{\mu}_h = \mathbf{E}_1 \mathbf{F}^h \mathbf{X}_{T_0} + \sum_{s=0}^{h-1} \mathbf{E}_1 \mathbf{F}^s \mathbf{D}_{T_0+h-s}. \tag{11}$$

To later construct the counterfactual scenarios conditional forecasts will be used. By conditioned is meant that for some variables the forecast values are restricted, in our case in a way to simulate the eurozone (read more about this in section 7). If we look at the endogenous forecast $\boldsymbol{\mu}_h$ in equation 11 compared to the forecast expression given by the solved difference equation in equation 10, it lacks the term that contains the idiosyncratic shock vector

$\sum_{s=0}^{h-1} \mathbf{F}^s \mathbf{V}_{T_0+h-s}$. In this application conditioned forecasts $\boldsymbol{\mu}_h^*$ will contain shocks so that the conditioned variables match the imposed restrictions as in M. H. Pesaran et al. (2007).

The conditioning is imposed by the restrictions given by the expression $\boldsymbol{\Psi}\mathbf{x}_{T_0+j} = \mathbf{d}_{T_0+j}, j = 1, 2, \ldots, \bar{H}$, where $\boldsymbol{\Psi}$ is a selection matrix where each row represents a restriction, and each column corresponds to a variable in $\mathbf{x}_t$. The inclusion of one or multiple non-zero values in a row will thus include those variables in the restriction that the row represents. $\mathbf{d}_{T_0+j}$ contains the values to which the linear combination of $\boldsymbol{\Psi}\mathbf{x}_{T_0+j}$ must match for each time index j of the forecast. Thus the conditional forecast can be expressed as

$$\boldsymbol{\mu}_h^* = E\left(\mathbf{x}_{T_0+h} | \mathcal{I}_T, \boldsymbol{\Psi}\mathbf{x}_{T_0+j} = \mathbf{d}_{T_0+j}, j = 1, 2, \ldots, \bar{H}\right), \tag{12}$$

where $\mathcal{I}_T$ is the information set at time T.

To solve the conditioned forecast for the given restriction, start with the expression $\mathbf{x}_{T_0+h} = \boldsymbol{\mu}_h + \boldsymbol{\xi}_{T_0+h}$, where $\boldsymbol{\xi}_{T_0+h} = \sum_{s=0}^{h-1} \mathbf{E}_1 \mathbf{F}^s \mathbf{V}_{T_0+h-s}$. It is assumed that the distribution of $\boldsymbol{\xi}_{T_0+h}$ is the same as for our model $\boldsymbol{\xi}_{T_0+h} | \mathcal{I}_T \sim N(\mathbf{0}, \boldsymbol{\Omega}_{hh})$.With the restrictions imposed it follows that $\boldsymbol{\Psi}\boldsymbol{\xi}_{T_0+j} = \mathbf{d}_{T_0+j} - \boldsymbol{\Psi}\boldsymbol{\mu}_j, j = 1, 2, \ldots, \bar{H}$, which is the difference between the endogenous forecast and the values for the restricted variables of the conditioned forecast. If we have this difference in a given vector $\mathbf{g}_j = \mathbf{d}_{T_0+j} - \boldsymbol{\Psi}\boldsymbol{\mu}_j \forall j$, we can then have the expression $\boldsymbol{\Psi}\boldsymbol{\xi}_{T_0+j} = \mathbf{g}_j$ where the effects of the idiosyncratic shocks fulfil the restrictions of the conditioned variables. To find a solution that satisfies the restrictions the system is written in its matrix representation $(\mathbf{I} \otimes \boldsymbol{\Psi})\, \widetilde{\boldsymbol{\xi}}_{\bar{H}} = \widetilde{\mathbf{g}}_{\bar{H}}$ where $\widetilde{\boldsymbol{\xi}}_{\bar{H}} = \left(\boldsymbol{\xi}'_{T_0+1}, \boldsymbol{\xi}'_{T_0+2}, \ldots, \boldsymbol{\xi}'_{T_0+\bar{H}}\right)'$ and $\widetilde{\mathbf{g}}_{\bar{H}} = \left(\mathbf{g}'_1, \mathbf{g}'_2, \ldots, \mathbf{g}'_{\bar{H}}\right)'$. The Kronecker product ($\otimes$) produces a matrix with $\boldsymbol{\Psi}$ matrices along the diagonal. When multiplied with $\widetilde{\boldsymbol{\xi}}_{\bar{H}}$ the $\boldsymbol{\Psi}$ matrices along the diagonal will be multiplied with the corresponding $\boldsymbol{\xi}'_{T_0+j}$ that in turn equals the corresponding vector $\mathbf{g}_j$ within the larger $\widetilde{\mathbf{g}}_{\bar{H}}$ vector so that all the equations from the normal form are present in the matrix representation.

Under joint normality of the shocks, we have for $h = 1, 2, \ldots, H < \bar{H}$

where H is the forecast horizon, and $\bar{H}$ is the commitment horizon,

$$
\begin{gathered}
E\left(\boldsymbol{\xi}_{T_0+h}|\mathcal{I}_T, \boldsymbol{\Psi}\mathbf{x}_{T_0+j} = \mathbf{d}_{T_0+j}, j = 1, 2, \ldots, \bar{H}\right) = \\
E\left(\boldsymbol{\xi}_{T_0+j}|\mathcal{I}_T, \left(\mathbf{I} \otimes \boldsymbol{\Psi}\right) \tilde{\boldsymbol{\xi}}_{\bar{H}} = \tilde{\mathbf{g}}_{\bar{H}}\right) = \\
(\mathfrak{s}'_{h\bar{H}} \otimes \mathbf{I})\tilde{\boldsymbol{\Omega}}_{\bar{H}} \left(\mathbf{I}_{\bar{H}} \otimes \boldsymbol{\Psi}'\right) \left[\left(\mathbf{I}_{\bar{H}} \otimes \boldsymbol{\Psi}\right) \tilde{\boldsymbol{\Omega}}_{\bar{H}} \left(\mathbf{I}_{\bar{H}} \otimes \boldsymbol{\Psi}'\right)\right]^{-1} \tilde{\mathbf{g}}_{\bar{H}} \quad , \\
\tilde{\boldsymbol{\Omega}}_{\bar{H}} = \begin{matrix} \boldsymbol{\Omega}_{11} & \cdots & \boldsymbol{\Omega}_{1\bar{H}} \\ \vdots & \ddots & \vdots \\ \boldsymbol{\Omega}_{\bar{H}1} & \cdots & \boldsymbol{\Omega}_{\bar{H}\bar{H}} \end{matrix} \quad \boldsymbol{\Omega}_{ij} = \begin{cases} \mathbf{E}_1 \sum_{s=0}^{i-1} \mathbf{F}^s \boldsymbol{\Sigma} \mathbf{F}'^s \mathbf{E}_1' & i = j \\ \mathbf{E}_1 \left(\sum_{s=0}^{i-1} \mathbf{F}^s \boldsymbol{\Sigma} \mathbf{F}'^s\right) \mathbf{F}'^{(j-i)} \mathbf{E}_1' & i < j \\ \mathbf{E}_1 \mathbf{F}'^{(j-i)} \left(\sum_{s=0}^{i-1} \mathbf{F}^s \boldsymbol{\Sigma} \mathbf{F}'^s\right) \mathbf{E}_1' & i > j \end{cases} ,
\end{gathered}
\tag{13}
$$

, where $\mathfrak{s}'_{h\bar{H}}$ is a selection vector where the h:th element is unity and zero elsewhere. $\tilde{\boldsymbol{\Omega}}_{\bar{H}}$ is the matrix that contains the dynamic effects of the covariance matrix over time. With this expression we can find a solution for $\boldsymbol{\xi}_{T_0+j}$, and obtain the conditional forecast $\boldsymbol{\mu}_h$.

6 Data and model estimation

This section presents the data, the model specification, and the model estimates that later will be used for the scenarios. The data and estimate properties are tested for if they match the model assumptions. The GVAR-Toolbox by L. V. Smith and Galesi (2014) is a software package for Matlab that brings both estimation and testing together and has been used producing the results for this thesis. To fit the counterfactual approach of the thesis the code has been modified, mostly in the packages forecasting functions.

Data

As Greece is the main subject of interest in the analysis, its top trading partners are included in the model. Seven countries were selected after reviewing Greek trade from IMF (2015a) for the selected period: France, Germany, Greece, Italy, Turkey, United Kingdom, and the United States which is the base country of the model. The dataset covers the period from the first quarter of 1995 to the last quarter of 2013 and its country variables

Table 1: Model variable specification

Incl.	Endogenous									Exogenous								
Type	Domestic						Global			Foreign/RoW						Global		
Vars.	y	π	e^R	i^S	i^L	a	b	c	m	y	π	e^R	i^S	i^L	a	b	c	m
FRA	•	•	•	•	•	•				•	•		•	•	•	•	•	•
GER	•	•	•	•	•	•				•	•		•	•	•	•	•	•
GRE	•	•	•	•	•	•				•	•		•	•	•	•	•	•
ITA	•	•	•	•	•	•				•	•		•	•	•	•	•	•
TUR	•	•	•	•		•				•	•		•	•	•	•	•	•
UK	•	•	•	•	•	•				•	•		•	•	•	•	•	•
USA	•	•		•	•	•	•	•	•	•	•	•	•	•	•			

are gathered from OECD (2015b), IMF (2015b), and the US FED (2015). Global variables are gathered from EIA (2015) and IMF (2015c). The weights are taken from L. V. Smith and Galesi (2014) and have been complemented using IMF (2015a) to also include Greece. For more detailed information about the data see appendix A.

The country specific models are small macro models. The included domestic variables are real output ($y_{i,t}$), inflation rate ($\pi_{i,t}$), real exchange rate ($e^R_{i,t}$), short-term interest rate ($i^S_{i,t}$), long-term interest rate ($i^L_{i,t}$), and current account ($a_{i,t}$). The i is country-specific index, and t is the time index. The same variables are also included as foreign variables. Exceptions to this are the following: The real exchange rate is only included as a foreign variable in the base country United States, and only as a domestic variable in the other countries. The long-term interest rate for Turkey does not cover the whole time period and has been omitted from the dataset. Global variables are the Brent oil prices (b_t), raw material prices/commodities (c_t), and metal prices (m_t), and are treated as exogenous variables except for the United States. As the global variables are the same for all countries they don't have an i index. Most of the variables used in the model transformed from its level form by some form of logarithmic function. For an overview see table 1 and equation 14.

Model form

$$y_{i,t} = \ln(Y_{i,t}) \qquad p_{i,t} = \ln(P_{i,t}) \qquad \pi_{i,t} = p_{i,t} - p_{i,t-1}$$

$$e_{i,t}^{N} = \ln\left(E_{i,t}^{N}\right) \qquad e_{i,t}^{R} = e_{i,t}^{N} - p_{i,t} \qquad i_{i,t}^{S} = \frac{1}{4}\ln\left(1 + \frac{I_{i,t}^{S}}{100}\right)$$

$$i_{i,t}^{L} = \frac{1}{4}\ln\left(1 + \frac{I_{i,t}^{L}}{100}\right) \qquad b_t = \ln(B_t) \qquad c_t = \ln(C_t)$$

$$m_t = \ln(M_t)$$

Normal form

$Y_{i,t}$	Real GDP	(14)
$P_{i,t}$	Consumer price index	
$E_{i,t}^{N}$	Exchange rate per U.S. dollar	
$I_{i,t}^{S}$	Short interest rate per annum	
$I_{i,t}^{L}$	Long interest rate per annum	
$A_{i,t}$	Current Account	
B_t	Brent oil price index	
C_t	Commodity price index	
M_t	Metal price index	

The country models variable set vectors are defined as,

$$
\mathbf{x}_{i,t} = \begin{pmatrix} y_{i,t} \\ \pi_{i,t} \\ e^{R}_{i,t} \\ i^{S}_{i,t} \\ i^{L}_{i,t} \\ A_{i,t} \end{pmatrix} \qquad \mathbf{x}^{*}_{i,t} = \begin{pmatrix} y^{*}_{i,t} \\ \pi^{*}_{i,t} \\ i^{S*}_{i,t} \\ i^{L*}_{i,t} \\ A^{*}_{i,t} \\ \mathbf{g}_{t} \end{pmatrix}
$$

$$
\mathbf{x}_{0,t} = \begin{pmatrix} y_{0,t} \\ \pi_{0,t} \\ i^{S}_{0,t} \\ i^{L}_{0,t} \\ A_{i,t} \\ \mathbf{g}_{t} \end{pmatrix} \qquad \mathbf{x}^{*}_{0,t} = \begin{pmatrix} y^{*}_{0,t} \\ \pi^{*}_{0,t} \\ e^{R*}_{0,t} \\ i^{S*}_{0,t} \\ i^{L*}_{0,t} \\ A^{*}_{i,t} \end{pmatrix} \qquad \mathbf{g}_{t} = \begin{pmatrix} b_{t} \\ c_{t} \\ m_{t} \end{pmatrix}. \tag{15}
$$

Unit root test

The independent series of the model are first tested for the presence of unit root with the augmented Dickey-Fuller (ADF) unit root test, using both the traditional version and the more powerful one, developed by Park and Fuller (1995) that is based on weighted symmetric estimation. For domestic variables the test results are presented in table A2, and for all but inflation a significant proportion of the tests rejects the variable when not differenced, and rejects it when differenced. This indicate that the variables are integrated of order one. Similar results are obtained for the foreign variables in table A3, indicating the variables being integrated of order one, but the case is not that clear for the inflation variables. There are many papers that indicate that inflation is not a stationary variable (Ball and Cecchetti 1990; Brunner and Hess 1993; MacDonald and Murphy 1989) The study is conducted on the assumption of the inflation variables are I(1). The global variables in table A4 are indicated to be first order integrated. In the case of the oil price that is the case with trend but not without trend, so there is no strong evidence for this variable not to be I(1).

Lag orders

The domestic (p_i) and foreign (q_i) variable lag order of the country specific VARX* models are selected with the Akaike information criterion (AIC). Owing to data limitations we are required to have a parsimonious model, and we restrict both p_i and q_i to be at most two. The resulting lag specification can be seen in table A5. It shows that p_i and q_i are set to two with the exception of the foreign variables for Italy which are set to one.

Cointegration rank and deterministic trends

The deterministic terms of the VECMX* model can be categorized into five cases, as described in MacKinnon et al. (1999) and M. Pesaran et al. (2000): (I) no intercepts and no trend coefficients, (II) restricted intercepts and no trend coefficients, (III) unrestricted intercepts and no trend coefficients, (IV) unrestricted intercepts and restricted trend coefficients, and (V) unrestricted intercepts and unrestricted trend coefficients. When considering the deterministic trend it is clear that variables such as real GDP (in its logarithmic model form y) contain a linear trend. Also noted is that no variable shows sign of exponential trends. This leaves us to choose between case III and IV. Case III does not include any deterministic trend, but has a trend in the domestic variables due to the drift coefficients (L. V. Smith and Galesi 2014). Case III was chosen because of its stable properties, as case IV caused eigenvalues to lay outside the unit circle. The rank-order was determined using the trace statistic with a 95 % critical value, and can be found in table A5.

Weak exogeneity test

As mentioned in section 5, the main assumption of the GVAR-model is that the foreign variables are weakly exogenous. To test this assumption, the error-correction terms and the other variables of the model in first-difference form are regressed with the foreign variables in first-difference form as dependent variable. The coefficients, if there are more than one, are then jointly tested with a F-test to see if they have a significant effect on the foreign variables, which in that case is a violation to the assumption of them not being endogenous. When using AIC, the lag orders of the regression are set to one and we get the result in table A6 where the weak exogeneity assumption is rejected for 10 of the 54 exogenous variables. When the lag orders are set to the same values as in the country specific models, foreign variables are only rejected twice (table A7). We thus consider the weak exogeneity assumption to hold.

Results

The model estimates can be viewed in the appendix. The coefficient estimates of the VECMX* models are presented in table A8, while the cointegrating vectors are found intables A9 to A15.

7 Scenario specification

How to model a Grexit

The eurozone is modelled by having the exchange rate and short-term interest rate of the member states to be equal. The first assumption is obvious from the fact that the countries share the same currency, and the second one as the countries share the same monetary policy authority under the ECB. The Greek exchange rate decoupling from the euro is the most obvious characteristic of a Grexit and essential for the scenario. A Grexit could thus also be modelled by the decoupling of the Greek exchange rate and short-term interest rate relative to the other eurozone members.

Following a Grexit a scenario worth considering is a Greek sovereign default. It is very likely that a Grexit under the conditions that Greece faced would coincide with a sovereign default, as the real costs could be unbearable for the Greek economy. The model does not have a financial system, but as a proxy to model a default, the current account is added to the model. The assumption is that a sovereign default would make it impossible for the

Greek economy to finance its large current account deficit that would rapidly decrease. Conditioning the current account in a similar way is a proxy to model a sovereign default.

When selecting the start date for the scenario, two possible occasions were considered: early 2010 when the economic problems of Greece were revealed and the first signs of severe austerity measures became apparent; and late 2011, as a possible outcome of the referendum that Prime Minister George Papandreou proposed on the 31 of October 2011. The latter option is perhaps the more likely occasion, but the former has the advantage of a longer period for scenario evaluation. Doing both scenarios would be an option, but was deemed to demand too much time and perhaps complicate the analysis. After considerations the first option was chosen.

Model and data preparations

As the model is estimated using real exchange rates, while we want to perform the scenario on nominal exchange rates, we have to transform the estimated coefficients and covariance matrix, and have the real exchange rate in the data replaced with nominal. As it is a linear model that includes inflation, a linear transformation can achieve this. Section B in the appendix contains information and the matrix operations for this transformation in the case of a Global VAR-model. Because of this transformation, the lag order will increase from 2 to 3, and the inflation variable $\pi_t = p_t - p_{t-1}$ will be replaced by the price level index p_t.

Conditioning approach

M. H. Pesaran et al. (2007) aggregate the non-subject Eurozone countries to one entity. The exchange rate for this entity and the subject country is then conditioned to be equal by having a row in $\mathbf{\Psi}$ that contains 1 and -1 at the positions that corresponds to the two exchange rate variables. This forms a linear combination of how much the two currencies must differ. When this restriction is set to be zero in the corresponding row in $\mathbf{d}$, the exchange rates are conditioned to be equal. The difference set in $\mathbf{d}$ does not have to

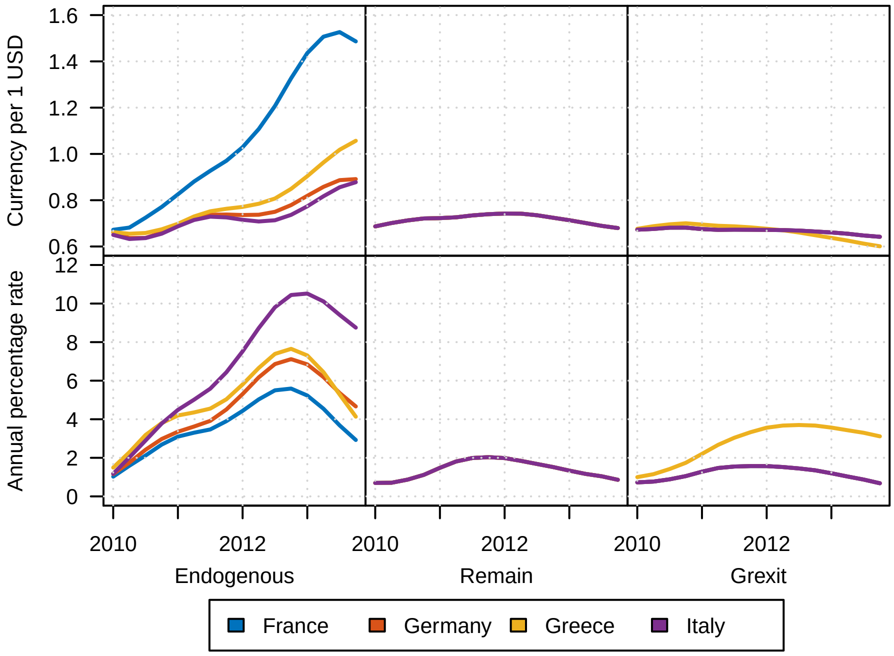

Figure 3: Model forecasts for exhange rate and short-term interest rate

be zero; other values can be set to model exchange rates that appreciates or depreciates, or as M. H. Pesaran et al. (2007) to model different fixing rates in the case of an entry. The common short-term interest-rates of the eurozone countries is modelled in the same way. In this thesis the exchange rate conditioning has been done in a disaggregated manner by having the Eurozone countries to be jointly conditioned. One Eurozone country that is not Greece is selected as a base country, which then all the other countries are conditioned to.

To model the effects of a Grexit two forecasts are made: one forecast with the above mentioned restrictions that includes Greece, and another one that does not; the difference between those two forecasts is the exchange rate effect of the Grexit. Figure 3 gives a good illustration of this, since it shows the exchange rate and short-term interest rate for the eurozone countries under different restriction settings. In the endogenous setting shown in the first column, the variables diverge a lot, though being seemingly consistent as the higher the interest rate forecast the stronger exchange rate forecast. The

Table 2: Scenario sets and included restriction sets

	Conditonal restriction sets													
	Factual baseline							Counterfactual alternative						
Scenario set name	e_{ez}	i_{ez}	e_{gr}	i_{gr}	a_g	x_{gl}	x_{US}	e_{ez}	i_{ez}	e_{gr}	i_{gr}	a_g	x_{gl}	x_{US}
Grexit	e	e	e	e				e	e					
Grexit,Def	e	e	e	e				e	e			n		
Grexit,Def,Com	e	e	e	e		o		e	e			n	o	
Grexit,Def,US	e	e	e	e			o	e	e			n		o
Grexit,Def,Com,US	e	e	e	e		o	o	e	e			n	o	o

The letters denote different kind of restrictions: e is the eurozone restriction, n is the non-negative restriction of current account, and o is the outcome restriction. Each row is a scenario set and the columns represent variables in the factual and counter factual case.

second column shows the *Remain* scenario where both variables are restricted to have the same value across the euro zone countries; as can be seen they all overlap each other. In the third column we can see the Grexit scenario, in which the restriction of the *Remain* scenario is imposed to all eurozone countries *exempt* Greece. This result in an initial depreciation of the Greek currency compared to the eurozone, which later turns into an appreciation. For the short-term interest rate the Greek forecast is considerably above the eurozone countries. This and other results are further discussed in the next section.

The *Remain* scenario above is a forecast of the factual outcome where Greece stays in the eurozone for the studied period, and is considered to be the baseline scenario. The *Grexit* scenario is the counterfactual scenario to this. When studying the effects we will not use the point forecast from the Grexit scenario, but instead the *scenario effects* that we get from the difference between the two scenarios.

Additional to the Grexit, we want to model a coinciding Greek default. This is done by restricting the Greek current account to be non-negative for four quarters, and is added to the Grexit scenario. To do this we restrict the model levels, and as we will do this in different scenario settings, the relative distance to zero might vary a little. Thus the current account variable might vary somewhat in the scenarios where the *Default* restriction is imposed.

Following M. H. Pesaran et al. (2007) we will also add scenario restrictions that can be described as *outcome restrictions*. In the Global VAR the scenario restrictions will have an effect on all variables. It could though be argued that some variables would not be affected by a Grexit. In this model it could be the global commodity variables, or the domestic variables of the United States. We call those scenario restrictions *Commodity* and *US*, and *Outcome* when they are jointly imposed. As those variables are considered to be unchanged, the outcome restrictions are added to both the factual baseline scenario, and the counterfactual alternative scenario. These three possible outcome restrictions are separately added to the scenario with the *Grexit* and *Default* scenarios to form three additional scenarios. For an overview of the scenario settings see table 2.

8 Results

The main focus of the analysis is primarily the effects on Greece, and the explanations of these effects. Secondarily to this comes the analysis of the eurozone countries. Analysis of the United States and global variables is also prioritised as conditioned on in some of the scenario sets.

Forecasting capabilities

Following the model estimation the forecasting performance of the model was studied. The reason for this is the hypothesis that if the model forecast the factual outcome in a suitable way, and can be considered to be well-specified in this regard; then it might also produce good forecasts for the counterfactual scenarios. This being true does not conflict with the Lucas critique discussed in section 4.

The main finding of this is that the *Remain* restriction significantly improves the forecast. As can be seen in the second pane of figure panels A1 to A43 and figure 3, the endogenous forecasts diverge a lot from the outcomes. When the *Remain* restriction set is added to the endogenous forecast it improves substantially, and it does so for all 43 variables, also for the non-euro countries.

An economic interpretation of this empirical observation is that the eurozone economies in this study are very different and that the eurozone membership imposes large restrictions on them. The restrictions also have effect on the non-euro countries in the model. One must bear in mind that the forecast period is a time of crisis with asymmetric effects to the included countries as mentioned in the theory overview in section 3. The eurozone countries might have pursued different policies in this period, had they not been part of the eurozone, and thus the restrictions might have larger effects during this period.

Adding the *Remain* restriction can be a practice to improve GVAR forecasts that include eurozone countries, if one accepts the assumptions of eurozone status quo. A notion to this is that the model forecasts in this thesis are in-sample. Further evaluation of the *Remain* restriction is suggested, conceivably as a out-of-sample or pseudo out-of-sample forecast evaluation.

Effects on Greece

The effect on Greek real GDP is negative for the entire forecast period in all scenarios. The effect of *Grexit* is smaller than the other scenarios, but the effect is increasing as seen in figure A13. The *Default* scenario has much more impact and the effects seem to also be persistent, and even more so when the scenarios condition on unchanged outcome for global and United States variables. Thus all scenarios project a lower real GDP for Greece. The effect is far away from the large estimated drops in GDP estimated by Feldstein (2012) and Åslund (2012). For the estimated effects that include *Default*, the decline in real GDP ranges from about 5.3 to 7.3 per cent after one year if we disregard the decline in the outcome. This is quite close to the estimated effect by IMF, but as IMF did this estimate for 2012 it is not a appropriate comparison to make.

The effects on the consumer price index are initially positive in all scenarios as seen in figure A14. As was the case for real GDP, the *Grexit* leads to small but increasing effects. The *Default* scenario show initially an even larger effect, especially with restricted commodity prices with a annual CPI increase of about 7.3 per cent compared to about 4.8 per cent for the *Grexit* scenario as well for the outcome. This changes over time and for the *Commodity*, *US* and *Outcome* scenarios the effect is negative in the end of the period. Figures A41 to A43 might show a explanation for this. When those variables are unrestricted they forecast negative prices effects in the short-term and positive effects in the longer-term, and this effect is similar for the US CPI. As those variables measure prices, it is possible that they covaries. When when the commodity variables are restricted to be zero, they are to be higher in the short-term and lower in the long-term, and this affects the Greek CPI in the same way.

The Greek nominal exchange rate appreciates compared to the dollar in all scenarios in figure A15. This is unexpected; referring to section 3 we should expect a rapid depreciation of the Greek currency. Initially the Greek currency depreciates compared to the euro in the *Grexit* scenario. This changes along the scenario and the Greek currency appreciates to a level that is stronger than the remaining euro. This appreciation effect is even stronger in the *Default* scenario. The reason for this is probably the short-term interest rate.

The effects on the Greek short-term interest rate are positive in all scenarios and are increasing over time, except for the scenarios with unchanged commodity prices under which it levels off after two years (see figure A16). The effect is larger for the *Default* scenarios. This differs from the other eurozone countries (see Germany in figure A10) and the US (see figure A38). In the *Grexit* scenario the short-term interest rate for eurozone and the US decreases for the whole period, except a very small increase for the eurozone in the first quarter. When the *Default* scenario is added, the effects on both the eurozone and the US is much larger with a decrease of 0.6 and 1.1 percentage points respectively, and thereafter an increase. In the *Commodity* scenarios the effects on the eurozone and the US short-term interest rates are negative for the whole period. This results in a short-term spread between Greece and the other countries.The empirical interpretation of this could be an appreciation of the currency, but that is not a likely outcome in the case of a Grexit. When specifying the scenario one objective was to keep the restrictions of the model as few as possible. Perhaps more restrictions could be added to have a better scenario for the exchange rate.

The Greek long-term interest rates can be seen in figure A17. The effect is negative for the whole period, and more negative for the *Default* scenarios. This is not expected as Greece should expect to face larger spreads (Eichengreen 2007). The observed effect seems to be related to the current account variable, as they both move very much. This additional effect is as strongest in the first year when the *Default* restriction is effective and then wear off. Economically the lower long-term rates could be explained as that a high current account deficit is associated with a high degree of risk of a default. So what in the model is used as a proxy for a default, might in this aspect work as a economic prudence variable. Thus the slashed current account deficit in the model is perceived as a greatly improved economic situation, and by that the effect on the long-term interest rate is negative. One could also argue that as a default relieves the financial situation for a country, the long-term rates afterwards will be lower as the government becomes more able to service its remaining debt.

The current account shows very small negative effects in the *Grexit* scenario in figure A18. For the *Default* scenarios the effect is of course large for the first year as the variable is conditioned as a proxy. This effect is persistent after the four restricted quarters and the effect decays very slowly, and the scenario that only adds the *Default* scenario moves in parallel with the *Grexit* scenario. The three outcome conditioning scenarios add some more positive effect on the current account, causing what can be considered to be a permanent shift in the variable. The persistence of the conditioning of the variable on itself means that the shock in the first of the four conditional quarters must have been very large compared to the three subsequent shocks.

Effects on other eurozone countries

For France and Italy the effects of the scenarios on real GDP are positive and show a similar profile, but being larger for Italy (figures A1 and A19). This effect is also increasing over time. This is not the case for Germany where the effects are more mixed in figure A7. All but one scenario show negative effects for the first two years, but after that all but one turn positive.

Figures A2 and A20 for consumer price index show a similar pattern for France and Italy as for the effects on real GDP. For all but one scenario the price index effects are positive and increasing for Italy. The *Default* scenario seems to induce higher inflation, and even more so when the *Commodity* restriction is added. The US restrictions seem though to have the opposite effect, adding negative effect to the CPI for both countries. Germany shows a different pattern with the effects of the *Grexit* scenario being negative for almost the whole period in figure A8. For Germany the *Default* scenario adds a very small effect. The effect from the commodity and US scenarios are though similar to the ones in France and Italy.

As France, Germany and Italy are jointly conditioned to have the same nominal exchange and short-term interest rate the scenario effects are identical for those two variables. For the exchange rate all scenarios initially have a appreciating effect compared to the dollar as seen in figure A9 for Germany. The *Default* scenario emphasises this effect even more, while the commodity scenario instead has a depreciating effect. This is somewhat consistent in an empirical sense. For the scenarios in which the US short-term interest is not restricted, the US short-term rates (figure A38) are initially lower than the ones of the eurozone (figure A10).

The long-term interest rates are similar. France, Germany and Italy all have negative effects for the whole period in all scenarios. The profile is most similar for France (figure A5) and Germany (figure A11), where the effect of the *Grexit* scenario is more negative and persistent, and where the additional effect from the *US* scenario is negative, compared to Italy (figure A23)

The results for the current account differ across the countries. The effects on France (figure A6) and Italy (figure A24) are both negative and increasing for the *Grexit* and *Default* scenario. That goes also for the other scenarios for Italy, while they are negative or slightly positive for France. For Germany, for which the outcome has a large current account surplus (figure A12), the *Grexit* scenario shows negative effects. The other scenarios show positive effects with the exception of a few quarters.

9 Conclusions

The model approach used in this thesis shows both strengths and weaknesses. To model the eurozone by dynamically restricting the nominal exchange rate and short-term interest rate for the eurozone countries shows very promising results as it improves the endogenous forecast for all variables, and does so significantly for almost all of them. This indicates that the model specification and estimation were carried out successfully, with the remark that the forecasting was done in-sample. The restriction can be a conceivable practice to improve forecasts when eurozone countries are included in a Global VAR, and should be considered to be further examined.

Our estimated effects of the Grexit are hard to evaluate as no other model-based estimates have been found. The estimated effect on Greek real GDP of a 5.3 to 7.3 per cent decline over one year was not far from the IMF estimates from 2012 of a 10 per cent decline.

The models estimated appreciation for the nominal exchange rate was not the expected effect. Both reference forecasters and I expect a Grexit to cause the Greek currency to depreciate. Albeit the Greek currency depreciates against the euro in the short term, this is a weakness of the scenario in this setting. This might come due to the specification of the model or the scenario. One objective of the application was to have a simple model concerning the restrictions, and let the model interpret the data with the eurozone restriction and a few additional restrictions. It might also come from the fact that even if the model seems to perform well in forecasting the outcome, its empirical properties make it less suitable for evaluating alternative policies as the Lucas critique proclaim.

Using current account as a variable to simulate a sovereign default is somewhat ambiguous when we inspect the results. When that scenario is added to the Grexit scenario the effect on real GDP is negative, an expected result. But the decrease in the long-term interest rates is not expected. This can be because of an empirical correlation between current account deficits and long-term interest rates. Restricting this deficit from positive to zero might be interpreted by the model as a government that suddenly gets its financial issues and trade balance in order, and not as a government that commits a default. However, the current account seems to be far from perfect as a proxy for a sovereign default.

My conclusion on why the eurozone restriction improves the endogenous forecast, is that the model interprets the data to have different properties for the different countries, and that the eurozone possibly constitutes a very restricting entity for the participating economies. By this I do not imply that this restriction is beneficial or not, but that it is likely to exist. And due to the presence of this restriction I also conclude that the Eurozone *was not* an optimal currency area in the period 2010–2013. If we suppose this to be correct, and that the eurozone is not an optimal currency area, the perception of the eurozone being beneficial or not in economic terms depends on one's assumptions and preferences. If one believes that the economies in the eurozone can adapt to the restrictions and because of that improve, then the restrictions have a purpose and can act as a commitment device to improve. But if one assumes the properties of the countries to be constant, then the view on the restrictions can be mixed. One can see them as a commitment tool to behave, while another can see them as a straight-jacket. Whether countries can adapt to each other and converge to form an optimal currency area is a very interesting question, but out of scope for this thesis.

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Appendices

A Data appendix

More detailed references for data used the figures and to estimate the model. Most variables are gathered via the *FRED* database by the Federal Reserve Bank of St. Louis (2015a). Variables with a higher frequency than required have been converted.

Figure data

The annual data in figure 1 are collected from the following sources. The data for GDP growth comes from *Economic Outlook* by OECD (2015a). Data for the period 1996–2014 comes from the No 98 release, and is extended for the period 1961–1995 with data from the No 86 release. The data for inflation comes from *World Development Indicators* by the World Bank (2015). The data for short-term interest rate comes from *Economic Outlook* by OECD (2015a). Data for the period 1995–2014 comes from the No 98 release, and is extended for the period 1960–1994 with data from the No 86 release. The data for long-term interest rate comes from *International Financial Statistics* by the IMF (2015b). The data for budget surplus rate comes from *Economic Outlook* by OECD (2015a). Data for the period 1995–2014 comes from the No 98 release, and is extended for the period 1960–1994 with data from the No 86 release. The exchange rate data comes from *Main Economic Indicators* by OECD (2015b). All the annual data for unit labour cost in figure 2 comes from *Main Economic Indicators* by OECD (2015b).

Model data

The quarterly data for the period 1995 to 2013 used in the model comes from the following sources by variable: *Real GDP* and *Consumer price index* are gathered from *Main Economic Indicators* by OECD (2015b). The *Nominal exchange rates* in the model are relative to one US dollar. The dollar exchange rate for the legacy currencies of the euro countries has been converted by its respective euro fixing rate and merged with the euro to dollar exchange rate. Exchange rate data for France, Germany, Greece and Italy comes from Federal Reserve Bank of St. Louis (2015b). For the eurozone and United Kingdom the data comes from US FED (2015). For Turkey the exchange rate comes from *Main Economic Indicators* by OECD (2015b). *Short-term interest rate* for Turkey is the deposit rate from the *International Financial Statistics* by the IMF (2015b) is used. For Greece after 2001 interbank rate from *Main Economic Indicators* by OECD (2015b) is used, before that it is extended with the deposit rate from *International Financial Statistics* by the IMF (2015b). For the other countries the interbank rate from *Main Economic Indicators* by OECD (2015b) is used. *Long-term interest rate* For Turkey no data was available. For Greece after 1997 Q1 10 year government bond rate from *Main Economic Indicators* by OECD (2015b) is used, before that it is extended with the government bond rate from *International Financial Statistics* by the IMF (2015b). For the other countries the 10 year government bond rate from *Main Economic Indicators* by OECD (2015b) is used. *Current account* data are gathered from *Main Economic Indicators* by OECD (2015b). *Oil price* is gathered from EIA (2015). *Raw materials index* and *Metals price index* comes from *Primary Commodity Prices* by IMF (2015c).

B Nominal transformation of the model

The model that is estimated in section 6 have real interest rate and inflation in its variable vector. In section 7 we are restricting the forecasts on a variable vector that has a nominal exchange rate. Thus the model is transformed as in M. H. Pesaran et al. (2007). Below it is the model estimates that is transformed, not the data.

In this section the variable vector with a real exchange rate $e^R_{i,t}$ has a ring above it $\mathring{\mathbf{x}}_{i,t}$, as shown in equation 16 with the corresponding coefficient matrices $\mathbf{G}$. The variable vector with the nominal exchange rate $e^N_{i,t}$ has no ring $\mathbf{x}_{i,t}$, as shown in equation 22 with its corresponding coefficient matrices $\mathbf{F}$. $\mathbf{x}^{rest}_{i,t}$ groups the variables that are the same in both models. In this transformation the inflation variable changes as well from its differenced form to level form, and the number of coefficient matrices increases from two to three.

$$\mathring{\mathbf{x}}_{i,t} = \begin{pmatrix} \pi_{i,t} \\ e^R_{i,t} \\ \mathbf{x}^{rest}_{i,t} \end{pmatrix} = \begin{pmatrix} p_{i,t} - p_{i,t-1} \\ e^N_{i,t} - p_{i,t} \\ \mathbf{x}^{rest}_{i,t} \end{pmatrix} \quad \mathring{\mathbf{x}}_{0,t} = \begin{pmatrix} \pi_{0,t} \\ \mathbf{x}^{rest}_{0,t} \end{pmatrix} = \begin{pmatrix} p_{0,t} - p_{0,t-1} \\ \mathbf{x}^{rest}_{0,t} \end{pmatrix} \tag{16}$$

$$\mathring{\mathbf{x}}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \mathbf{G}_1 \mathring{\mathbf{x}}_{t-1} + \mathbf{G}_2 \mathring{\mathbf{x}}_{t-2} + \mathring{\mathbf{v}}_t \tag{17}$$

$$\mathbf{x}_{i,t} = \begin{pmatrix} p_{i,t} \\ e^N_{i,t} \\ \mathbf{x}^{rest}_{i,t} \end{pmatrix} \quad \mathbf{x}_{0,t} = \begin{pmatrix} p_{0,t} \\ \mathbf{x}^{rest}_{0,t} \end{pmatrix} \tag{18}$$

$$\mathscr{B}_0 = \mathbf{I}_{k_0}, \quad \mathscr{C}_0 = \begin{pmatrix} 1 & \mathbf{0}_{1\times(k_0-1)} \\ \mathbf{0}_{(k_0-1)\times 1} & \mathbf{0}_{(k_0-1)\times(k_0-1)} \end{pmatrix} \tag{19}$$

$$\mathscr{B}_i = \begin{pmatrix} \begin{matrix} 1 & 0 \\ 1 & 1 \end{matrix} & \mathbf{0}_{2\times(k_i-2)} \\ \mathbf{0}_{(k_i-2)\times 2} & \mathbf{0}_{(k_i-2)\times(k_i-2)} \end{pmatrix}, \quad \mathscr{C}_i = \begin{pmatrix} \begin{matrix} 1 & 0 \\ 1 & 0 \end{matrix} & \mathbf{0}_{2\times(k_i-2)} \\ \mathbf{0}_{(k_i-2)\times 2} & \mathbf{0}_{(k_i-2)\times(k_i-2)} \end{pmatrix} \tag{20}$$

$$\mathscr{B} = diag(\mathscr{B}_0, \mathscr{B}_1, \ldots, \mathscr{B}_N), \quad \mathscr{C} = diag(\mathscr{C}_0, \mathscr{C}_1, \ldots, \mathscr{C}_N) \tag{21}$$

$$\begin{gathered} \mathbf{x}_t = \mathbf{b}_0 + \mathbf{b}_1 t + \mathbf{F}_1 \mathbf{x}_{t-1} + \mathbf{F}_2 \mathbf{x}_{t-2} + \mathbf{F}_3 \mathbf{x}_{t-3} + \mathbf{v}_t \\ \mathbf{b}_0 = \mathscr{B}\mathbf{a}_0, \quad \mathbf{b}_1 = \mathscr{B}\mathbf{a}_1, \quad \mathbf{v}_t = \mathscr{B}\mathring{\mathbf{v}}_t \\ \mathbf{F}_1 = \mathscr{B}\mathbf{G}_1\mathscr{B}^{-1} + \mathscr{C}, \quad \mathbf{F}_2 = \mathscr{B}(\mathbf{G}_2\mathscr{B}^{-1} - \mathbf{G}_1\mathscr{B}^{-1}\mathscr{C}), \\ \mathbf{F}_3 = -\mathscr{B}\mathbf{G}_2\mathscr{B}^{-1}\mathscr{C} \end{gathered} \tag{22}$$

C Specification & estimation

Table A1: Trade weight matrix

Country	FRA	GER	GRE	ITA	TUR	UK	USA
FRA	0.000	0.295	0.103	0.273	0.142	0.209	0.187
GER	0.373	0.000	0.283	0.308	0.308	0.308	0.333
GRE	0.018	0.023	0.000	0.045	0.044	0.015	0.013
ITA	0.202	0.203	0.262	0.000	0.170	0.100	0.100
TUR	0.032	0.039	0.105	0.048	0.000	0.027	0.049
UK	0.182	0.193	0.131	0.130	0.190	0.000	0.319
USA	0.193	0.247	0.116	0.198	0.146	0.341	0.000

Table A2: Domestic variables unit root test

Variables	Stat.	Crit.	FRA	GER	GRE	ITA	TUR	UK	USA
y, trend	ADF	−3.45	−1.68	−3.00	−0.26	−1.29	−2.75	−1.18	−2.18
y, trend	WS	−3.24	−1.54	−3.15	−1.22	−1.25	−2.93	−0.89	−1.47
y	ADF	−2.89	−2.19	−0.98	−1.48	−2.24	−0.65	−2.57	−2.09
y	WS	−2.55	0.26	0.33	−1.01	−0.83	0.99	0.74	0.78
Δy	ADF	−2.89	−3.29*	−4.63*	−1.30	−3.92*	−5.25*	−3.86*	−3.38*
Δy	WS	−2.55	−3.49*	−4.82*	−1.63	−4.12*	−5.40*	−4.10*	−3.60*
$\Delta^2 y$	ADF	−2.89	−5.96*	−5.38*	−8.25*	−6.80*	−6.87*	−6.37*	−5.62*
$\Delta^2 y$	WS	−2.55	−6.27*	−5.66*	−8.50*	−7.12*	−7.20*	−6.60*	−5.65*
π, trend	ADF	−3.45	−4.46*	−4.63*	−3.48*	−4.61*	−1.17	−5.41*	−6.57*
π, trend	WS	−3.24	−4.68*	−4.91*	−3.44*	−3.36*	−1.61	−5.11*	−6.78*
π	ADF	−2.89	−4.48*	−4.58*	−2.60	−4.53*	−1.35	−4.63*	−6.53*
π	WS	−2.55	−4.71*	−4.86*	−1.96	−2.73*	−0.16	−4.67*	−6.73*
$\Delta\pi$	ADF	−2.89	−6.04*	−4.68*	−5.65*	−5.33*	−7.92*	−7.02*	−7.51*
$\Delta\pi$	WS	−2.55	−6.37*	−5.22*	−5.88*	−5.49*	−8.27*	−8.25*	−7.86*
$\Delta^2\pi$	ADF	−2.89	−9.02*	−15.75*	−6.62*	−6.85*	−8.58*	−7.87*	−7.76*
$\Delta^2\pi$	WS	−2.55	−9.32*	−16.12*	−6.79*	−7.02*	−8.48*	−8.84*	−8.13*
e^R, trend	ADF	−3.45	−2.45	−2.61	−2.31	−2.15	−2.48	−1.98	
e^R, trend	WS	−3.24	−1.97	−1.86	−2.04	−2.24	−2.65	−2.28	
e^R	ADF	−2.89	−0.77	−0.77	−0.39	−0.82	−0.99	−1.05	
e^R	WS	−2.55	−1.18	−1.21	−0.66	−0.80	−0.57	−0.54	
Δe^R	ADF	−2.89	−5.75*	−5.73*	−6.10*	−5.93*	−6.35*	−7.20*	
Δe^R	WS	−2.55	−5.91*	−5.91*	−6.27*	−6.10*	−6.34*	−7.43*	
$\Delta^2 e^R$	ADF	−2.89	−7.78*	−7.93*	−7.26*	−7.48*	−8.09*	−6.57*	
$\Delta^2 e^R$	WS	−2.55	−8.00*	−7.91*	−7.50*	−7.97*	−8.28*	−6.78*	
i^S, trend	ADF	−3.45	−3.63*	−3.04	−2.25	−3.52*	−1.83	−3.04	−3.70*
i^S, trend	WS	−3.24	−3.75*	−3.23	−1.02	−2.90	−2.19	−3.19	−4.00*
i^S	ADF	−2.89	−2.31	−2.03	−2.28	−3.14*	−1.14	−1.42	−1.52
i^S	WS	−2.55	−1.41	−1.79	1.15	−1.26	−0.31	−1.41	−1.36
Δi^S	ADF	−2.89	−4.22*	−4.39*	−5.20*	−3.84*	−7.05*	−4.77*	−4.23*
Δi^S	WS	−2.55	−3.95*	−4.50*	−4.91*	−3.79*	−7.31*	−4.96*	−4.42*
$\Delta^2 i^S$	ADF	−2.89	−5.20*	−7.68*	−8.88*	−6.45*	−7.66*	−8.09*	−7.72*
$\Delta^2 i^S$	WS	−2.55	−5.30*	−7.91*	−9.02*	−5.94*	−7.98*	−8.31*	−7.99*
i^L, trend	ADF	−3.45	−3.46*	−3.31	−2.69	−4.50*		−2.47	−3.77*
i^L, trend	WS	−3.24	−2.12	−3.03	−2.08	−1.83		−1.83	−4.02*
i^L	ADF	−2.89	−2.14	−1.27	−2.65	−4.55*		−1.82	−0.75
i^L	WS	−2.55	0.60	0.75	−2.13	−0.26		0.67	0.09
Δi^L	ADF	−2.89	−6.10*	−6.68*	−5.02*	−3.30*		−6.56*	−5.03*
Δi^L	WS	−2.55	−6.13*	−6.74*	−5.14*	−3.17*		−6.71*	−4.89*
$\Delta^2 i^L$	ADF	−2.89	−10.43*	−6.54*	−7.13*	−6.52*		−6.73*	−7.32*
$\Delta^2 i^L$	WS	−2.55	−10.68*	−6.33*	−7.43*	−6.37*		−6.78*	−6.60*
A, trend	ADF	−3.45	−3.07	−2.23	−0.10	−0.12	−4.24*	−2.91	−0.68
A, trend	WS	−3.24	−1.69	−2.32	−0.93	−0.70	−4.28*	−3.19	−0.84
A	ADF	−2.89	−0.93	−0.75	−1.17	−1.37	−1.94	−2.01	−1.24
A	WS	−2.55	−1.36	−0.44	−1.10	−1.21	−1.83	−1.96	−0.90
ΔA	ADF	−2.89	−6.42*	−6.65*	−3.62*	−6.93*	−4.74*	−8.63*	−5.44*
ΔA	WS	−2.55	−6.52*	−6.86*	−3.80*	−7.09*	−5.01*	−8.67*	−5.61*
$\Delta^2 A$	ADF	−2.89	−6.98*	−9.77*	−8.39*	−7.60*	−7.72*	−8.23*	−7.76*
$\Delta^2 A$	WS	−2.55	−6.75*	−10.10*	−8.73*	−7.92*	−7.68*	−8.86*	−7.99*

Table A3: Foreign variables unit root test

Variables	Stat.	Crit.	FRA	GER	GRE	ITA	TUR	UK	USA
y^*, trend	ADF	−3.45	−2.09	−1.72	−2.31	−1.85	−1.69	−2.07	−2.01
y^*, trend	WS	−3.24	−1.88	−1.45	−2.14	−1.64	−1.52	−1.78	−1.88
y^*	ADF	−2.89	−1.78	−2.20	−1.65	−1.79	−2.00	−1.77	−1.67
y^*	WS	−2.55	0.49	0.37	0.48	0.73	0.42	0.70	0.55
Δy^*	ADF	−2.89	−4.09*	−3.56*	−4.26*	−3.99*	−3.82*	−4.00*	−3.95*
Δy^*	WS	−2.55	−4.28*	−3.77*	−4.44*	−4.18*	−4.02*	−4.20*	−4.13*
$\Delta^2 y^*$	ADF	−2.89	−7.27*	−6.16*	−7.26*	−7.40*	−7.19*	−7.28*	−7.04*
$\Delta^2 y^*$	WS	−2.55	−7.49*	−6.40*	−7.47*	−7.61*	−7.41*	−7.50*	−7.24*
π^*, trend	ADF	−3.45	−4.86*	−5.68*	−3.83*	−4.97*	−4.68*	−5.37*	−4.38*
$\pi^*\pi^*$, trend	WS	−3.24	−4.77*	−5.68*	−3.87*	−5.12*	−4.60*	−5.52*	−4.33*
π^*	ADF	−2.89	−3.80*	−2.45	−1.60	−3.22*	−4.71*	−4.19*	−2.67
π^*	WS	−2.55	−3.21*	−1.36	−0.20	−2.94*	−4.60*	−4.08*	−1.79
$\Delta\pi^*$	ADF	−2.89	−6.57*	−6.30*	−7.06*	−6.68*	−8.76*	−6.82*	−6.13*
$\Delta\pi^*$	WS	−2.55	−6.87*	−6.65*	−7.38*	−6.99*	−8.99*	−7.15*	−6.65*
$\Delta^2\pi^*$	ADF	−2.89	−7.50*	−7.61*	−7.68*	−7.44*	−7.18*	−7.28*	−7.34*
$\Delta^2\pi^*$	WS	−2.55	−7.79*	−7.81*	−7.73*	−7.47*	−7.49*	−7.49*	−7.41*
e^{R*}, trend	ADF	−3.45	−2.42	−2.37	−2.33	−2.49	−2.45	−2.42	−2.50
e^{R*}, trend	WS	−3.24	−2.21	−2.29	−2.17	−2.09	−2.20	−1.97	−2.29
e^{R*}	ADF	−2.89	−0.46	−0.49	−0.66	−0.69	−0.49	−0.68	−0.49
e^{R*}	WS	−2.55	−0.77	−0.69	−0.87	−1.05	−0.83	−1.08	−0.77
Δe^{R*}	ADF	−2.89	−6.17*	−6.22*	−6.02*	−5.98*	−6.18*	−5.79*	−6.28*
Δe^{R*}	WS	−2.55	−6.35*	−6.39*	−6.17*	−6.15*	−6.37*	−5.94*	−6.46*
$\Delta^2 e^{R*}$	ADF	−2.89	−7.62*	−7.46*	−7.28*	−7.64*	−7.77*	−7.67*	−7.58*
$\Delta^2 e^{R*}$	WS	−2.55	−7.80*	−7.75*	−7.48*	−7.68*	−7.97*	−7.81*	−7.70*
i^{S*}, trend	ADF	−3.45	−2.90	−3.39	−3.11	−3.46*	−3.16	−3.52*	−3.24
i^{S*}, trend	WS	−3.24	−3.07	−3.50*	−3.29*	−3.65*	−3.21	−3.69*	−3.42*
i^{S*}	ADF	−2.89	−1.34	−1.57	−1.27	−1.31	−1.90	−1.49	−1.34
i^{S*}	WS	−2.55	−0.50	−0.33	0.22	−0.37	−1.04	−0.54	−0.57
Δi^{S*}	ADF	−2.89	−4.55*	−4.53*	−5.56*	−4.66*	−4.22*	−4.46*	−4.59*
Δi^{S*}	WS	−2.55	−4.73*	−4.71*	−5.81*	−4.72*	−4.46*	−4.60*	−4.74*
$\Delta^2 i^{S*}$	ADF	−2.89	−7.79*	−7.90*	−6.77*	−7.92*	−7.15*	−7.90*	−7.59*
$\Delta^2 i^{S*}$	WS	−2.55	−8.08*	−8.06*	−7.10*	−8.21*	−7.19*	−8.14*	−7.87*
i^{L*}, trend	ADF	−3.45	−3.18	−3.30	−3.46*	−3.19	−3.24	−3.23	−3.10
i^{L*}, trend	WS	−3.24	−1.02	−0.74	−1.27	−1.54	−0.84	−2.23	−1.32
i^{L*}	ADF	−2.89	−2.52	−2.87	−2.84	−1.99	−2.72	−1.66	−2.27
i^{L*}	WS	−2.55	1.50	1.59	1.00	1.40	1.57	1.29	1.34
Δi^{L*}	ADF	−2.89	−4.47*	−4.29*	−6.02*	−4.92*	−6.34*	−4.77*	−6.42*
Δi^{L*}	WS	−2.55	−4.24*	−4.07*	−6.01*	−4.55*	−6.28*	−4.38*	−6.47*
$\Delta^2 i^{L*}$	ADF	−2.89	−6.89*	−6.81*	−6.68*	−7.02*	−6.80*	−6.99*	−10.63*
$\Delta^2 i^{L*}$	WS	−2.55	−6.94*	−6.94*	−6.89*	−6.92*	−6.88*	−6.90*	−10.90*
A^*, trend	ADF	−3.45	−2.28	−0.92	−2.59	−2.80	−2.07	−1.81	−3.03
A^*, trend	WS	−3.24	−2.26	−1.31	−2.79	−2.99	−2.22	−2.00	−3.24
A^*	ADF	−2.89	−1.13	−1.38	−2.60	−2.20	−1.44	−1.05	−2.62
A^*	WS	−2.55	−1.43	−0.98	−2.79*	−2.42	−1.72	−1.33	−2.79*
ΔA^*	ADF	−2.89	−6.58*	−6.05*	−6.00*	−6.91*	−7.05*	−5.87*	−7.66*
ΔA^*	WS	−2.55	−6.78*	−6.14*	−6.17*	−6.97*	−7.20*	−6.07*	−7.74*
$\Delta^2 A^*$	ADF	−2.89	−6.89*	−7.35*	−7.99*	−6.50*	−7.14*	−8.13*	−7.85*
$\Delta^2 A^*$	WS	−2.55	−7.20*	−7.47*	−8.15*	−6.76*	−7.43*	−8.39*	−8.19*

Table A4: Global variables unit root test

Variable	Test	Crit.	Stat.
b, trend	ADF	−3.45	−3.83*
b, trend	WS	−3.24	−3.80*
b	ADF	−2.89	−0.90
b	WS	−2.55	−0.53
Δb	ADF	−2.89	−6.79*
Δb	WS	−2.55	−6.99*
$\Delta^2 b$	ADF	−2.89	−6.52*
$\Delta^2 b$	WS	−2.55	−6.85*
c, trend	ADF	−3.45	−2.30
c, trend	WS	−3.24	−2.07
c	ADF	−2.89	−1.44
c	WS	−2.55	−1.74
Δc	ADF	−2.89	−6.46*
Δc	WS	−2.55	−6.58*
$\Delta^2 c$	ADF	−2.89	−8.04*
$\Delta^2 c$	WS	−2.55	−8.39*
m, trend	ADF	−3.45	−2.47
m, trend	WS	−3.24	−1.89
m	ADF	−2.89	−0.89
m	WS	−2.55	−1.25
Δm	ADF	−2.89	−5.40*
Δm	WS	−2.55	−5.59*
$\Delta^2 m$	ADF	−2.89	−8.20*
$\Delta^2 m$	WS	−2.55	−8.50*

Table A5: Lags and cointegrating relations

	p	q	Case	Co.
FRANCE	2	2	3	5
GERMANY	2	2	3	3
GREECE	2	2	3	3
ITALY	2	1	3	3
TURKEY	2	2	3	4
UNITED KINGDOM	2	2	3	2
UNITED STATES	2	2	3	5

Table A6: Weak exogeneity test, AIC lags

Country	p*	q*	F test	Fcrit_0.05	y^*	π^*	e^{R*}	i^{S*}	i^{L*}	A^*	b	c	m
FRANCE	1	1	F(5,54)	2.39	1.58	1.85		2.22	1.71	0.81	0.56	0.73	0.15
GERMANY	1	1	F(3,56)	2.77	0.35	1.37		4.01*	0.13	0.48	0.24	4.35*	1.25
GREECE	1	1	F(3,56)	2.77	1.48	1.67		2.47	0.36	0.21	2.12	4.69*	1.25
ITALY	1	1	F(3,56)	2.77	3.56*	0.23		4.64*	0.15	1.22	0.05	0.89	0.26
TURKEY	1	1	F(4,56)	2.54	1.43	0.58		2.49	0.70	1.02	0.51	2.40	0.92
UK	1	1	F(2,57)	3.16	0.33	5.21*		3.45*	0.42	1.31	0.71	1.19	1.32
USA	1	1	F(5,54)	2.39	4.05*	3.78*	2.47*	1.62	0.85	1.68			

Table A7: Weak exogeneity test, VARX* lags

Country	p*	q*	F test	Fcrit_0.05	y^*	π^*	e^{R*}	i^{S*}	i^{L*}	A^*	b	c	m
FRANCE	2	2	F(5,54)	2.46	0.91	0.76		1.85	3.14*	0.22	1.68	0.74	0.64
GERMANY	2	2	F(3,56)	2.83	0.56	1.28		3.95*	0.53	1.19	1.95	0.16	0.44
GREECE	2	2	F(3,56)	2.83	0.80	0.52		0.34	0.34	0.14	0.31	0.12	0.38
ITALY	2	1	F(3,56)	2.79	1.72	0.58		2.26	0.27	0.37	0.79	0.83	1.27
TURKEY	2	2	F(4,56)	2.59	0.26	1.61		0.72	0.34	1.42	0.48	0.41	0.34
UK	2	2	F(2,57)	3.22	0.53	0.96		0.79	2.69	1.29	1.11	0.43	1.95
USA	2	2	F(5,54)	2.46	1.52	0.73	0.55	0.77	0.45	0.65			

Table A8: VECMX* Estimates of the Individual Models

FRA	*cnst.*	y_1	π_1	e_1	r_1^S	r_1^L	a_1	y_1^*	π_1^*	r_1^{S*}	r_1^{L*}	a_1^*	b_1	c_1	m_1	Δy_0^*	$\Delta\pi_0^*$	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δb_0	Δc_0	Δm_0	Δy_1^*	$\Delta\pi_1^*$	Δr_1^{S*}	Δr_1^{L*}	Δa_1^*	Δb_1	Δc_1	Δm_1	Δy_1	$\Delta\pi_1$	Δe_1	Δr_1^S	Δr_1^L	Δa_1
Δy	0.09	-0.22	-0.07	0	-0.57	0.7	0	0.21	0.78	-0.38	-0.7	0	-0.01	-0.01	0.01	0.43	0.5	0.45	1	0	0	0	0	-0.1	-0.15	0.94	-0.02	0	0	0	0	-0.18	0.21	0.01	1.2	0.16	0
$\Delta\pi$	-0.33	-0.13	-1.7	-0.01	0.71	-0.11	0	0.2	1.4	-1.1	1.2	0	0	0	-0.01	0.11	0.92	-0.89	-0.13	0	0.01	0	-0.01	-0.01	-0.33	0.6	-0.56	0	0	0	0.01	0.21	0.44	0	-0.89	-0.22	0
Δe	-2.9	4	0.3	-0.31	-18	17	-0.01	-3.6	8.5	11	-4.2	-0.02	-0.03	-0.02	-0.06	0.53	6.3	4.3	28	-0.03	-0.17	0.02	-0.19	2.5	1.1	-6.9	-49	-0.01	-0.06	0	0.01	-3.7	-1.7	0.42	17	42	0.02
Δr^S	-0.08	-0.02	-0.11	0	-0.25	0.25	0	0.03	0.09	0.15	-0.03	0	0	0	0	0.03	-0.04	0.7	-0.04	0	0	0	0	0.03	-0.07	0	0.26	0	0	0	0	0	0.08	0	-0.28	-0.36	0
Δr^L	0.01	-0.04	-0.1	0	0.26	-0.36	0	0.04	0.08	-0.26	0.32	0	0	0	0	0	0.01	-0.08	0.81	0	0	0	0	-0.03	-0.04	0.08	0.17	0	0	0	0	0.03	0.05	0	-0.11	-0.21	0
Δa	4.3	1.9	28	1.2	-200	470	-0.86	-2	-110	210	-490	0.26	-1.6	2.1	-0.38	5	-5.9	-74	160	0.16	-1.4	-0.32	-0.76	28	99	-54	340	-0.22	1.2	-3.2	1.6	-24	-34	2.9	190	-220	0.16
GER	*cnst.*	y_1	π_1	e_1	r_1^S	r_1^L	a_1	y_1^*	π_1^*	r_1^{S*}	r_1^{L*}	a_1^*	b_1	c_1	m_1	Δy_0^*	$\Delta\pi_0^*$	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δb_0	Δc_0	Δm_0	Δy_1^*	$\Delta\pi_1^*$	Δr_1^{S*}	Δr_1^{L*}	Δa_1^*	Δb_1	Δc_1	Δm_1	Δy_1	$\Delta\pi_1$	Δe_1	Δr_1^S	Δr_1^L	Δa_1
Δy	0.71	-0.64	-0.28	0.06	5.4	-5.3	0	0.48	-0.45	-2.8	4.9	0.01	0.01	0.04	0.04	0.95	-0.91	-0.85	2.3	0	0	0.05	-0.01	0.38	-0.4	-1	-1.6	-0.01	0.01	0.02	-0.03	0.02	0.15	-0.07	-2.3	2.1	0
$\Delta\pi$	-0.34	0.02	-0.59	0	-0.32	0.7	0	0.05	0.16	0.21	-0.05	0	0	0.01	0	0.17	0.24	-0.05	0.24	0	0	0.01	0	-0.08	0.1	0.42	-1.1	0	0	0	0	0.03	-0.56	0.02	-0.31	0.19	0
Δe	-3.4	1.3	12	-0.15	-27	5.6	-0.01	-0.37	0.58	15	1.4	-0.02	0.01	-0.25	-0.05	-0.3	2.7	4.6	13	-0.04	-0.12	-0.03	-0.11	-4	0.97	-8.4	29	-0.03	-0.02	0.23	0.1	-0.19	-7.6	0.22	19	-47	0.01
Δr^S	-0.22	0	-0.09	0	-0.45	0.22	0	0.04	0.08	0.28	0.24	0	0	0	0	0.04	0.04	0.59	0.13	0	0	0	0	-0.02	-0.01	-0.06	-0.42	0	0	0	0	0	0.05	0	0.08	0.17	0
Δr^L	0.02	0.01	0.11	0	-0.08	-0.03	0	-0.01	-0.01	0.04	-0.02	0	0	0	0	0	0.02	0.03	0.86	0	0	0	0	0	0.02	0.06	0.03	0	0	0	0	0	-0.03	0	-0.05	0.16	0
Δa	-75	-42	-41	3.3	82	-260	-0.37	57	9.5	-12	500	1.3	-0.08	3.1	2.2	74	-140	-100	110	1	2.1	2.1	0.3	-5.9	-82	-17	170	-0.22	-0.98	0.94	-1.8	1.7	25	-8.7	-400	-180	-0.11
GRE	*cnst.*	y_1	π_1	e_1	r_1^S	r_1^L	a_1	y_1^*	π_1^*	r_1^{S*}	r_1^{L*}	a_1^*	b_1	c_1	m_1	Δy_0^*	$\Delta\pi_0^*$	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δb_0	Δc_0	Δm_0	Δy_1^*	$\Delta\pi_1^*$	Δr_1^{S*}	Δr_1^{L*}	Δa_1^*	Δb_1	Δc_1	Δm_1	Δy_1	$\Delta\pi_1$	Δe_1	Δr_1^S	Δr_1^L	Δa_1
Δy	0.19	-0.13	0.53	0.05	2.6	-0.19	0	0.16	-4.5	0.51	-0.66	0.01	0.03	0	-0.04	0.27	-2.2	2.2	2.5	0.01	0.02	-0.11	0.05	0.5	1.8	-0.51	3.6	0	-0.01	-0.03	0.06	-0.23	-0.05	-0.04	0.55	0.18	0
$\Delta\pi$	-0.27	0.03	-0.96	-0.03	-0.47	0.21	0	0.02	0.94	0.27	2	0	0	-0.01	-0.01	0.1	0.82	0.5	-1.4	0	0	0.01	0.01	-0.02	-0.02	-1.1	-2	0	0	0.02	0.01	0	-0.01	0.05	2.1	-0.14	0
Δe	-1.3	-0.06	-4.1	-0.23	-3.9	0.6	0	0.29	5	1.4	13	-0.02	-0.04	-0.13	-0.03	1.6	2.9	2.3	16	-0.03	-0.14	-0.04	-0.11	0.4	-2	4	-12	-0.01	0	0.11	0.02	-0.62	0.37	0.29	-4.1	-0.95	0
Δr^S	0	0	0.03	0	-0.1	-0.02	0	0	0.11	-0.02	0.04	0	0	0	0	0.05	0.05	0.22	0.03	0	0	0	0	-0.04	-0.02	0.05	0.06	0	0	0	0	0.02	0	0	0.49	-0.03	0
Δr^L	0.03	-0.06	0.29	-0.02	-0.44	-0.16	0	0.05	0.06	0	0.68	0	-0.01	-0.02	0	0.07	0.24	-0.28	0.4	0	0	-0.02	-0.01	0.04	0.1	0.49	0.98	0	0	0.01	0	0.05	-0.06	0.01	0.12	0.51	0
Δa	-8.3	-38	88	-16	-270	-83	-0.43	38	36	36	610	-0.57	-3.6	-12	-1.2	63	-78	480	-260	1.1	-0.42	-9.3	-1.5	-78	-19	150	-720	1.3	0.95	9.1	-0.56	20	-110	13	180	77	-0.27
ITA	*cnst.*	y_1	π_1	e_1	r_1^S	r_1^L	a_1	y_1^*	π_1^*	r_1^{S*}	r_1^{L*}	a_1^*	b_1	c_1	m_1	Δy_0^*	$\Delta\pi_0^*$	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δb_0	Δc_0	Δm_0	Δy_1	$\Delta\pi_1$	Δe_1	Δr_1^S	Δr_1^L	Δa_1								
Δy	0.23	-0.1	-0.49	0	0.66	-0.1	0	0.06	0.45	0.05	-0.42	0	0	0	-0.01	0.71	0.11	1	-1.4	0	0	0.02	0.01	0.1	0.38	0.03	1.6	-1.2	0								
$\Delta\pi$	0.14	-0.09	-0.39	0	0.28	0.12	0	0.07	0.38	0.22	0.01	0	0	0	-0.01	0.2	0.36	0.88	0.38	0	0	0	0	-0.05	-0.29	0	0.4	-0.36	0								
Δe	-1.4	0.61	6.4	-0.01	-5.4	-4.4	0.02	-0.41	-3.3	-2.2	8.4	-0.03	-0.02	0	0.09	1	2.3	-6.5	16	-0.03	-0.11	-0.05	-0.16	-0.09	-1.8	0.19	-13	-0.35	-0.02								
Δr^S	-0.03	0	0.06	0	-0.14	0.04	0	0.01	-0.01	0.06	0.23	0	0	0	0	0.05	0.01	0.42	0.3	0	0	0	0	0.03	-0.01	0	0.05	-0.05	0								
Δr^L	0.03	-0.02	0.15	0	-0.07	-0.29	0	0.01	0.04	-0.05	0.46	0	0	0	0	0.01	0.05	-0.06	1	0	0	-0.01	0	-0.01	-0.09	0	0.07	-0.25	0								
Δa	-21	-7.5	-56	-0.5	-89	170	-0.32	12	31	120	83	0.36	0.75	0.11	-1.7	11	34	82	240	0.83	1.3	-4.1	-1.2	20	33	3.1	-190	-330	-0.27								
TUR	*cnst.*	y_1	π_1	e_1	r_1^S	a_1	y_1^*	π_1^*	r_1^{S*}	r_1^{L*}	a_1^*	b_1	c_1	m_1	Δy_0^*	$\Delta\pi_0^*$	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δb_0	Δc_0	Δm_0	Δy_1^*	$\Delta\pi_1^*$	Δr_1^{S*}	Δr_1^{L*}	Δa_1^*	Δb_1	Δc_1	Δm_1	Δy_1	$\Delta\pi_1$	Δe_1	Δr_1^S	Δa_1		
Δy	0.88	-0.39	0.33	0.02	-0.36	-0.01	0.2	-2.4	-2.6	-5.5	0.02	0.01	-0.05	0.06	-0.61	2.1	6.6	-3.7	0.01	0	0.03	0.05	-0.45	4.2	5.7	-6.6	-0.01	0.01	0.05	-0.04	-0.19	-0.11	-0.05	-0.43	0		
$\Delta\pi$	2	0.14	-0.99	0.06	1.3	0	-0.47	4.3	-1.4	0.94	0	0.04	-0.13	0.05	-0.37	4	0.57	2.9	0	0	-0.11	-0.02	0.69	0	2.5	-2.9	0	-0.01	-0.01	0.05	-0.08	-0.09	0.08	-0.22	0		
Δe	-4.7	-0.13	0.57	-0.24	0.13	0.01	0.75	-8.1	2.8	-0.26	-0.02	-0.01	0.33	-0.11	0.35	-4.7	-23	15	0.01	-0.02	0.22	-0.17	-0.01	-7.5	11	-3	0	0.16	-0.03	0.14	1.1	-0.28	0.22	1.8	0.01		
Δr^S	0.61	0.21	-0.04	0.05	-0.53	0	-0.28	2.3	2.2	0.43	-0.01	-0.01	0.01	-0.01	0.06	1.7	2.8	-3.2	0	-0.02	0.03	-0.04	0.18	-0.13	-7.1	3.4	0	0	0	0	-0.09	0.08	-0.02	0.57	0		
Δa	7.1	24	-17	4	57	-0.78	-5.3	370	-250	910	0.17	-0.68	-17	-1.3	39	230	-600	-50	-0.2	-3.9	-4.2	-1.9	-22	-71	62	-18	0.35	-3.9	6.7	3.3	-27	11	-2.5	1.4	-0.1		
UK	*cnst.*	y_1	π_1	e_1	r_1^S	r_1^L	a_1	y_1^*	π_1^*	r_1^{S*}	r_1^{L*}	a_1^*	b_1	c_1	m_1	Δy_0^*	$\Delta\pi_0^*$	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δb_0	Δc_0	Δm_0	Δy_1^*	$\Delta\pi_1^*$	Δr_1^{S*}	Δr_1^{L*}	Δa_1^*	Δb_1	Δc_1	Δm_1	Δy_1	$\Delta\pi_1$	Δe_1	Δr_1^S	Δr_1^L	Δa_1
Δy	0.03	0.04	0.26	0.01	0.24	-0.1	0	-0.04	-0.29	0.03	0.06	0	0	0	0	0.81	-0.21	-2.3	-0.98	0	0.01	-0.02	0	0.14	0.51	1.4	-4.8	0	0	0	0.01	0.18	-0.4	0.02	-0.65	3.2	0
$\Delta\pi$	-0.01	-0.04	-0.56	0.01	0.19	-0.28	0	0.05	0.14	-0.34	0.1	0	0	0	0	-0.15	0.53	0.76	0.11	0	0	0.01	0	0.1	0.04	-0.38	-1.2	0	0	0	-0.01	0.06	-0.02	-0.02	-0.31	1.6	0
Δe	-1.4	-1.2	-1.2	-0.62	-18	12	0	1.1	12	6.7	-5.4	-0.02	-0.02	-0.24	-0.05	-1.1	2.9	4	10	-0.02	-0.12	-0.01	-0.09	-1.8	-2.6	7.3	6.5	0	-0.12	0.13	0.02	-0.72	0.42	0.4	4.1	-13	0
Δr^S	-0.01	-0.01	0.02	-0.01	-0.15	0.12	0	0.01	0.09	0.07	-0.05	0	0	0	0	0.01	0.02	0.7	0.05	0	0	0	0	-0.02	0	-0.33	0.3	0	0	0	0	0.02	-0.02	0	0.58	-0.38	0
Δr^L	0	0	0.04	0	-0.05	0.05	0	0	0.02	0.04	-0.02	0	0	0	0	-0.03	-0.04	0.1	0.82	0	0	0	0	0.02	0	-0.09	-0.2	0	0	0	0	0.01	-0.02	0	0	0.14	0
Δa	-13	2.8	240	-11	-340	300	-0.93	-6.9	110	250	-120	0.41	-0.41	-2.9	-2.8	-26	290	37	-520	0.66	-2.2	2.8	-0.94	-74	-15	-270	1200	0.27	-0.4	5.2	4.8	12	1.4	14	660	-1500	0.05
USA	*cnst.*	y_1	π_1	r_1^S	r_1^L	a_1	b_1	c_1	m_1	y_1^*	π_1^*	eps_1	r_1^{S*}	r_1^{L*}	a_1^*	Δy_0^*	$\Delta\pi_0^*$	Δes_0	Δr_0^{S*}	Δr_0^{L*}	Δa_0^*	Δy_1^*	$\Delta\pi_1^*$	Δes_1	Δr_1^{S*}	Δr_1^{L*}	Δa_1^*	Δy_1	$\Delta\pi_1$	Δr_1^S	Δr_1^L	Δa_1	Δb_1	Δc_1	Δm_1		
Δy	0.08	0.08	0.4	-0.19	-0.3	0	0	0.01	0.01	-0.11	-0.65	0.01	0.46	0.38	0	0.61	0.38	-0.01	1.5	-0.29	0	0.12	0.28	-0.02	-3.4	-1.3	0	0.13	-0.54	-0.25	1.8	-0.01	0	-0.03	-0.01		
$\Delta\pi$	-0.55	0.01	-0.74	1.1	-0.9	0	0	0.01	-0.02	0.1	1	-0.02	-1.1	1.7	0	0.24	0.94	-0.06	0.01	0.34	0	-0.2	-0.15	0.02	-0.11	-1.3	0	0.06	-0.11	-0.4	0.15	0	0	0.01	0.01		
Δr^S	0.13	0.01	0.11	-0.17	0.14	0	0	0	0	-0.04	-0.2	0.01	0.17	-0.32	0	-0.04	-0.02	0	0.45	0.42	0	-0.02	0.07	0	-0.64	0.34	0	0.04	-0.02	0.52	-0.2	0	0	0	0		
Δr^L	0.04	0	0.04	0.17	-0.18	0	0	0	0	-0.01	0.05	0	-0.29	0.14	0	-0.01	0	0	-0.2	1.1	0	-0.02	-0.03	0	0.13	0.09	0	0.01	0.03	-0.22	0.01	0	0	0	0		
Δa	52	6.5	-0.1	-120	89	-0.13	0.88	1.4	1.8	-20	-230	1.6	220	-150	-0.15	17	-49	-0.16	-65	-77	-0.1	6.2	55	-3	-110	180	0.06	1.5	-26	-88	27	-0.56	-0.19	-2.5	-0.77		
Δb	-19	2.4	13	20	-42	0.06	-0.4	0.18	-0.23	1.6	17	-0.47	-19	76	-0.05	8.2	37	-1.6	-3.6	40	-0.06	-8.4	6.4	1.1	-30	-24	0	1.3	-7.5	18	22	-0.09	0	0.23	0.2		
Δc	1.9	-2.2	-0.66	-2.7	7.3	0.01	0.11	-0.41	0.04	2	-4.7	-0.08	-1.4	-12	-0.04	2.4	5.2	-0.2	2.3	14	-0.01	-0.36	4.7	-0.39	5	-1.7	0	2.3	0.23	-3.3	15	-0.04	-0.09	0.18	-0.1		
Δm	4.3	-2.3	-4.2	22	-13	-0.01	0.11	-0.33	-0.2	1.6	12	-0.23	-40	6	0.02	0.48	11	-0.81	-21	42	0	-0.6	4.2	-0.37	19	37	-0.04	-0.51	1.9	-4.7	-23	-0.01	-0.1	0.25	-0.06		

Table A9: France: Cointegrating Vectors

ALPHA	a1	a2	a3	a4	a5
y	-0.22	-0.07	0.00	-0.57	0.70
π	-0.13	-1.75	-0.01	0.71	-0.11
e^R	4.04	0.30	-0.31	-18.27	16.68
i^S	-0.02	-0.11	0.00	-0.25	0.25
i^L	-0.04	-0.10	0.00	0.26	-0.36
A	1.86	28.23	1.16	-200.22	474.33

BETA	CV1	CV2	CV3	CV4	CV5
y	1.00	0.00	0.00	0.00	0.00
π	0.00	1.00	0.00	0.00	0.00
e^R	0.00	0.00	1.00	0.00	0.00
i^S	0.00	0.00	0.00	1.00	0.00
i^L	0.00	0.00	0.00	0.00	1.00
A	0.00	0.00	0.11	0.00	0.00
y^*	-0.86	-0.09	2.86	-0.07	-0.03
π^*	-3.78	-0.24	-77.57	0.01	-0.01
r^{S*}	4.03	-0.25	62.23	-0.85	-0.07
r^{L*}	1.46	-1.09	8.26	-0.85	-1.36
A^*	0.00	0.00	0.04	0.00	0.00
b	0.03	-0.01	0.65	-0.01	-0.01
c	0.07	-0.01	1.06	0.00	0.00
m	-0.03	0.01	-0.15	0.00	0.00

Table A10: Germany: Cointegrating Vectors

ALPHA	a1	a2	a3
y	-0.64	-0.28	0.06
π	0.02	-0.59	0.00
e^R	1.26	11.80	-0.15
i^S	0.00	-0.09	0.00
i^L	0.01	0.11	0.00
A	-42.24	-40.70	3.26

BETA	CV1	CV2	CV3
y	1.00	0.00	0.00
π	0.00	1.00	0.00
e^R	0.00	0.00	1.00
i^S	28.78	-0.41	393.46
i^L	-1.35	-0.72	-106.36
A	0.03	0.00	0.32
y^*	-3.93	-0.04	-34.03
π^*	-3.88	-0.16	-49.31
r^{S*}	-18.60	0.21	-242.46
r^{L*}	-31.65	0.30	-253.70
A^*	-0.07	0.00	-0.50
b	0.04	0.00	0.47
c	-0.10	-0.02	-0.52
m	-0.04	0.00	0.19

Table A11: Greece: Cointegrating Vectors

ALPHA	a1	a2	a3
y	-0.13	0.53	0.05
π	0.03	-0.96	-0.03
e^R	-0.06	-4.14	-0.23
i^S	0.00	0.03	0.00
i^L	-0.06	0.29	-0.02
A	-37.94	87.76	-16.02

BETA	CV1	CV2	CV3
y	1.00	0.00	0.00
π	0.00	1.00	0.00
e^R	0.00	0.00	1.00
i^S	-10.00	-0.89	35.42
i^L	0.98	-0.24	1.52
A	0.01	0.00	-0.01
y^*	-1.35	-0.07	0.41
π^*	21.30	1.07	-46.84
r^{S*}	-4.27	-0.55	4.85
r^{L*}	-9.85	-1.59	-23.34
A^*	-0.03	0.00	0.11
b	-0.10	-0.01	0.41
c	0.17	0.01	0.39
m	0.28	0.03	-0.43

Table A12: Italy: Cointegrating Vectors

ALPHA	a1	a2	a3
y	-0.10	-0.49	0.00
π	-0.09	-0.39	0.00
e^R	0.61	6.38	-0.01
i^S	0.00	0.05	0.00
i^L	-0.02	0.15	0.00
A	-7.55	-56.47	-0.50

BETA	CV1	CV2	CV3
y	1.00	0.00	0.00
π	0.00	1.00	0.00
e^R	0.00	0.00	1.00
i^S	-1.60	-0.19	224.54
i^L	5.33	-1.72	-233.82
A	0.02	0.00	0.15
y^*	-0.68	-0.02	-10.89
π^*	-3.60	-0.15	10.23
r^{S*}	-0.07	-0.70	-165.60
r^{L*}	-7.82	1.56	-225.51
A^*	0.00	0.00	-0.15
b	0.02	-0.01	-1.04
c	0.00	0.00	-0.26
m	0.03	0.01	1.41

Table A13: Turkey: Cointegrating Vectors

ALPHA	a1	a2	a3	a4
y	-0.39	0.33	0.02	-0.36
π	0.14	-0.99	0.06	1.31
e^R	-0.13	0.57	-0.24	0.13
i^S	0.21	-0.04	0.05	-0.53
A	24.06	-17.41	4.03	57.49

BETA	CV1	CV2	CV3	CV4
y	1.00	0.00	0.00	0.00
π	0.00	1.00	0.00	0.00
e^R	0.00	0.00	1.00	0.00
i^S	0.00	0.00	0.00	1.00
A	0.00	-0.02	-0.11	-0.01
y^*	-0.19	0.77	-1.03	0.29
π^*	7.08	0.60	32.40	1.43
r^{S*}	3.35	-7.74	-35.33	-5.57
r^{L*}	21.47	16.75	35.01	9.42
A^*	-0.03	0.02	0.14	0.01
b	-0.06	-0.04	-0.01	0.00
c	-0.05	-0.29	-2.17	-0.22
m	-0.17	-0.04	0.48	0.00

Table A14: UK: Cointegrating Vectors

ALPHA	a1	a2
y	0.04	0.26
π	-0.04	-0.56
e^R	-1.19	-1.17
i^S	-0.01	0.02
i^L	0.00	0.04
A	2.83	240.04

BETA	CV1	CV2
y	1.00	0.00
π	0.00	1.00
e^R	0.58	-0.05
i^S	16.66	-1.60
i^L	-11.88	1.40
A	0.01	0.00
y^*	-0.92	-0.02
π^*	-11.02	0.58
r^{S*}	-6.74	1.11
r^{L*}	5.07	-0.55
A^*	0.01	0.00
b	0.01	0.00
c	0.21	-0.01
m	0.05	-0.01

Table A15: USA: Cointegrating Vectors

ALPHA	a1	a2	a3	a4	a5
y	0.08	0.40	-0.19	-0.30	0.00
π	0.01	-0.74	1.14	-0.90	0.00
i^S	0.01	0.11	-0.17	0.14	0.00
i^L	0.00	0.04	0.17	-0.18	0.00
A	6.50	-0.10	-116.35	89.14	-0.13
b	2.40	13.01	19.98	-42.13	0.06
c	-2.16	-0.66	-2.70	7.31	0.01
m	-2.26	-4.16	22.05	-12.53	-0.01

BETA	CV1	CV2	CV3	CV4	CV5
y	1.00	0.00	0.00	0.00	0.00
π	0.00	1.00	0.00	0.00	0.00
i^S	0.00	0.00	1.00	0.00	0.00
i^L	0.00	0.00	0.00	1.00	0.00
A	0.00	0.00	0.00	0.00	1.00
b	-0.10	-0.01	-0.02	-0.02	-5.07
c	0.18	-0.01	0.00	0.00	-2.01
m	-0.06	-0.01	-0.03	-0.02	-3.95
y^*	-0.25	0.07	0.20	0.17	78.89
π^*	14.50	2.56	5.82	5.04	761.18
e^{R*}	0.07	0.02	0.01	0.02	-3.66
r^{S*}	-0.48	-1.41	-3.03	-1.51	-50.98
r^{L*}	3.52	-0.13	0.28	-0.97	389.08
A^*	0.04	0.01	0.01	0.01	-0.26

D Variable plotpanels

Each of the 43 variable panels represents a variable, and contain four panes. The first pane shows the outcome series for the whole sample period. The vertical line marks the beginning of the period for the counterfactual analysis. The purpose is to show the results of the scenarios, thus the nominal exchange rate and the price level are included and not the real exchange rate and inflation included in the estimated model.

The second pane shows model forecasts. It consist of the endogenous forecast, and four other forecasts that are of the type that in the scenario section are called factual baseline forecasts. The forecasts are transformed from its logarithmic form back to normal form by a inverse transformation of variable definitions at page 18. For reference is also the variable outcome included.

The third pane displays the scenario effects also mentioned in scenario section. This is the difference between the counterfactual alternative scenario and a factual baseline scenario as one of the four in the second pane.

In the last pane the scenario effects of the third pane are added on top of the variable outcome to out of the scenarios form counter factual point forecasts.

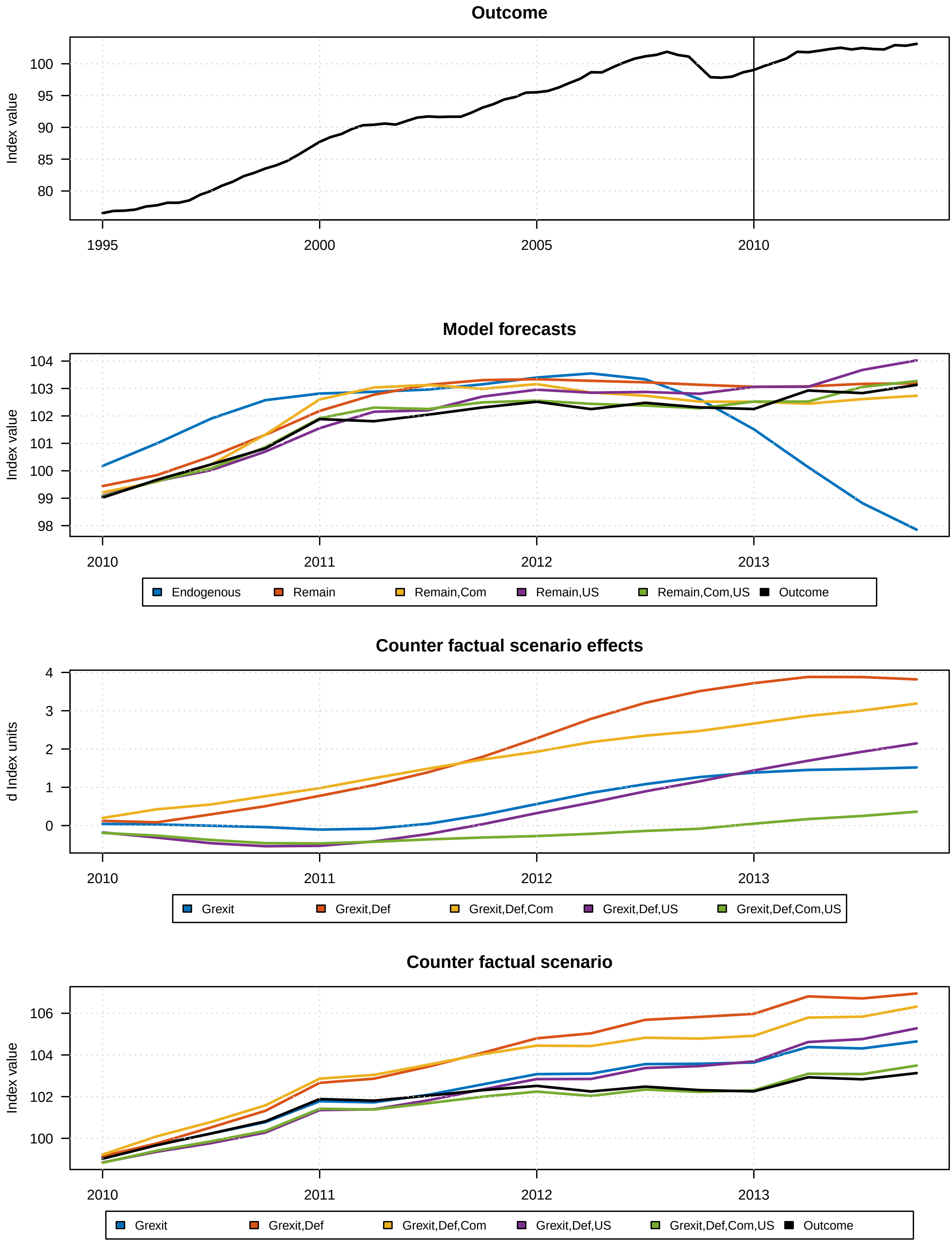


Figure A1: France, Real GDP

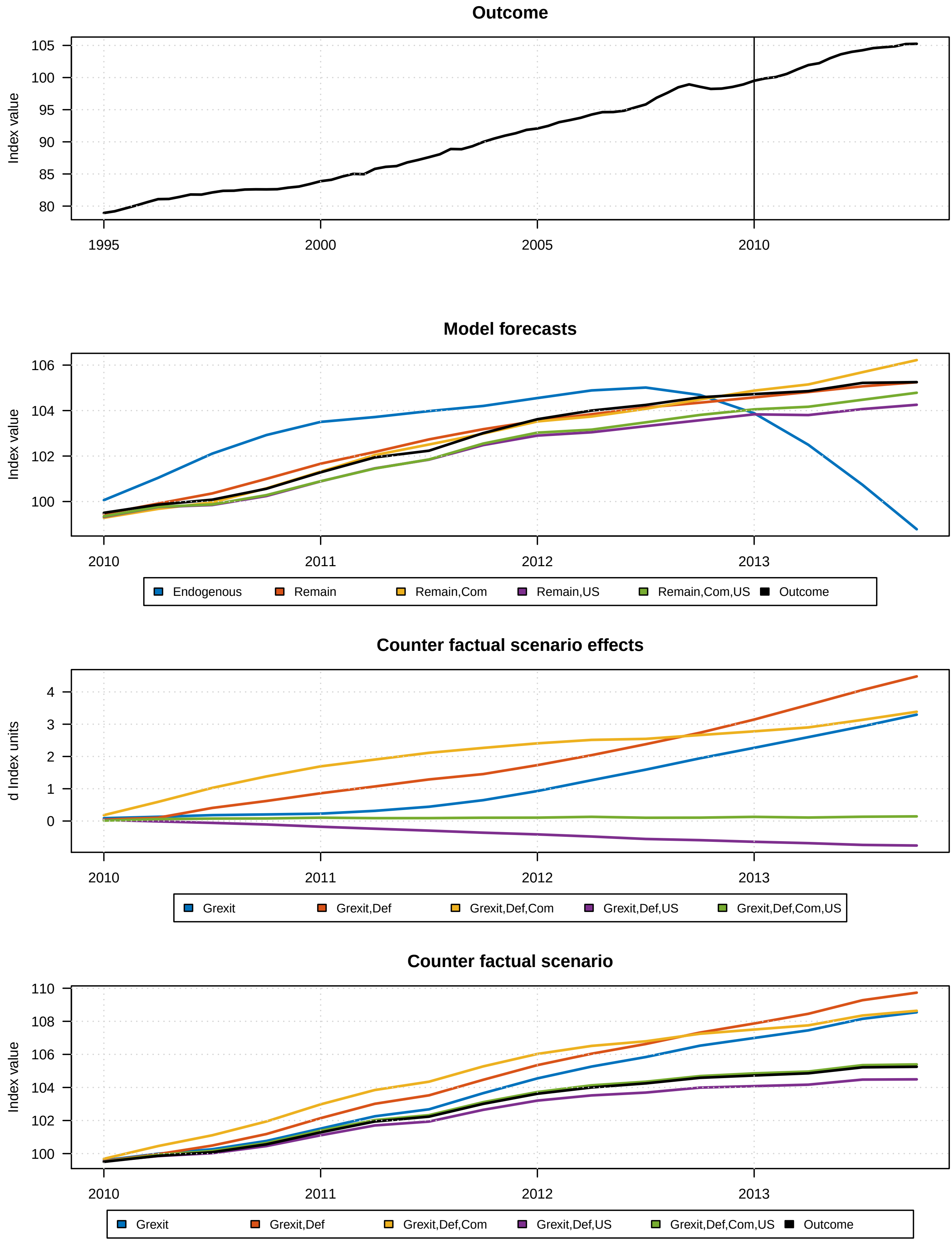


Figure A2: France, Consumer price index

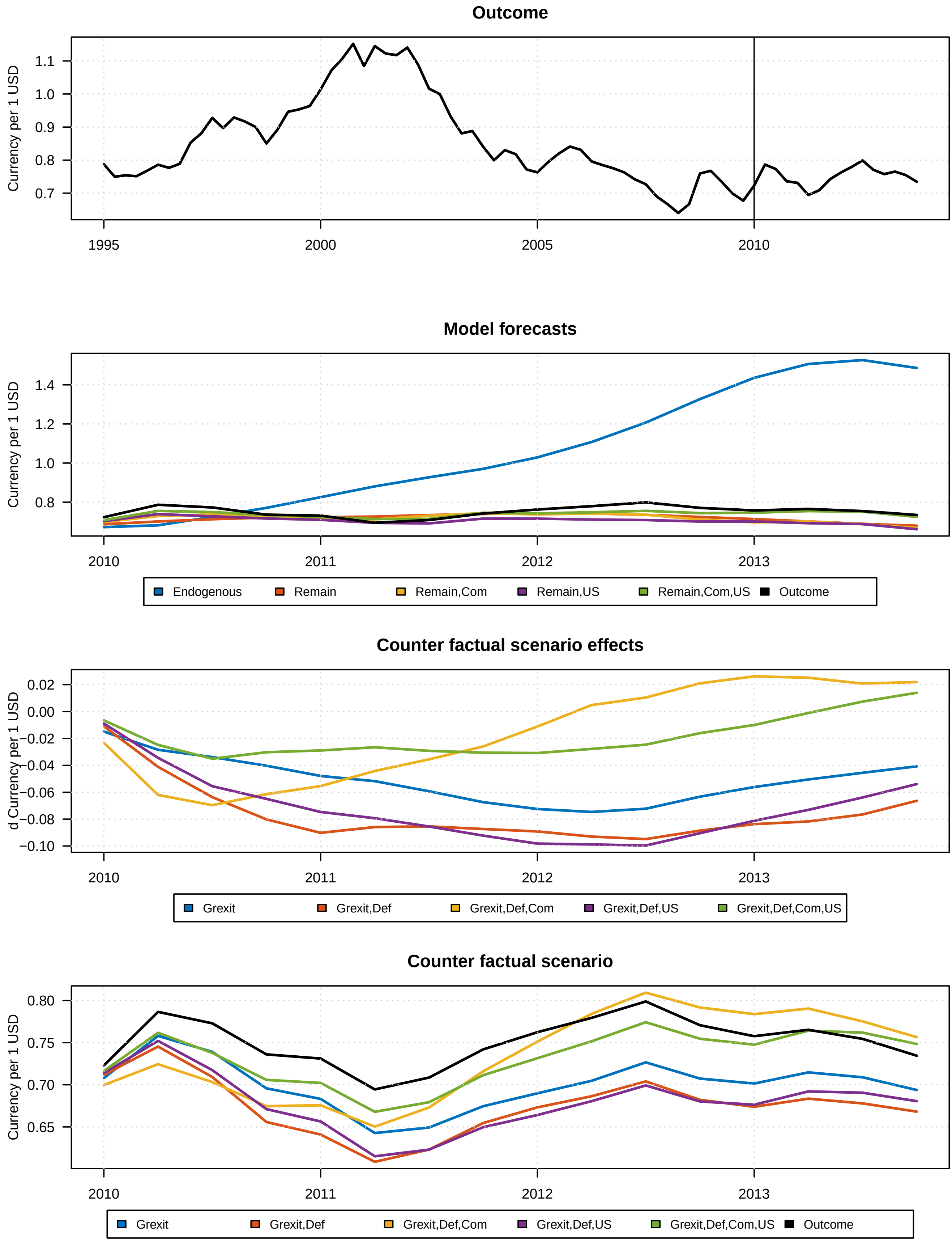


Figure A3: France, Nominal exchange rate

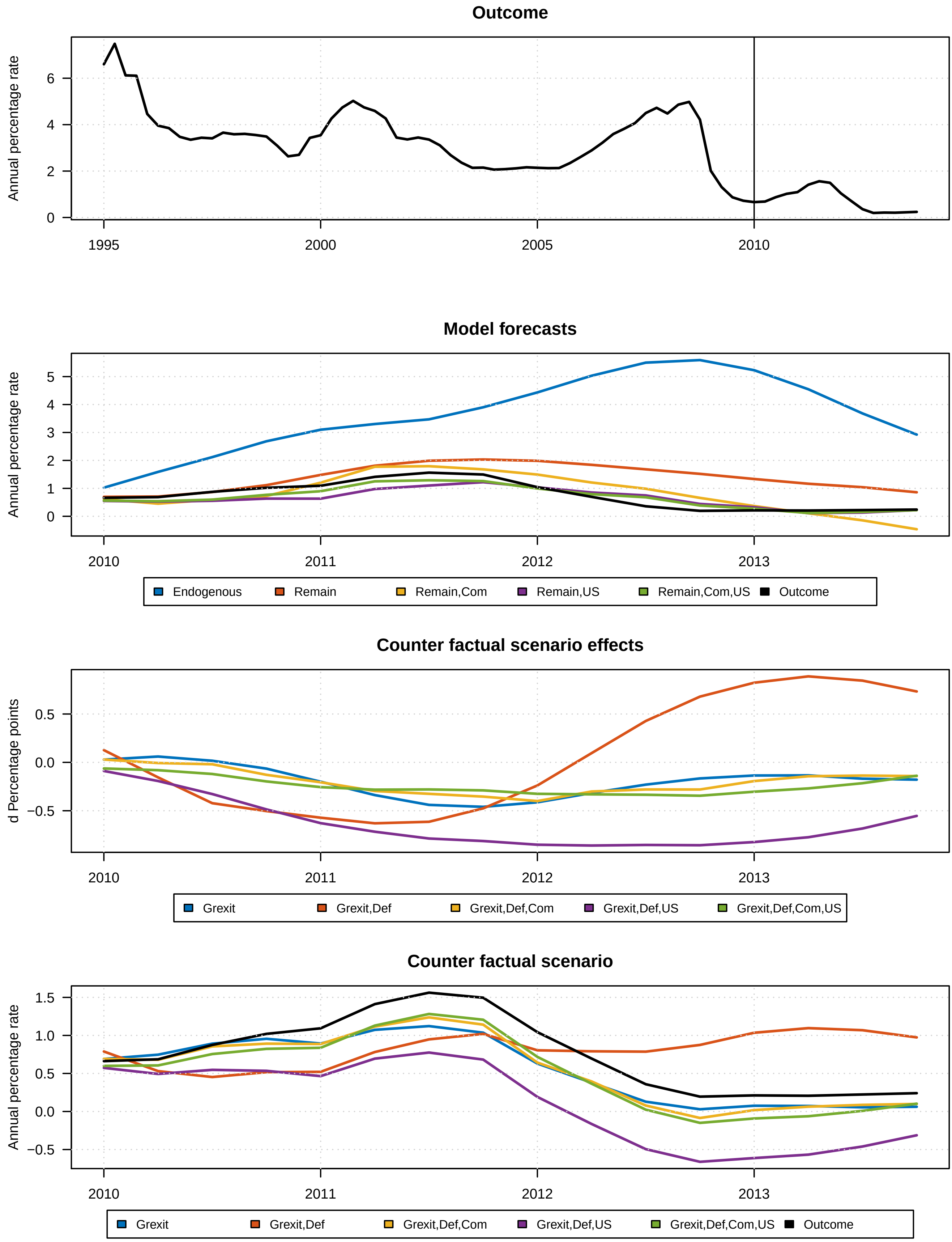


Figure A4: France, Short-term interest rate

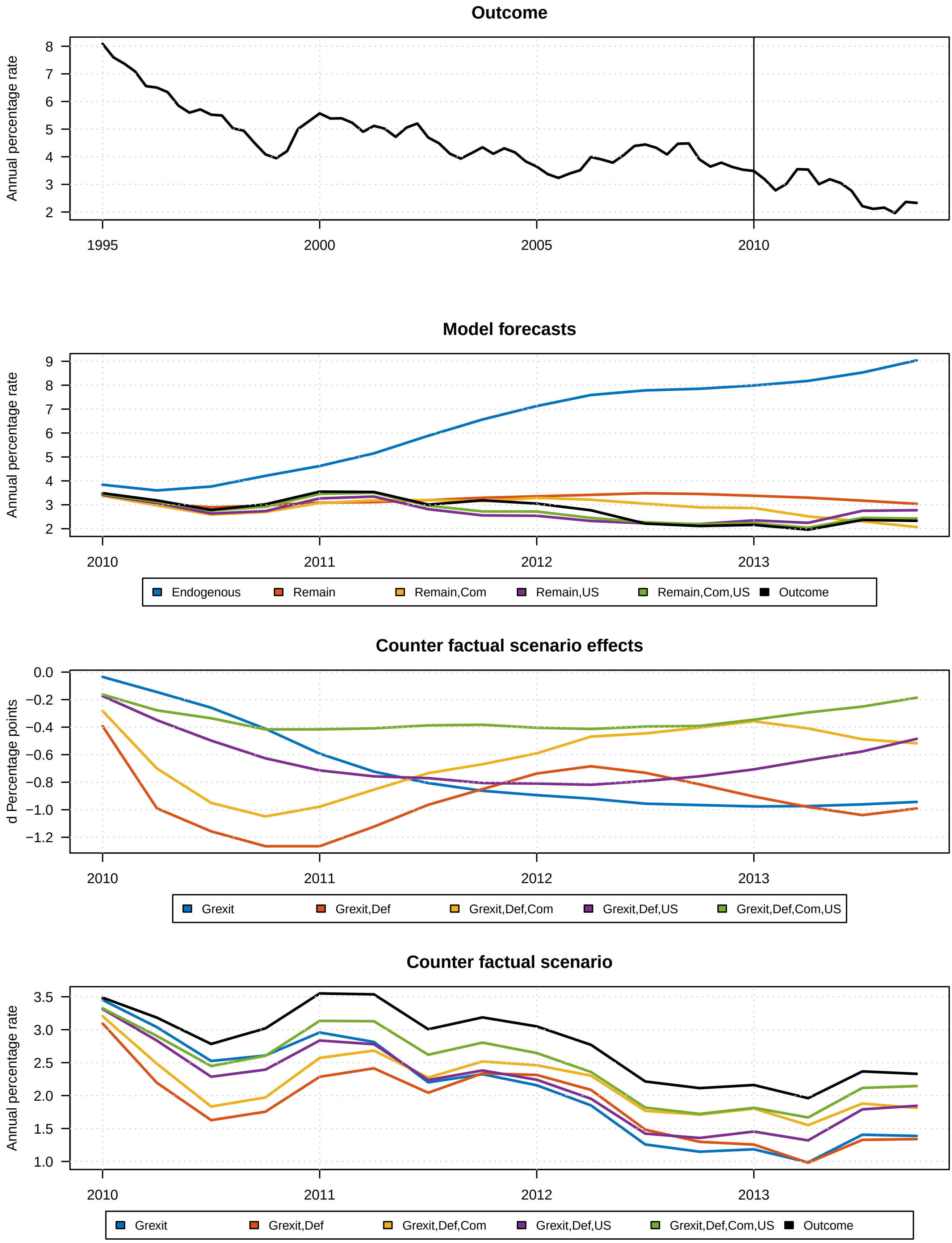


Figure A5: France, Long-term interest rate

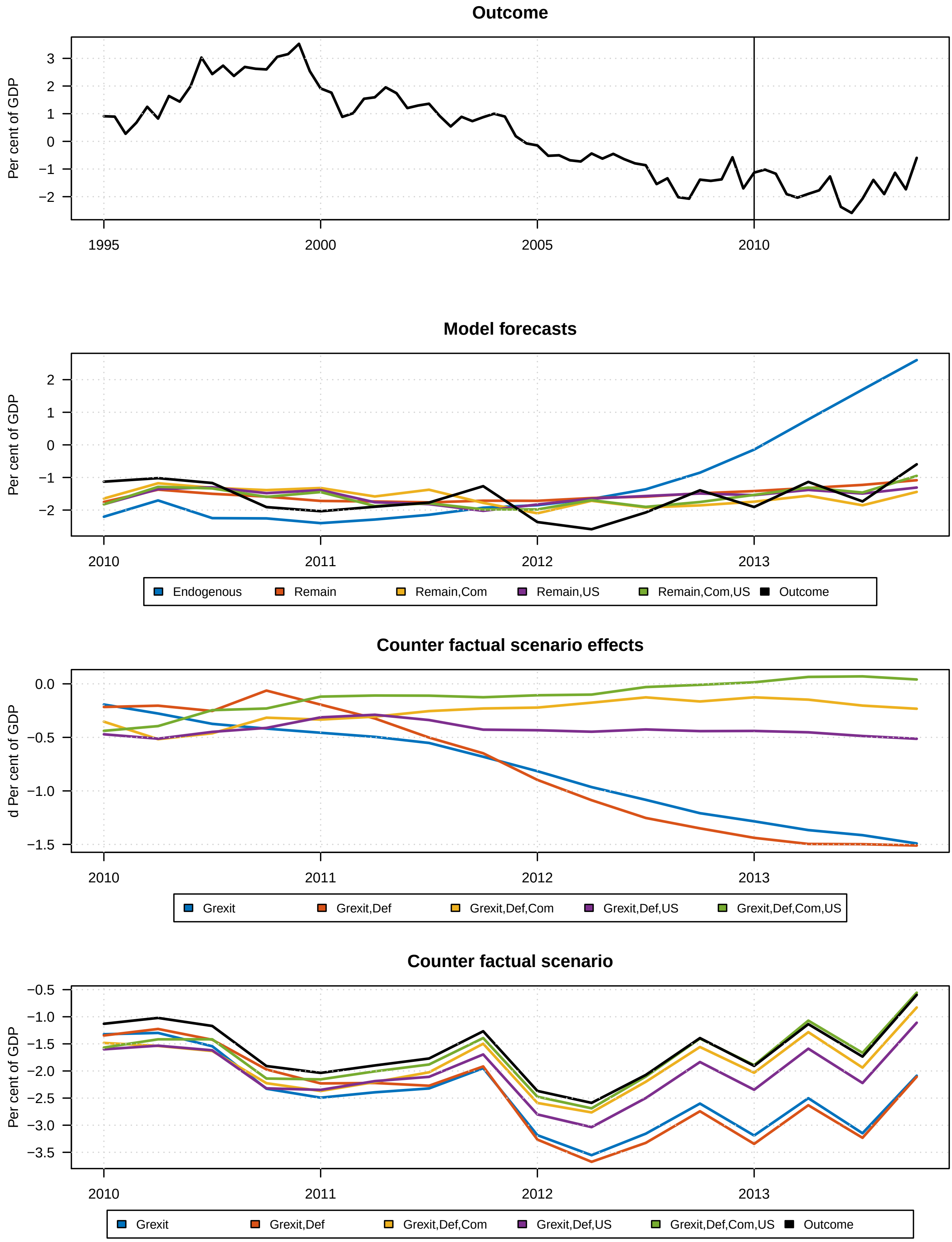


Figure A6: France, Current account

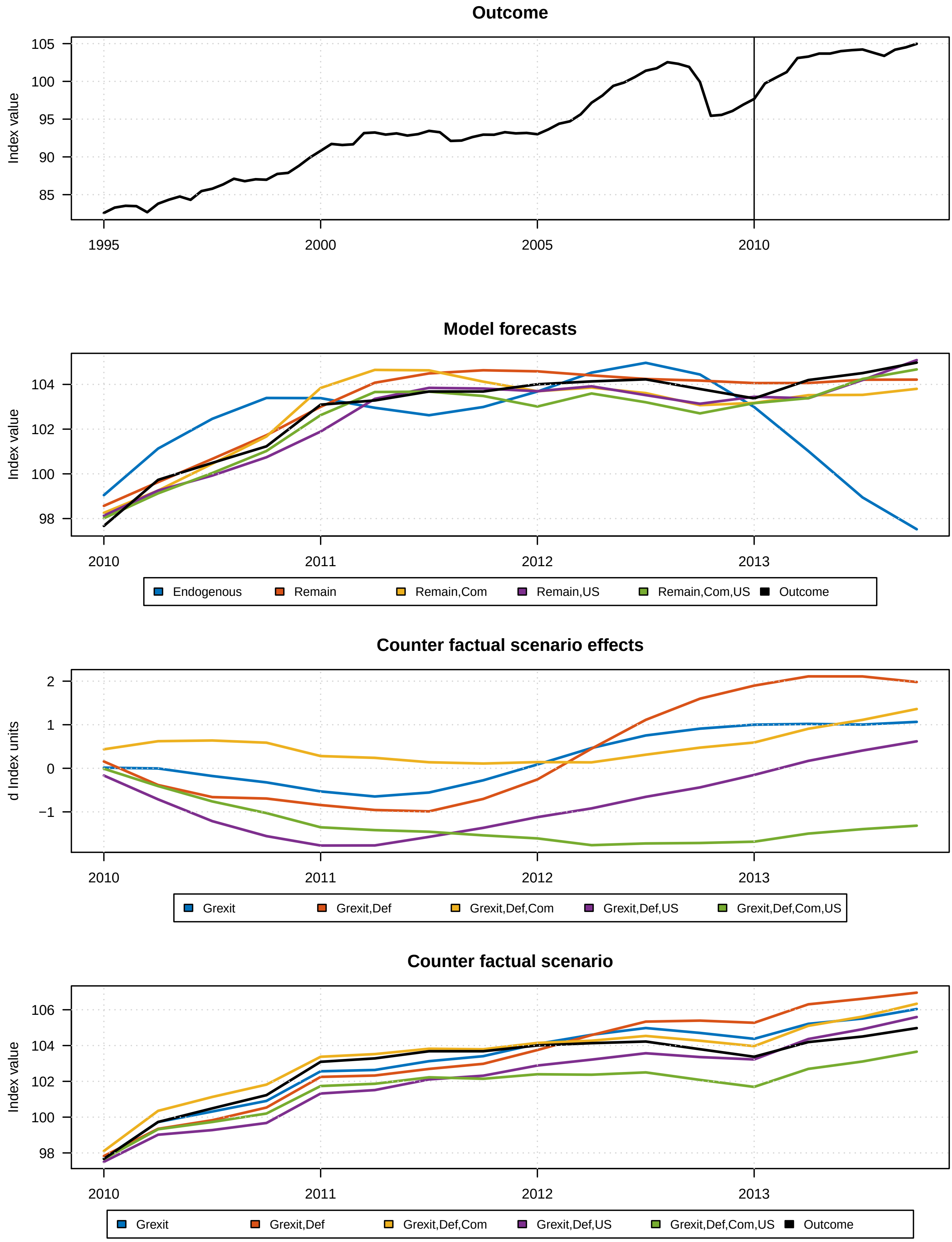
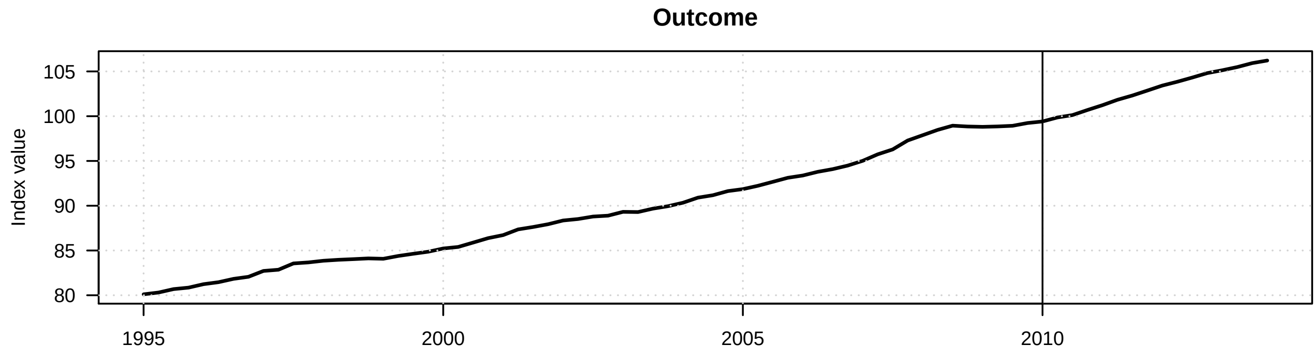
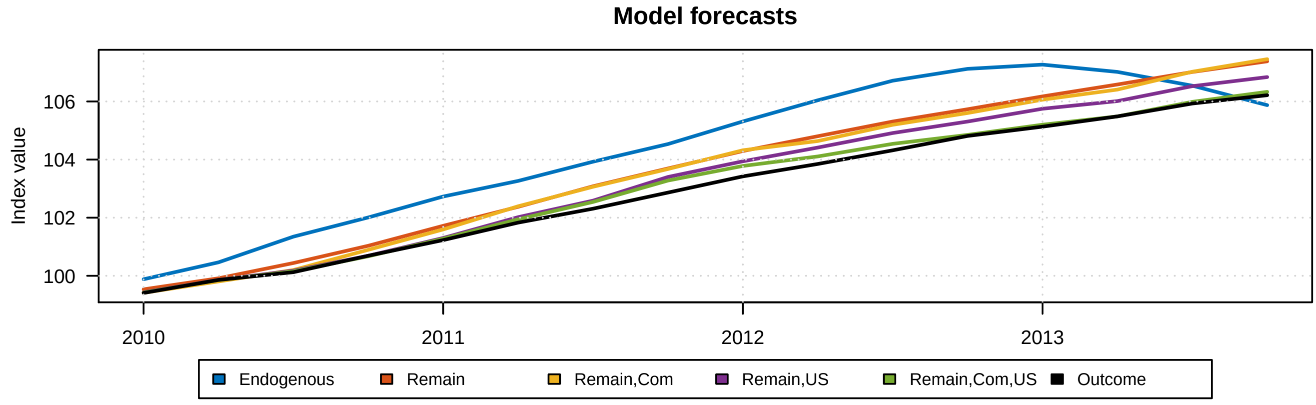
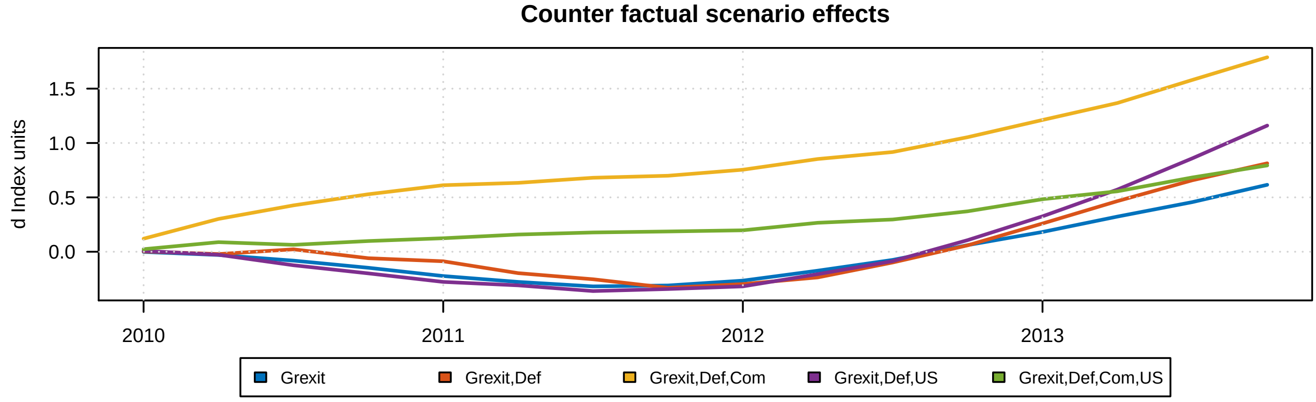


Figure A7: Germany, Real GDP







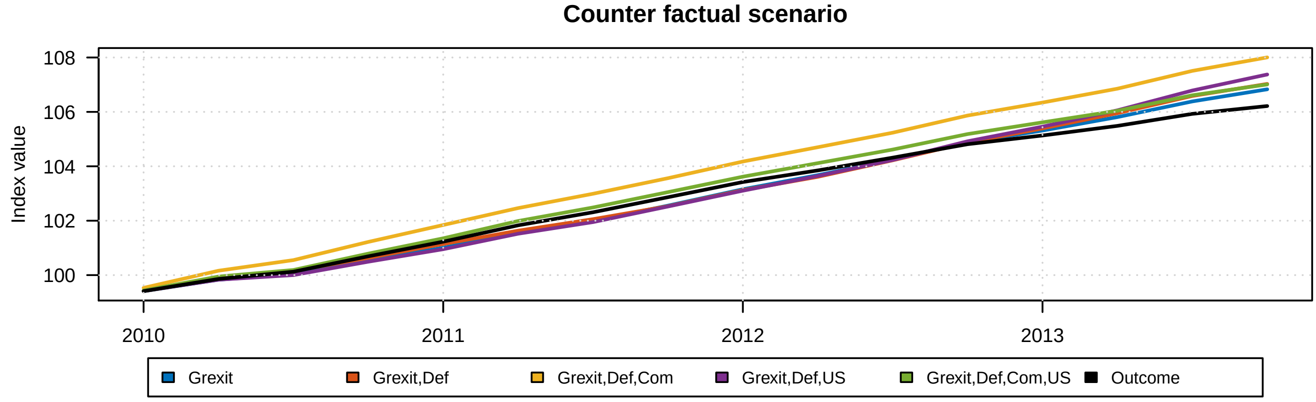


Figure A8: Germany, Consumer price index

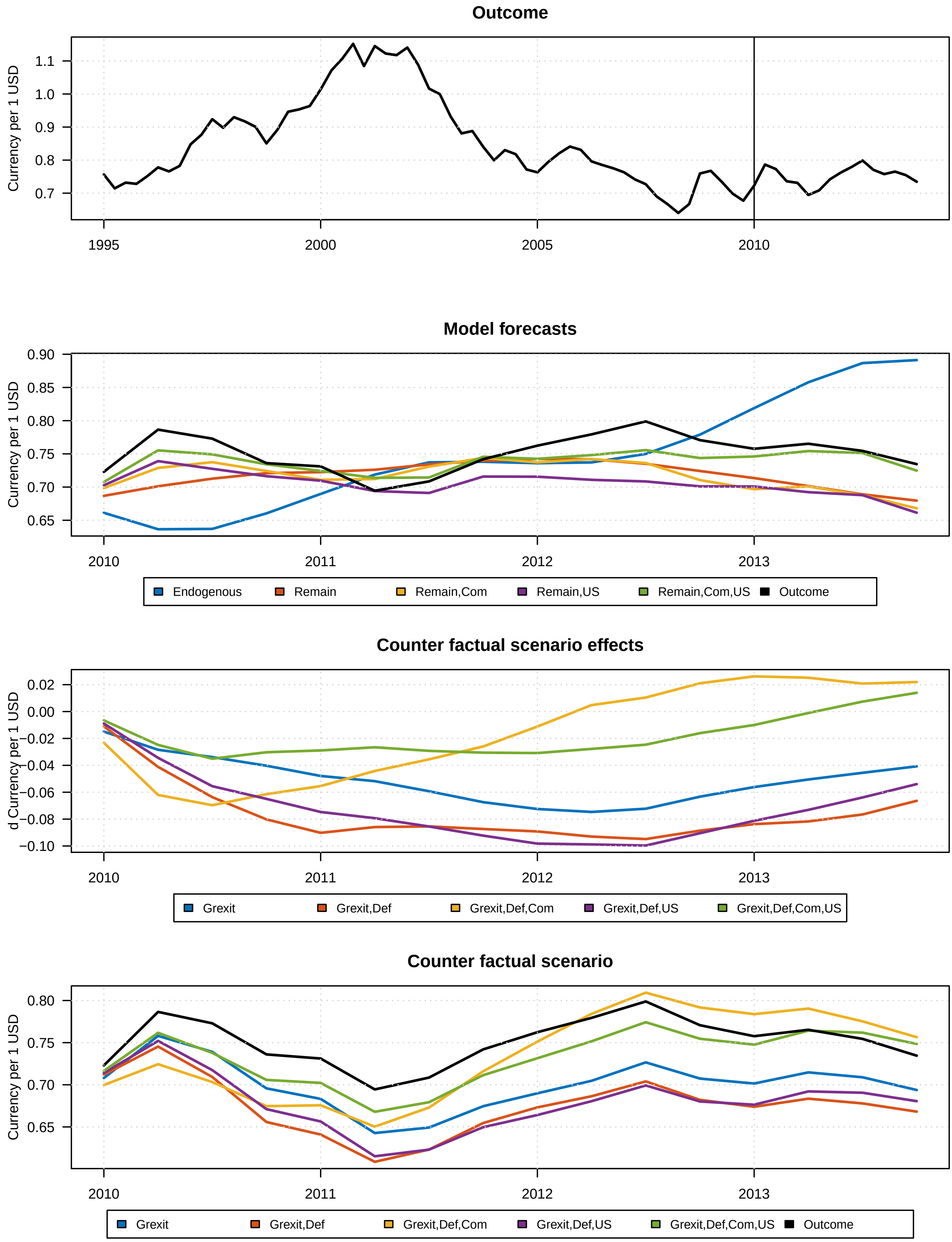


Figure A9: Germany, Nominal exchange rate

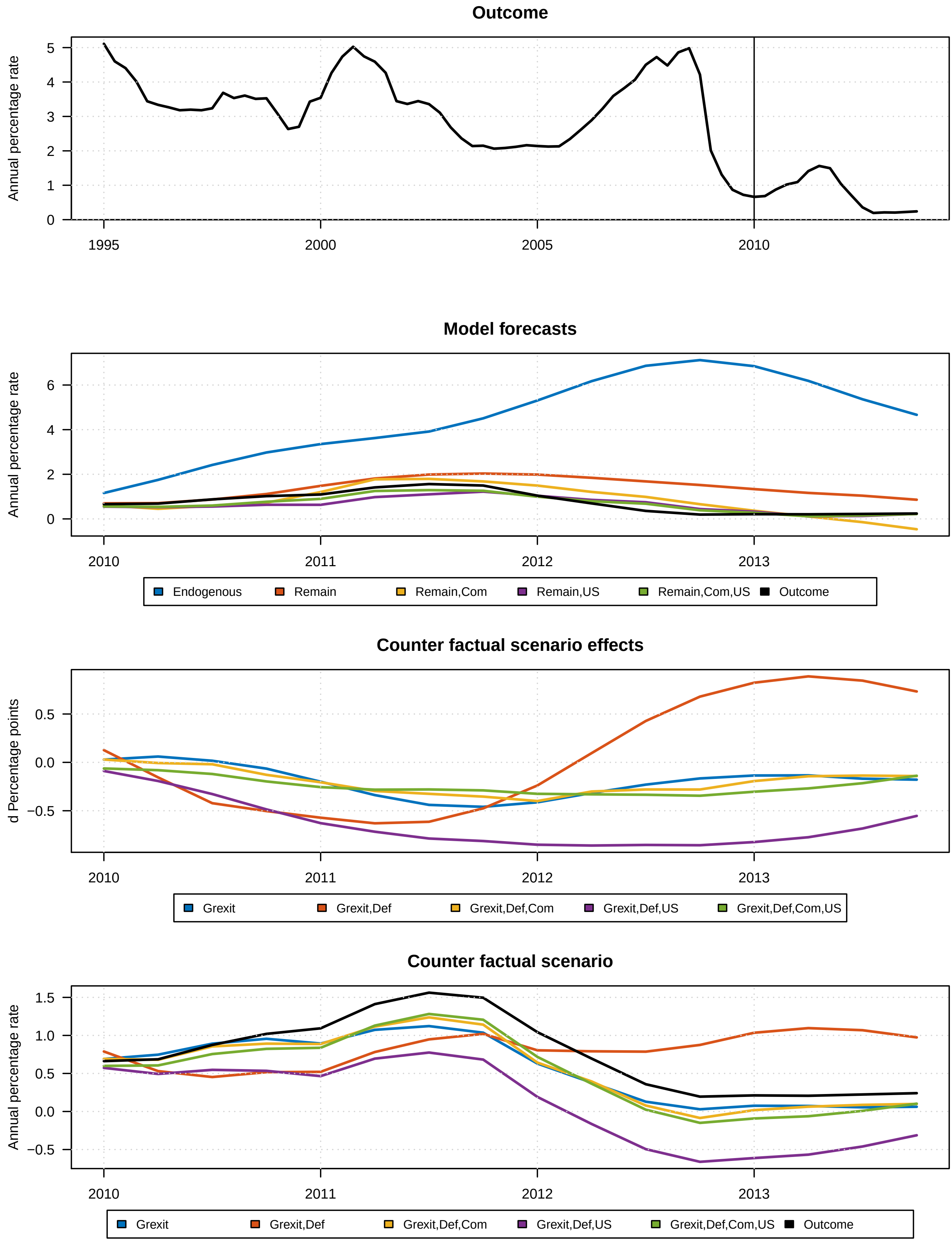


Figure A10: Germany, Short-term interest rate

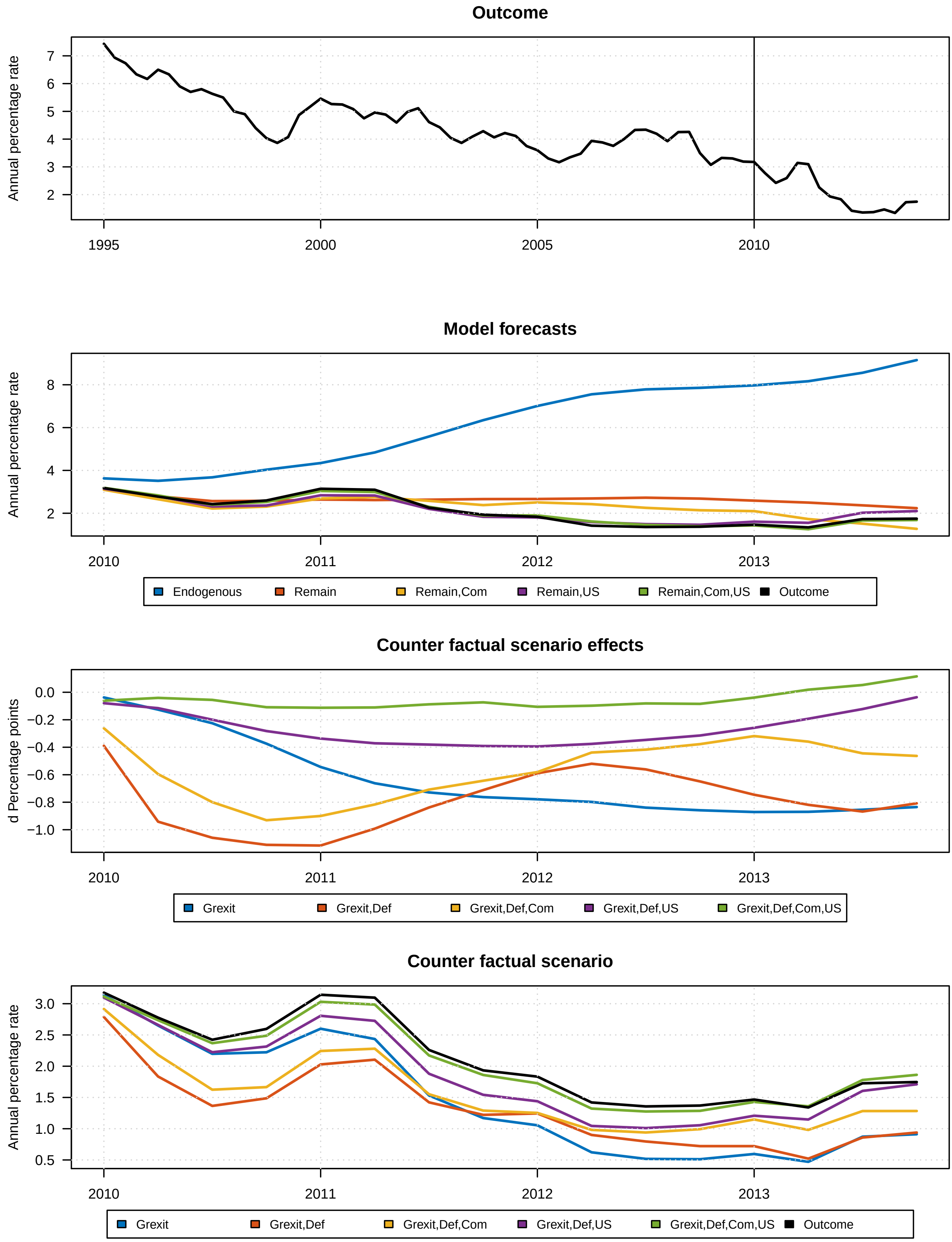


Figure A11: Germany, Long-term interest rate

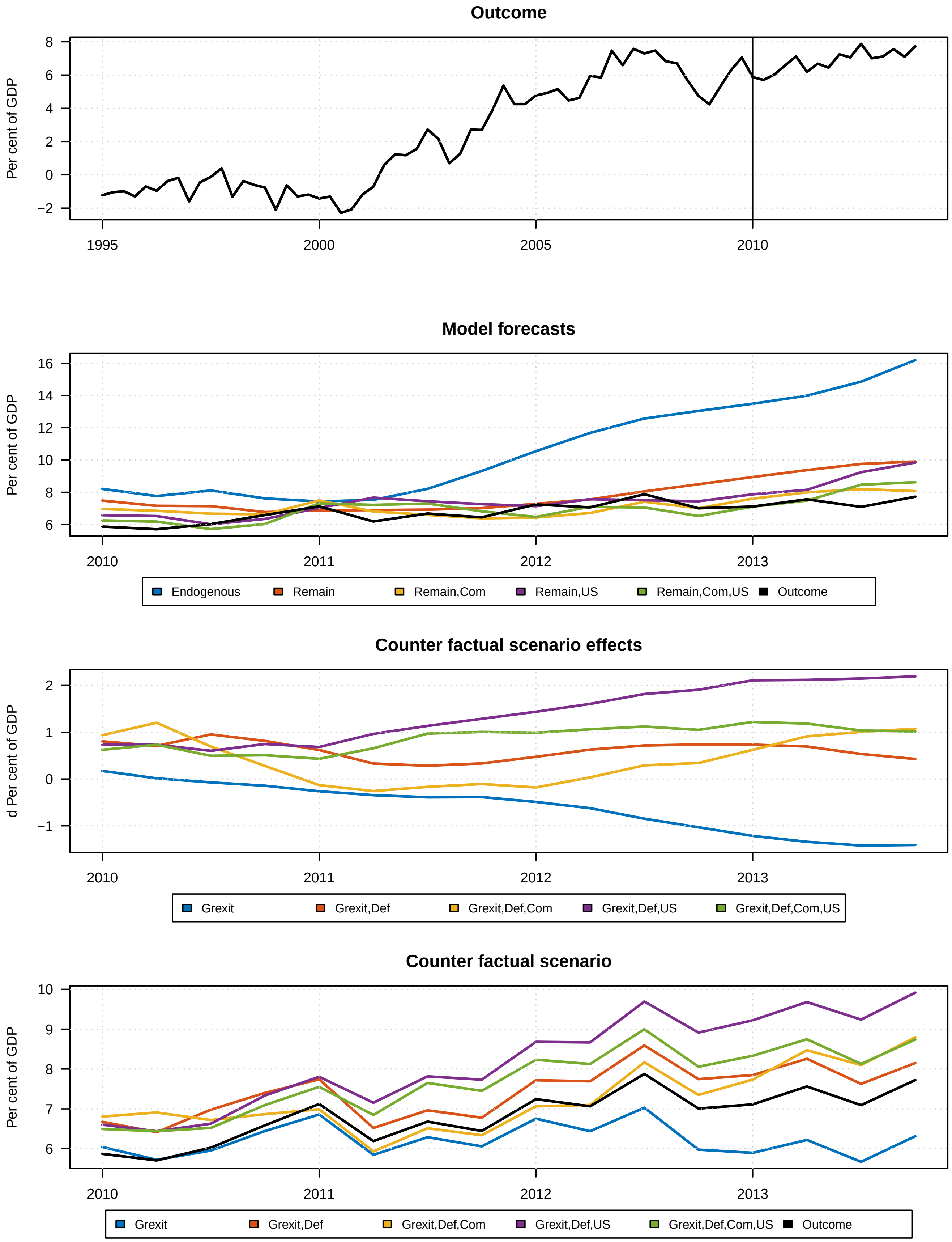


Figure A12: Germany, Current account

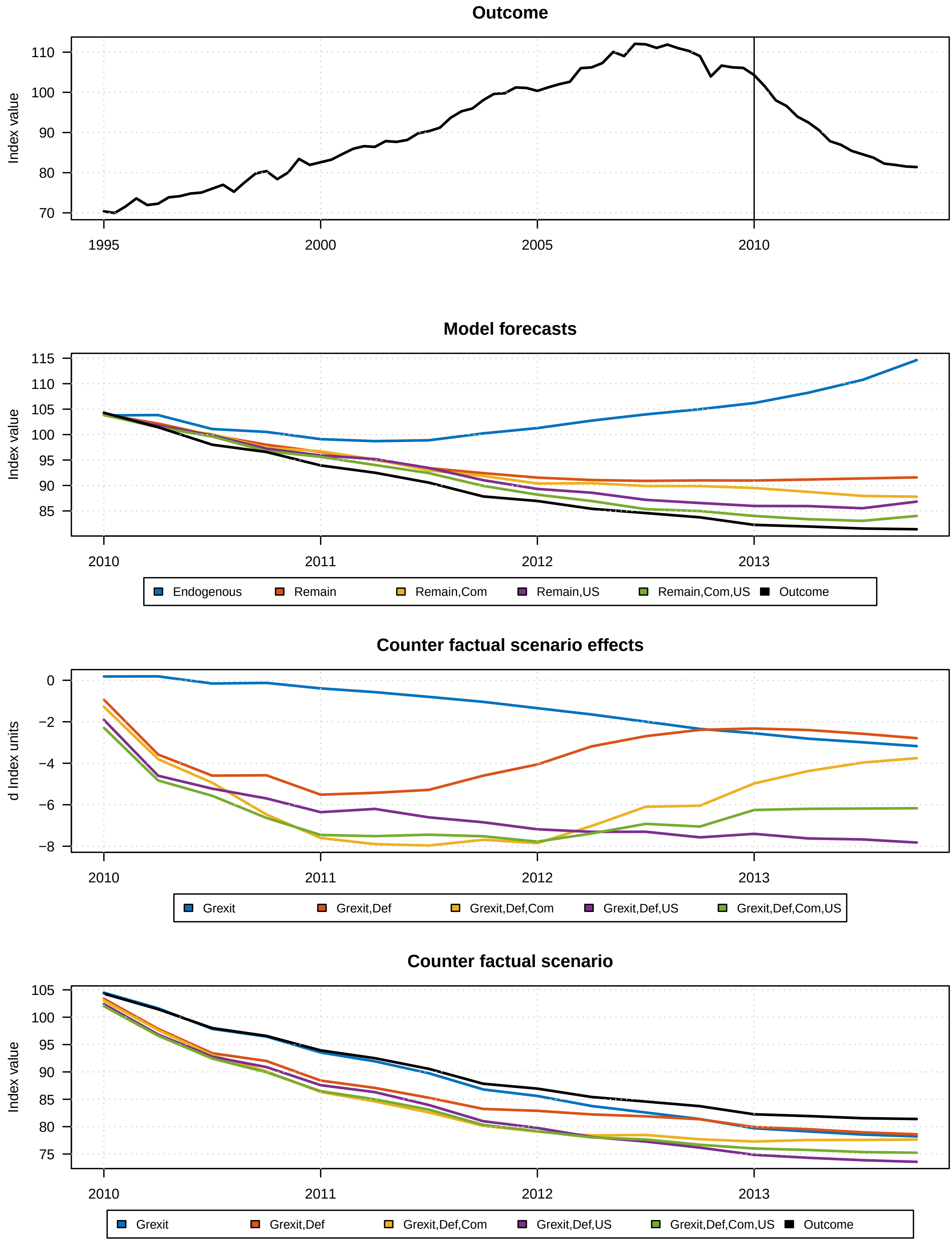


Figure A13: Greece, Real GDP

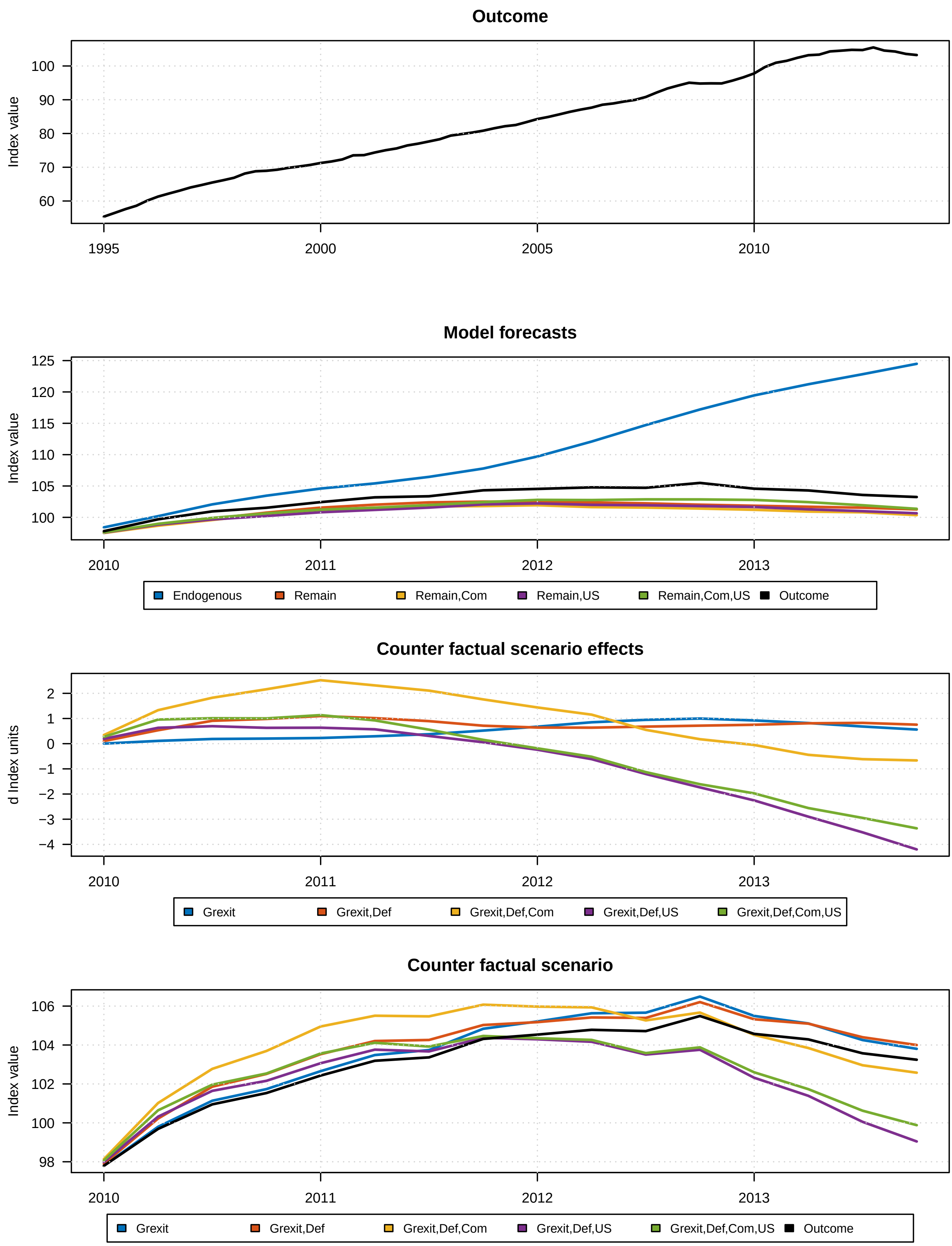


Figure A14: Greece, Consumer price index

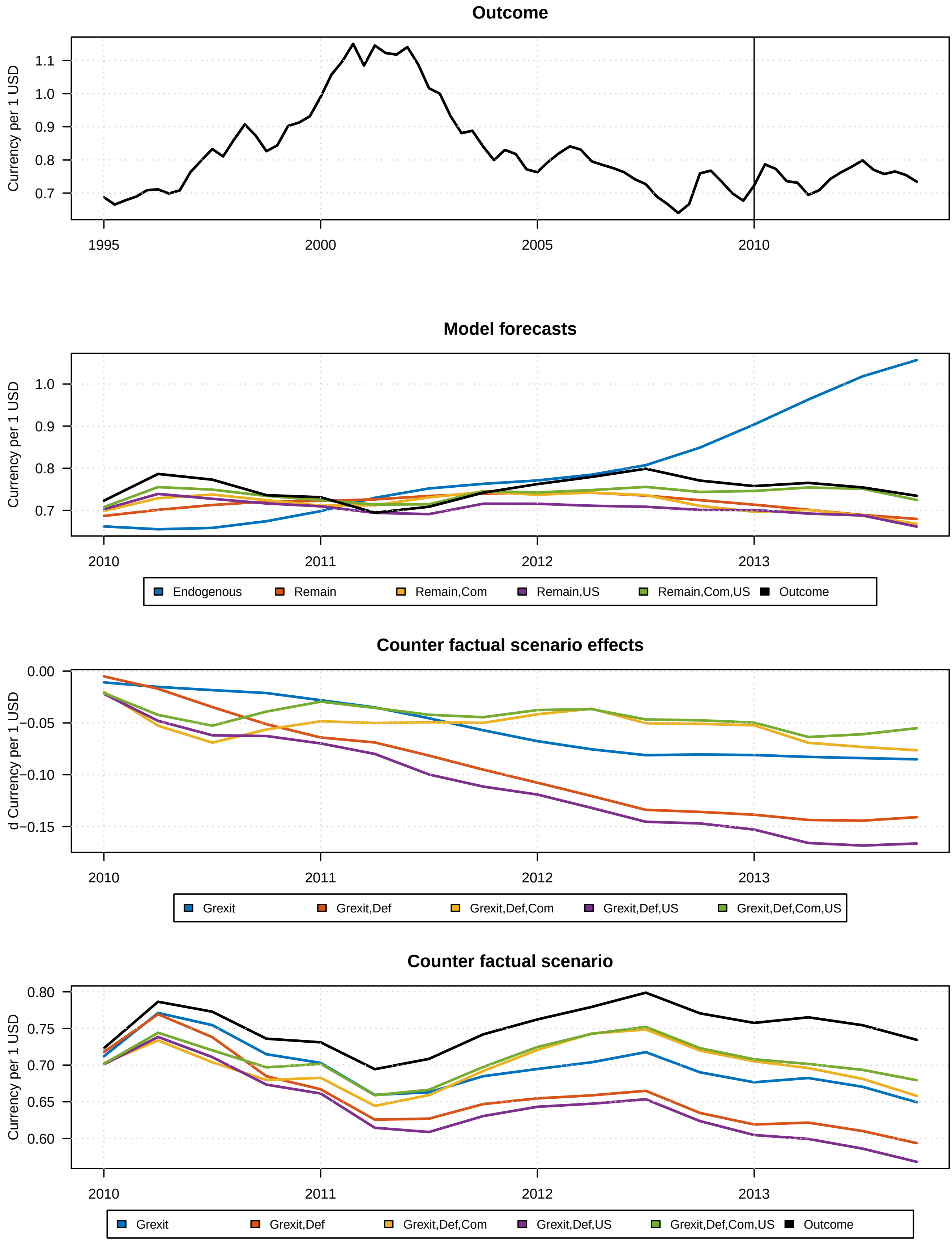


Figure A15: Greece, Nominal exchange rate

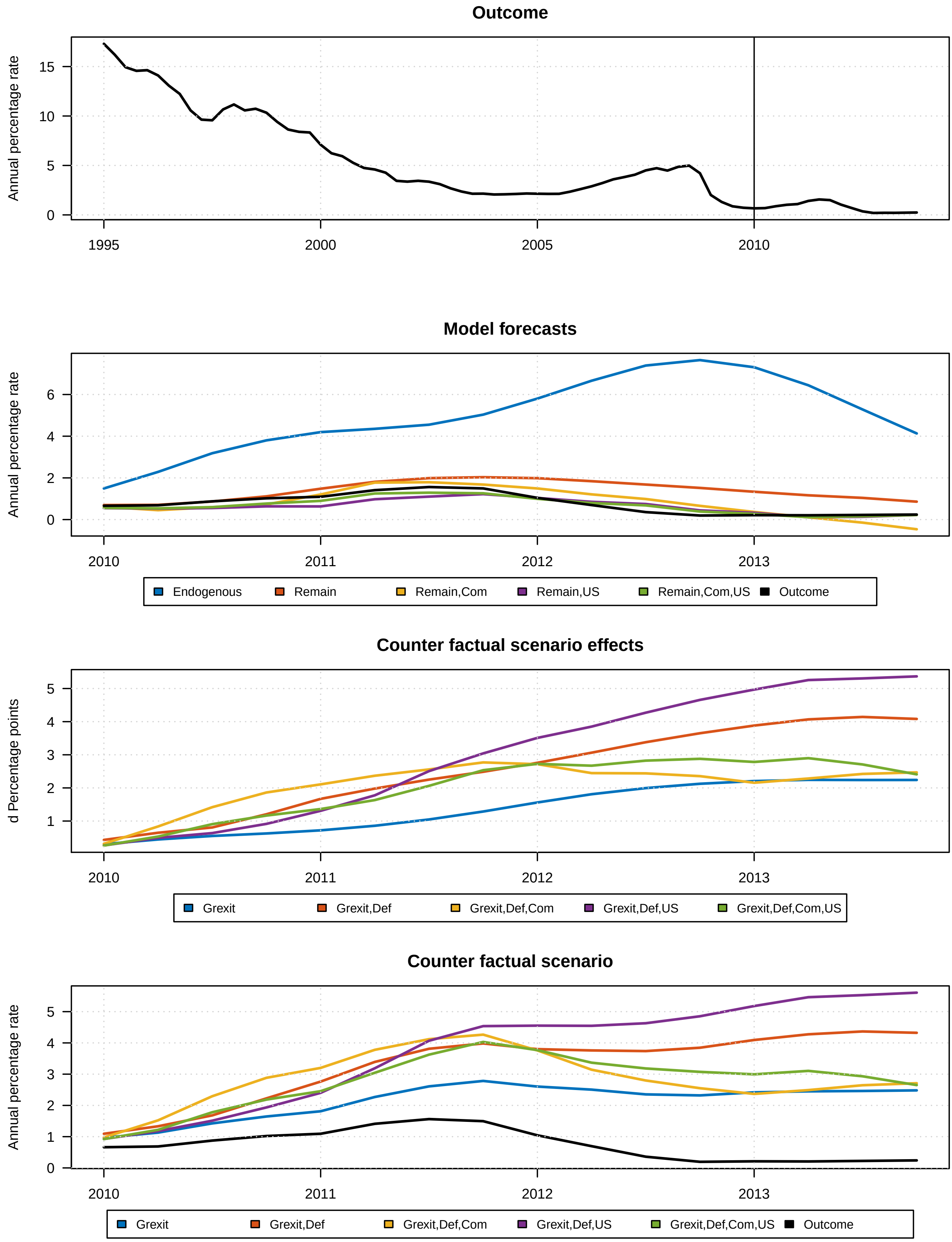


Figure A16: Greece, Short-term interest rate

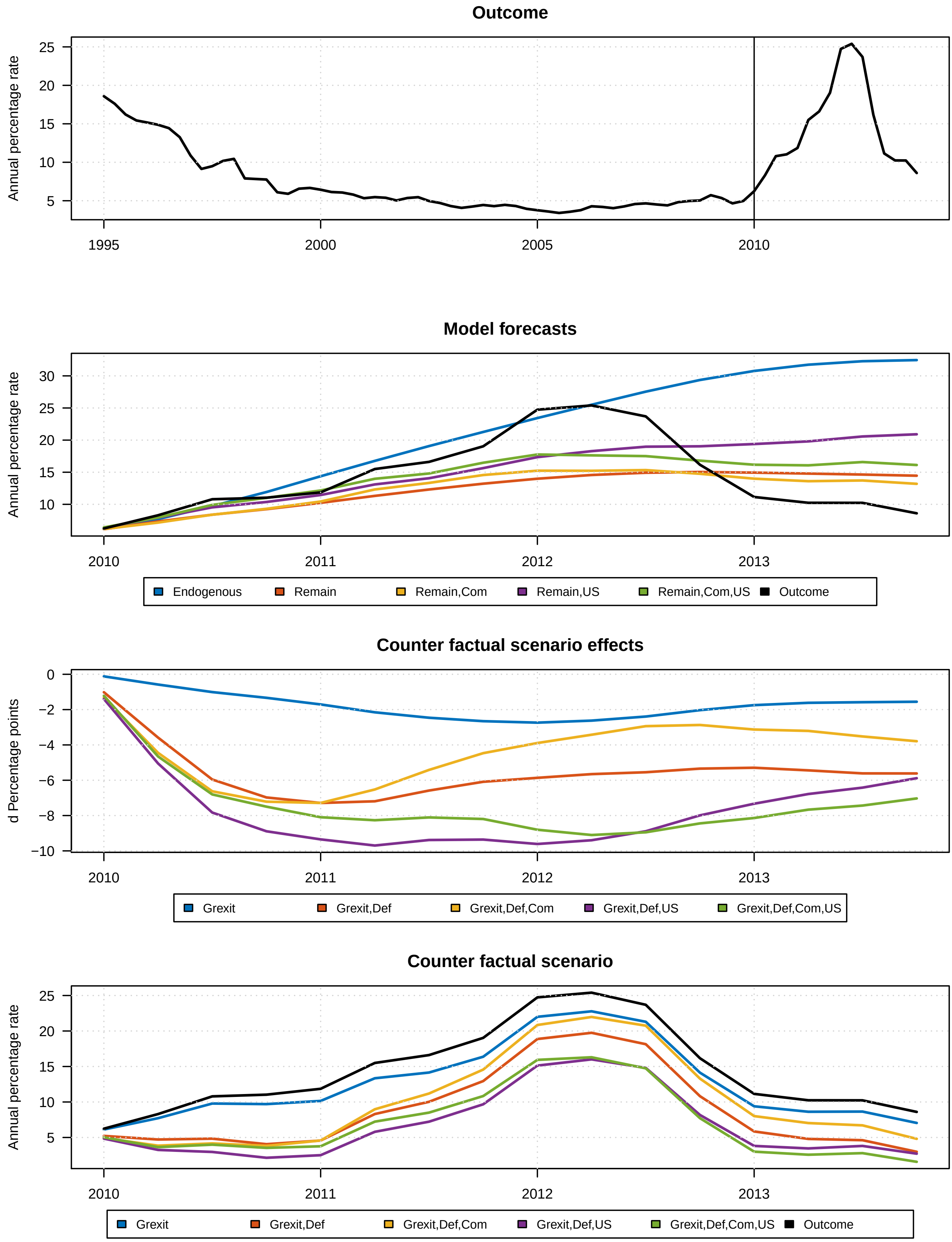


Figure A17: Greece, Long-term interest rate

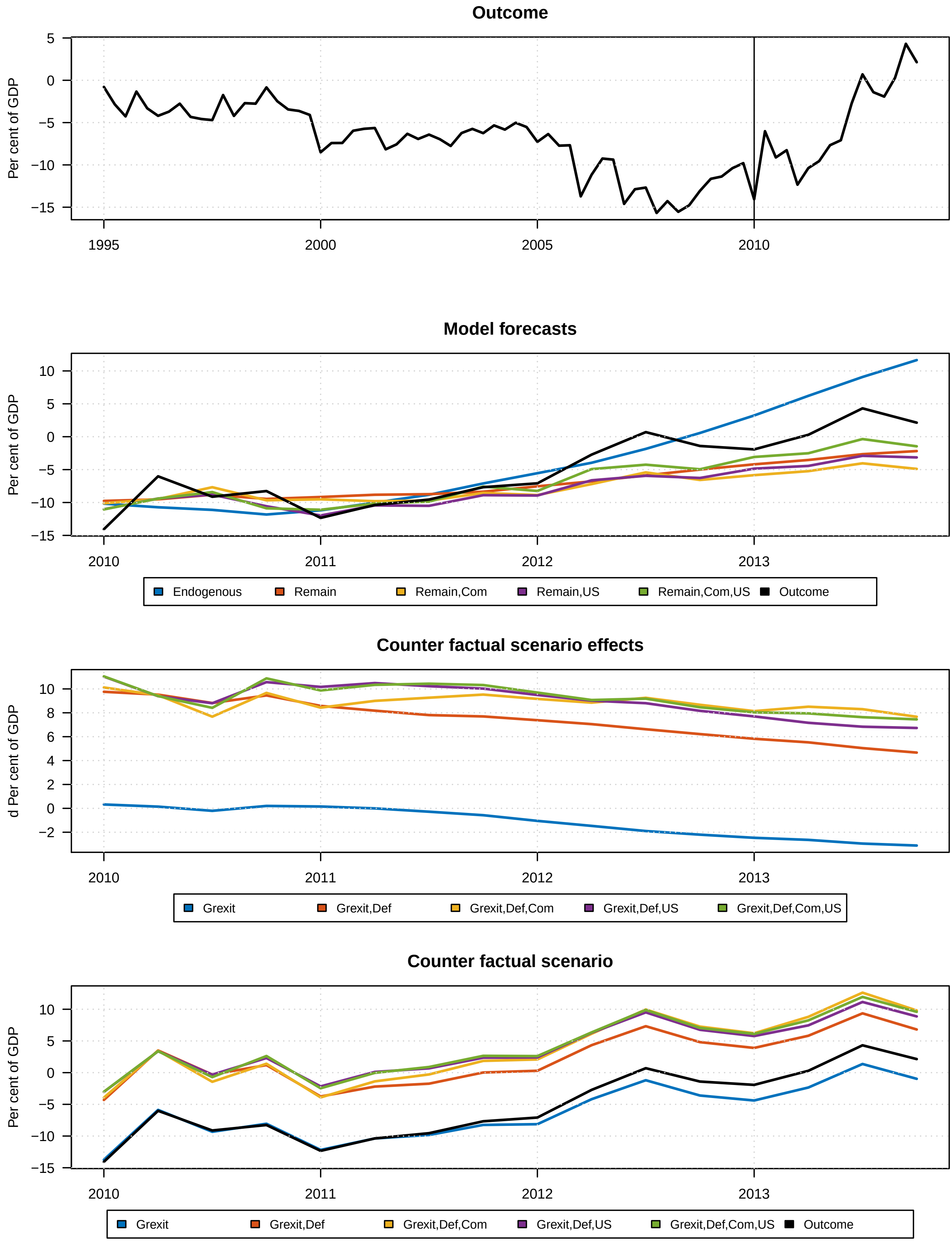


Figure A18: Greece, Current account

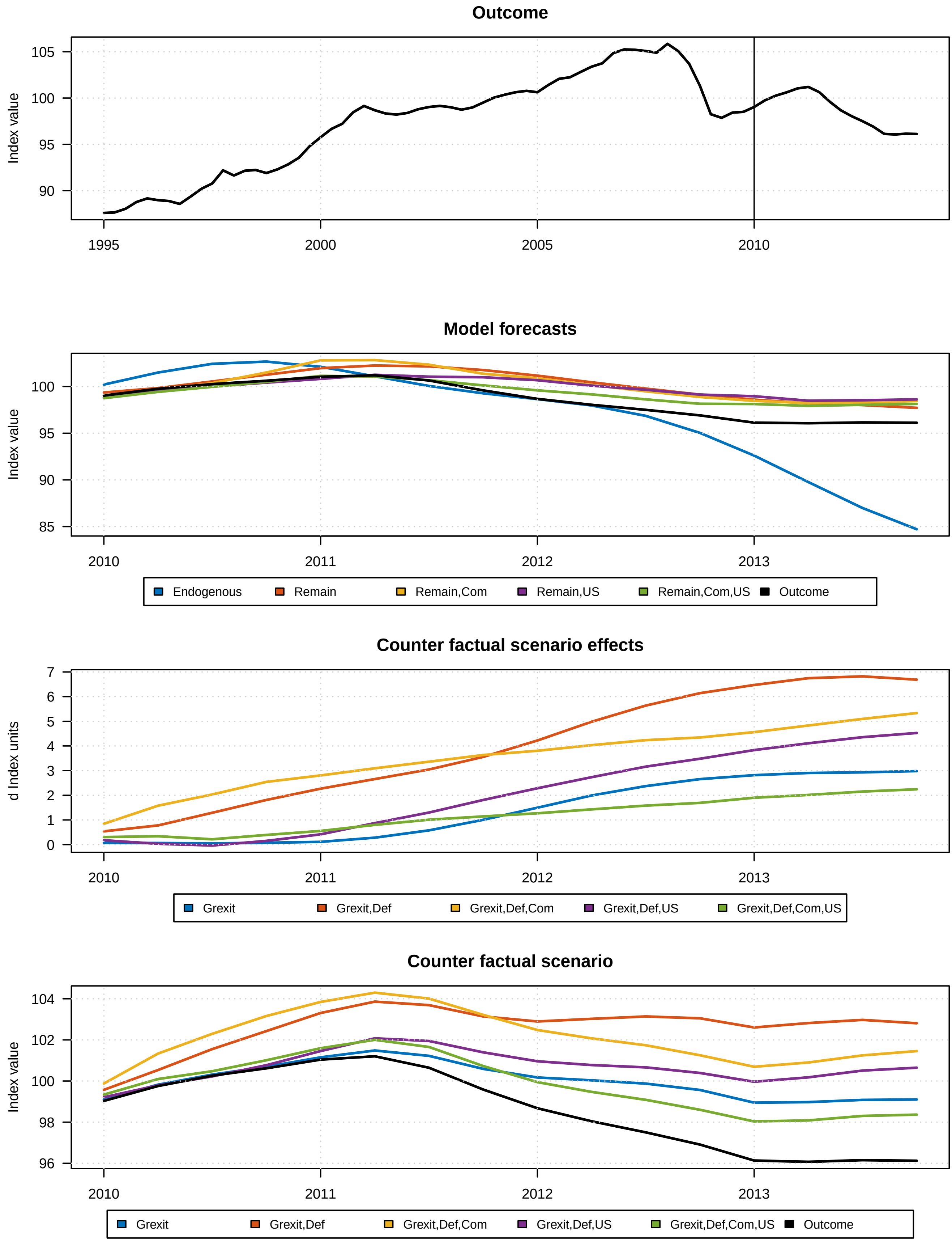


Figure A19: Italy, Real GDP

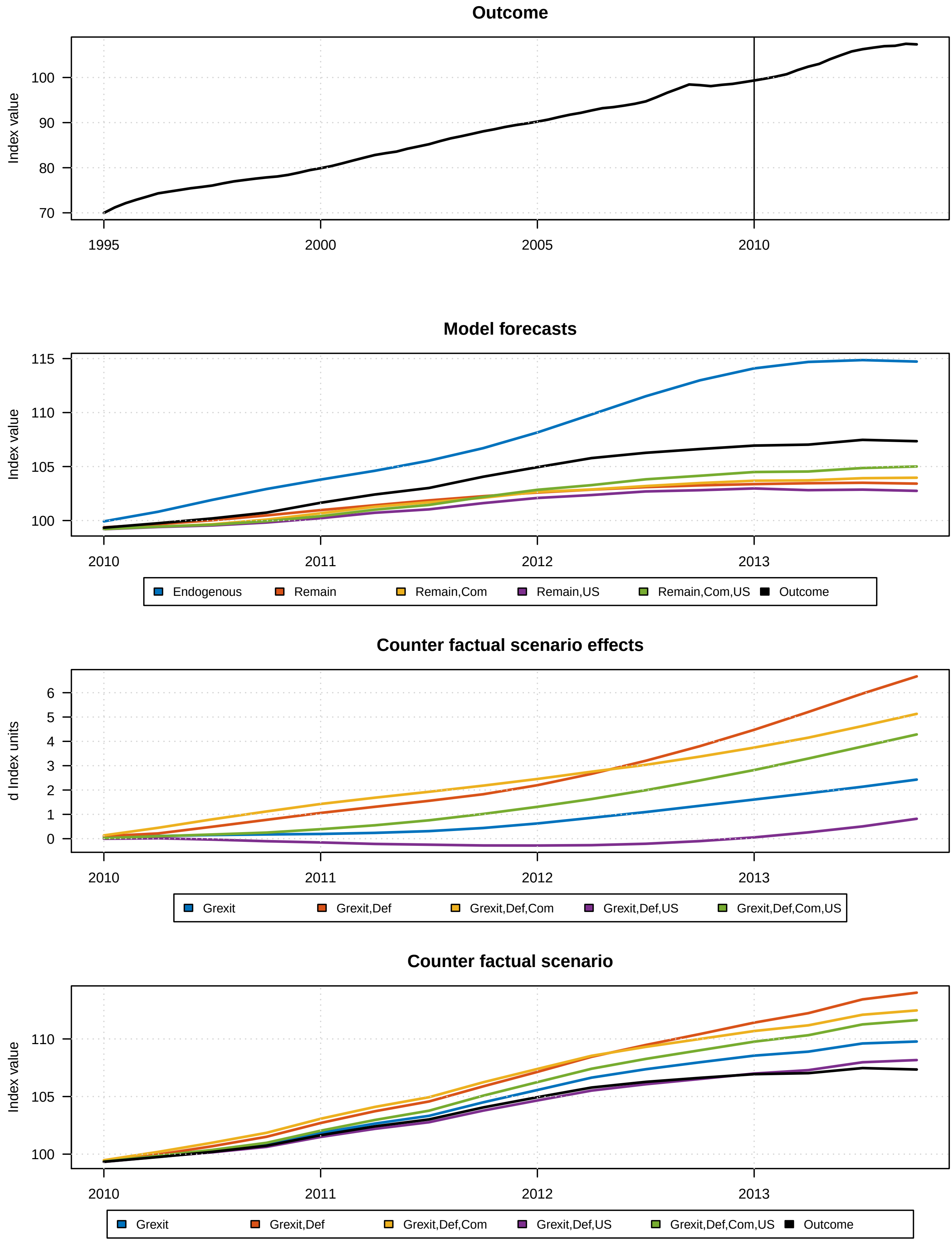


Figure A20: Italy, Consumer price index

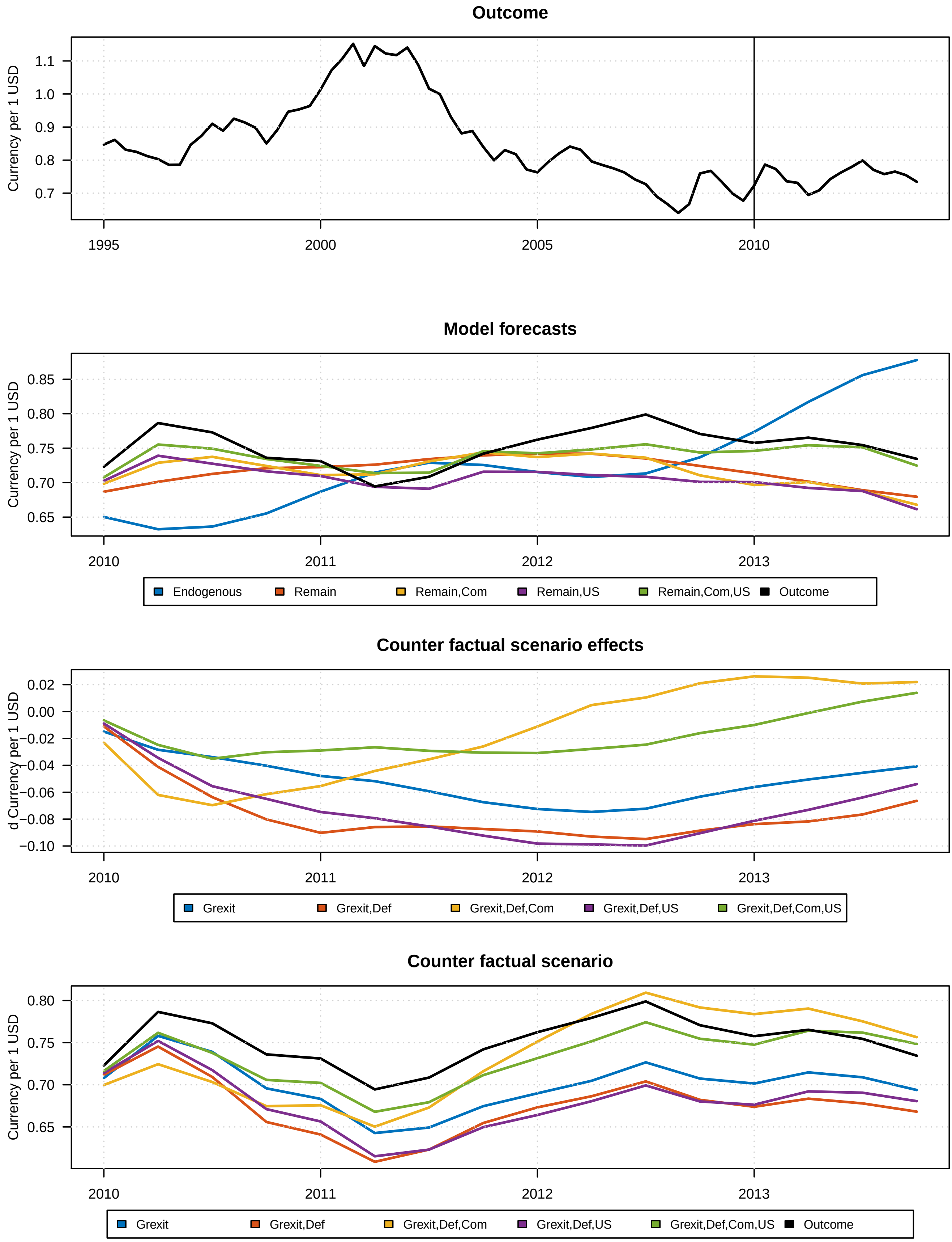


Figure A21: Italy, Nominal exchange rate

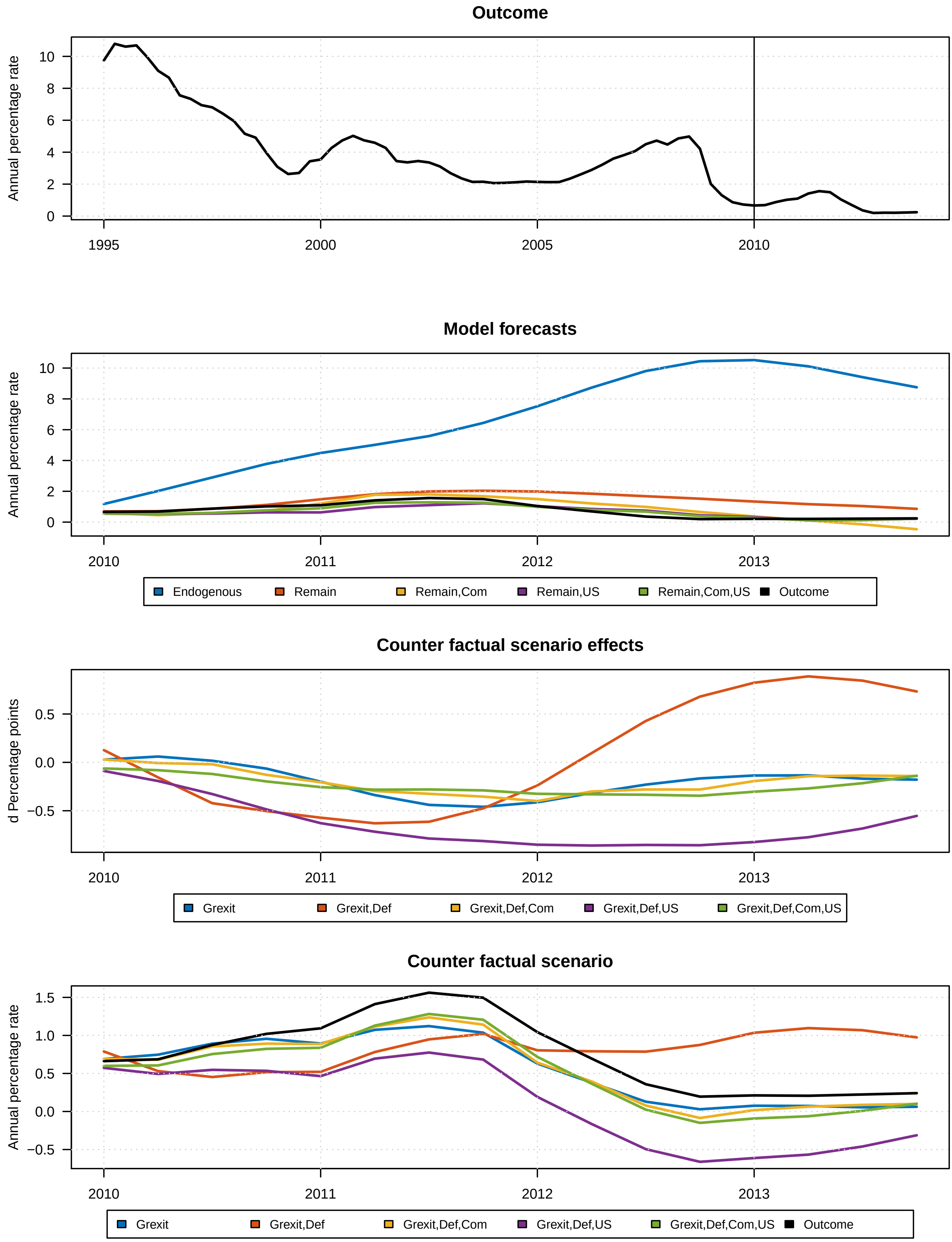


Figure A22: Italy, Short-term interest rate

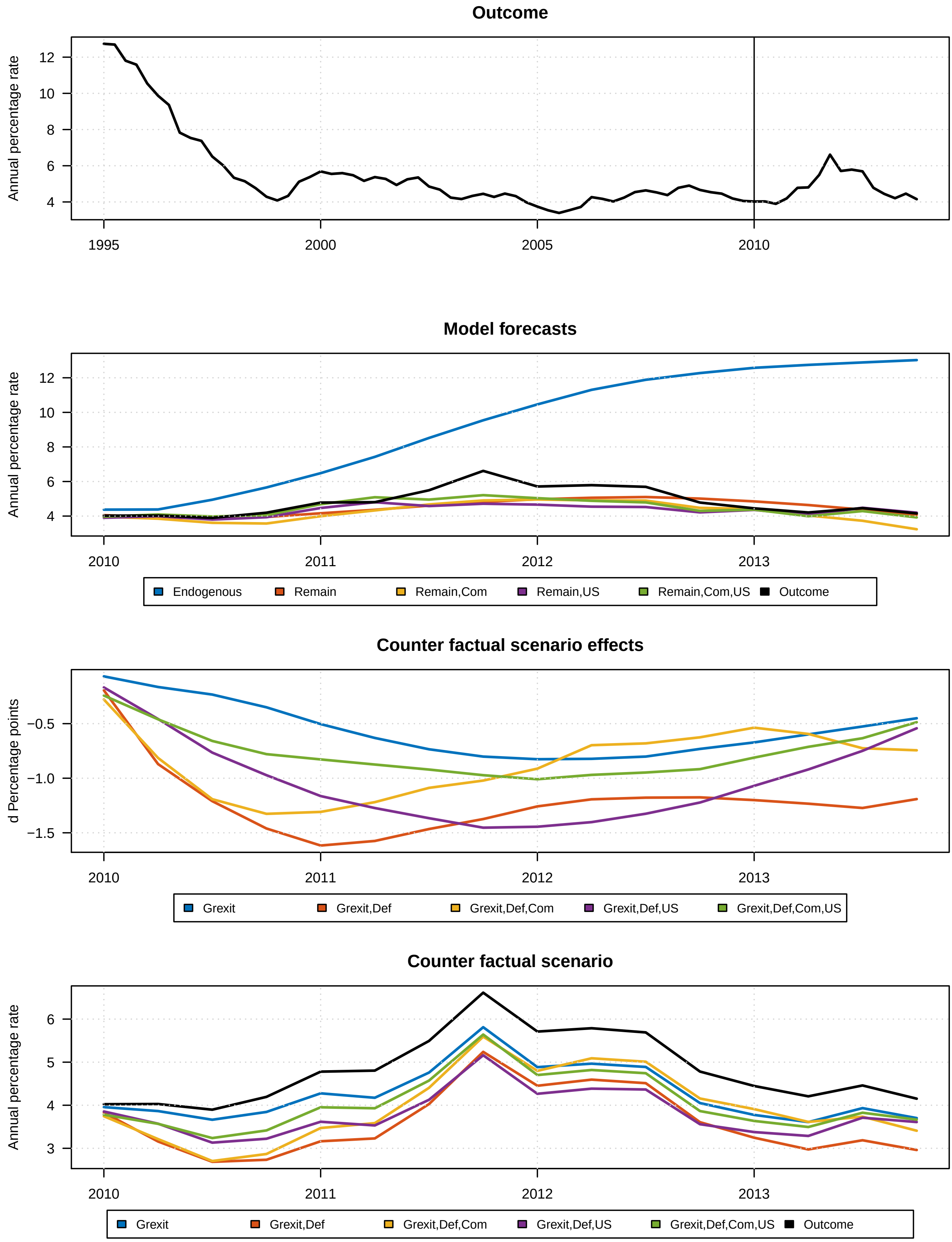


Figure A23: Italy, Long-term interest rate

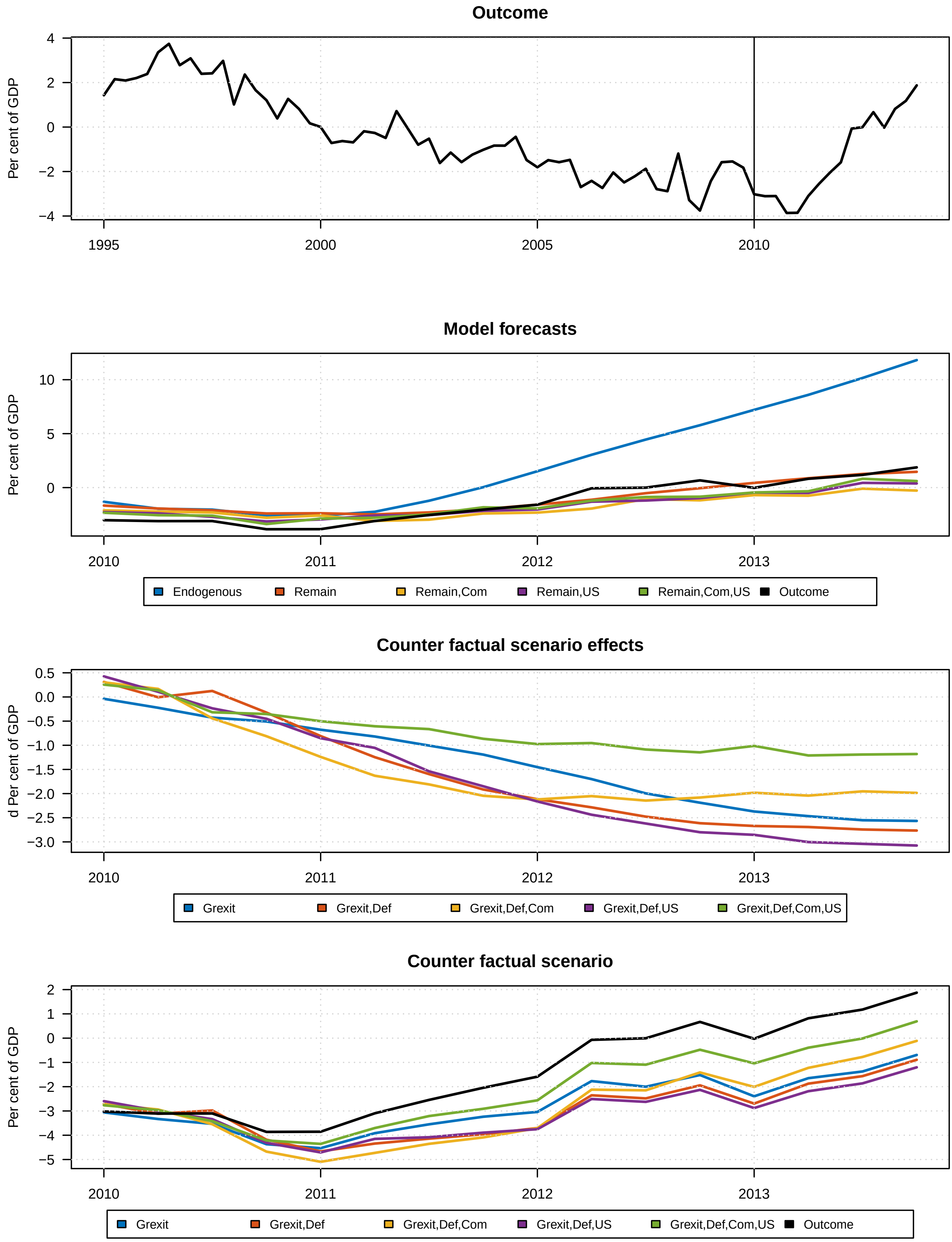
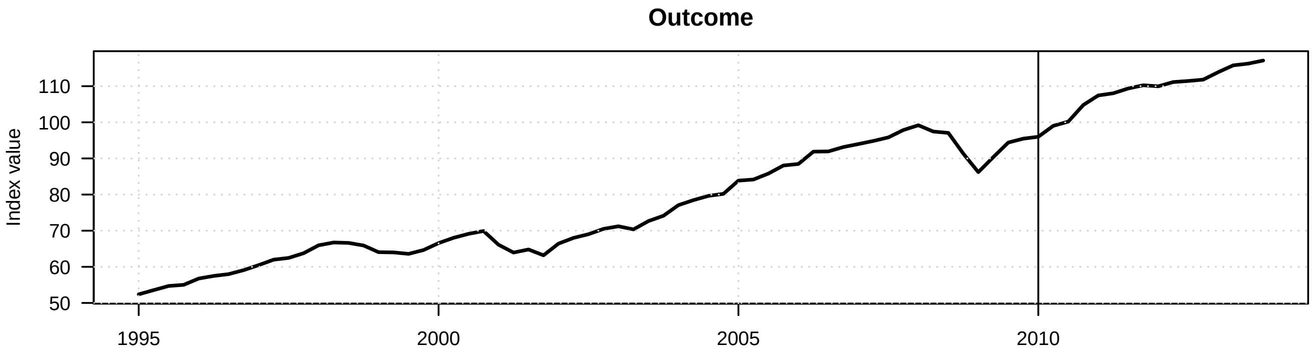
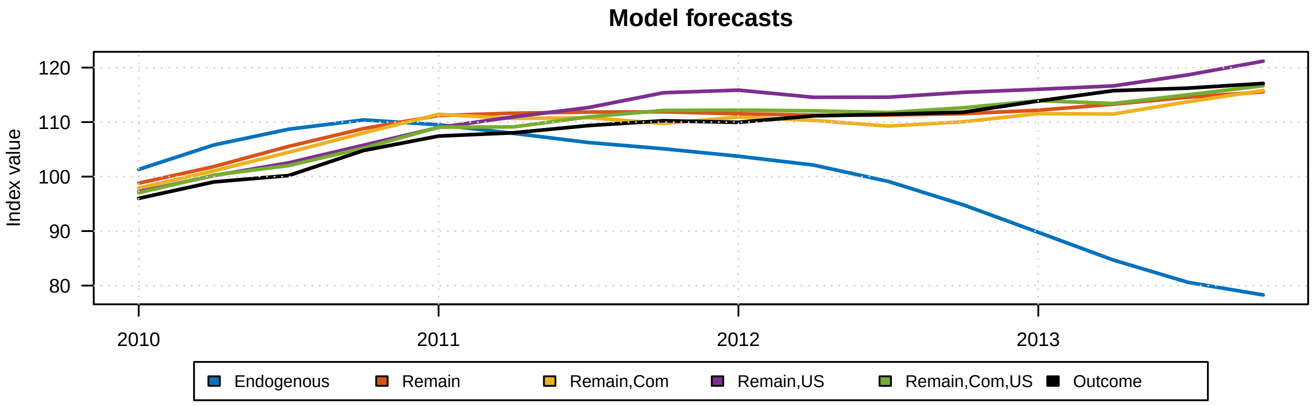
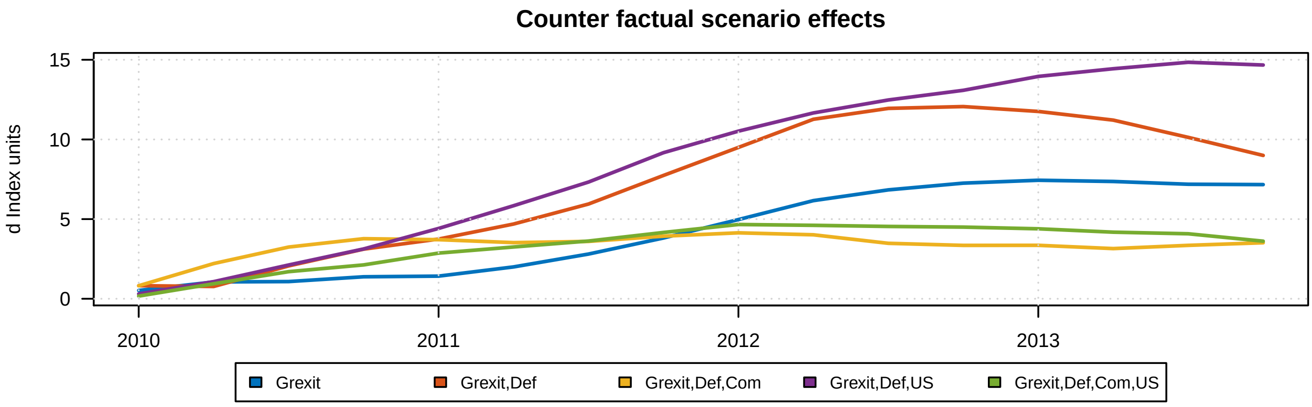


Figure A24: Italy, Current account







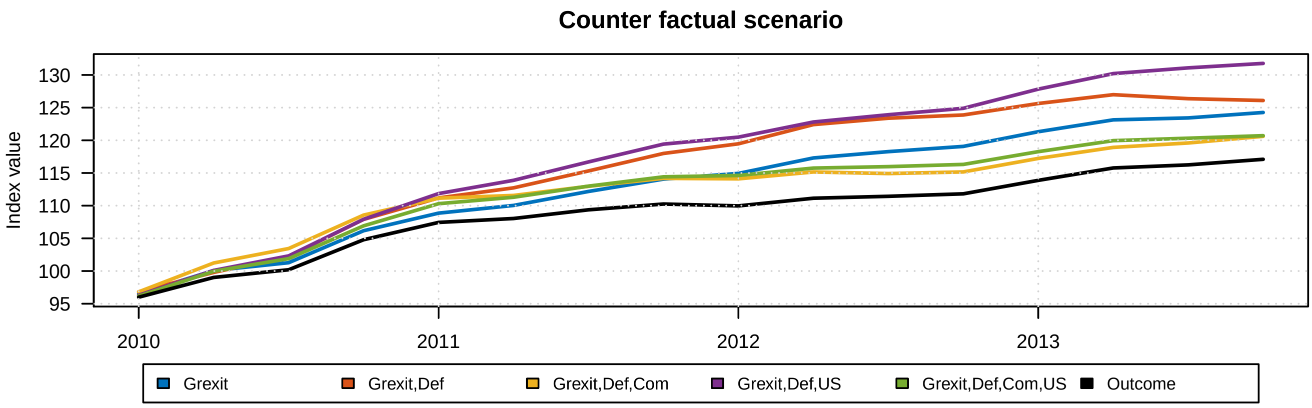
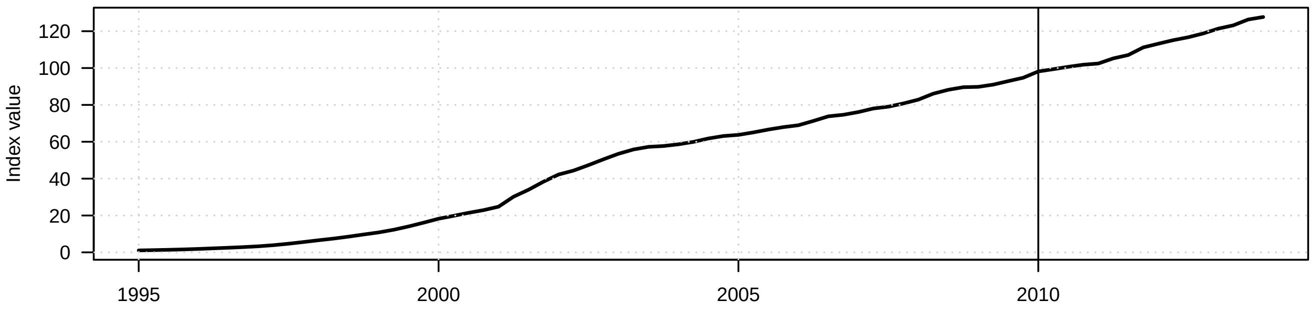
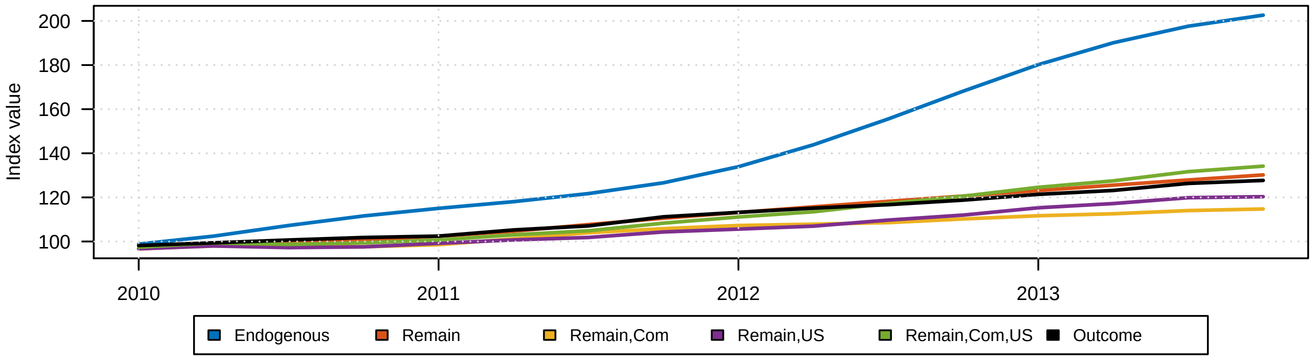


Figure A25: Turkey, Real GDP

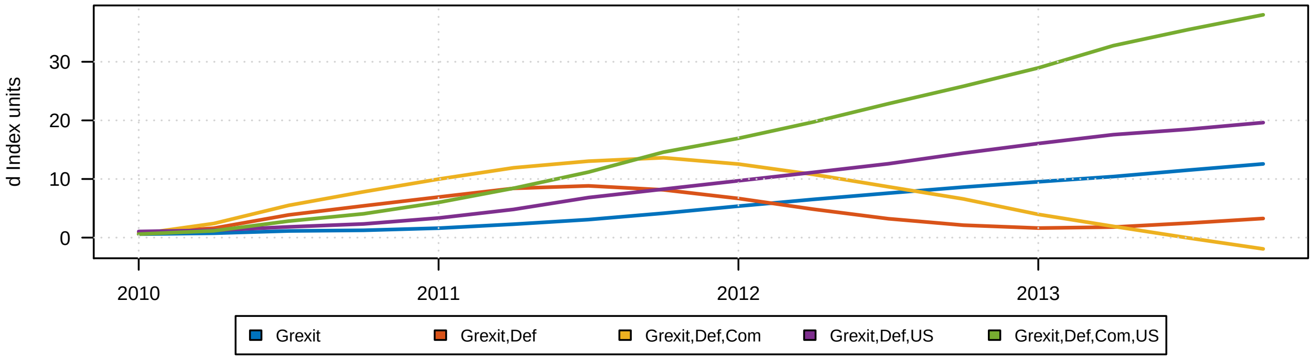
Outcome



Model forecasts



Counter factual scenario effects



Counter factual scenario

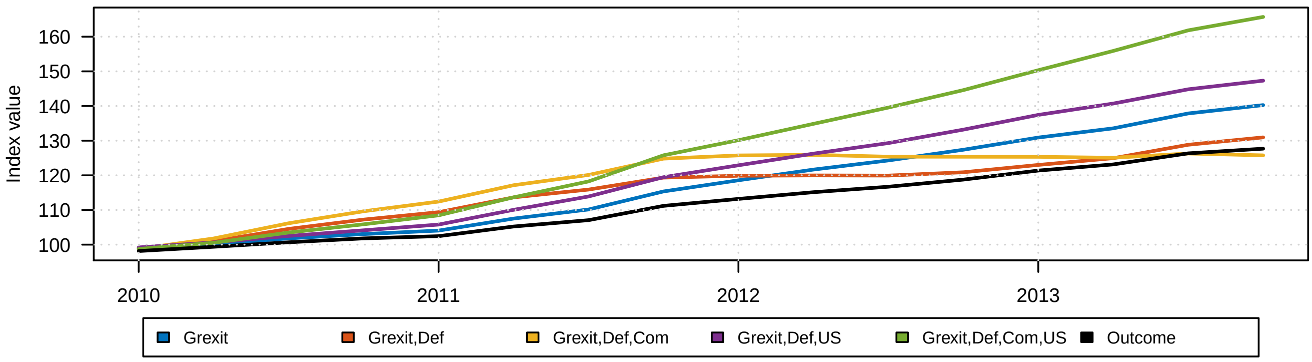


Figure A26: Turkey, Consumer price index

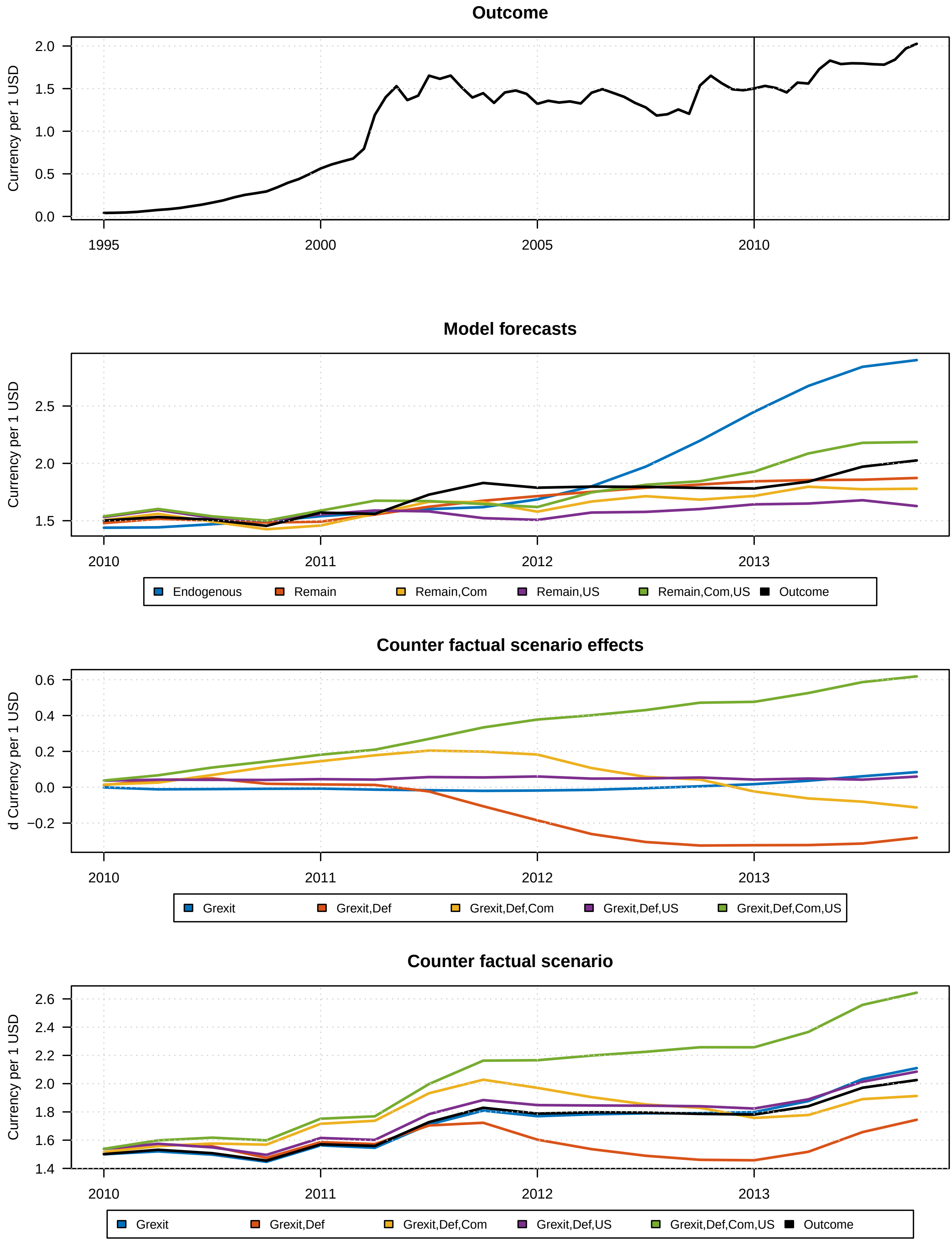


Figure A27: Turkey, Nominal exchange rate

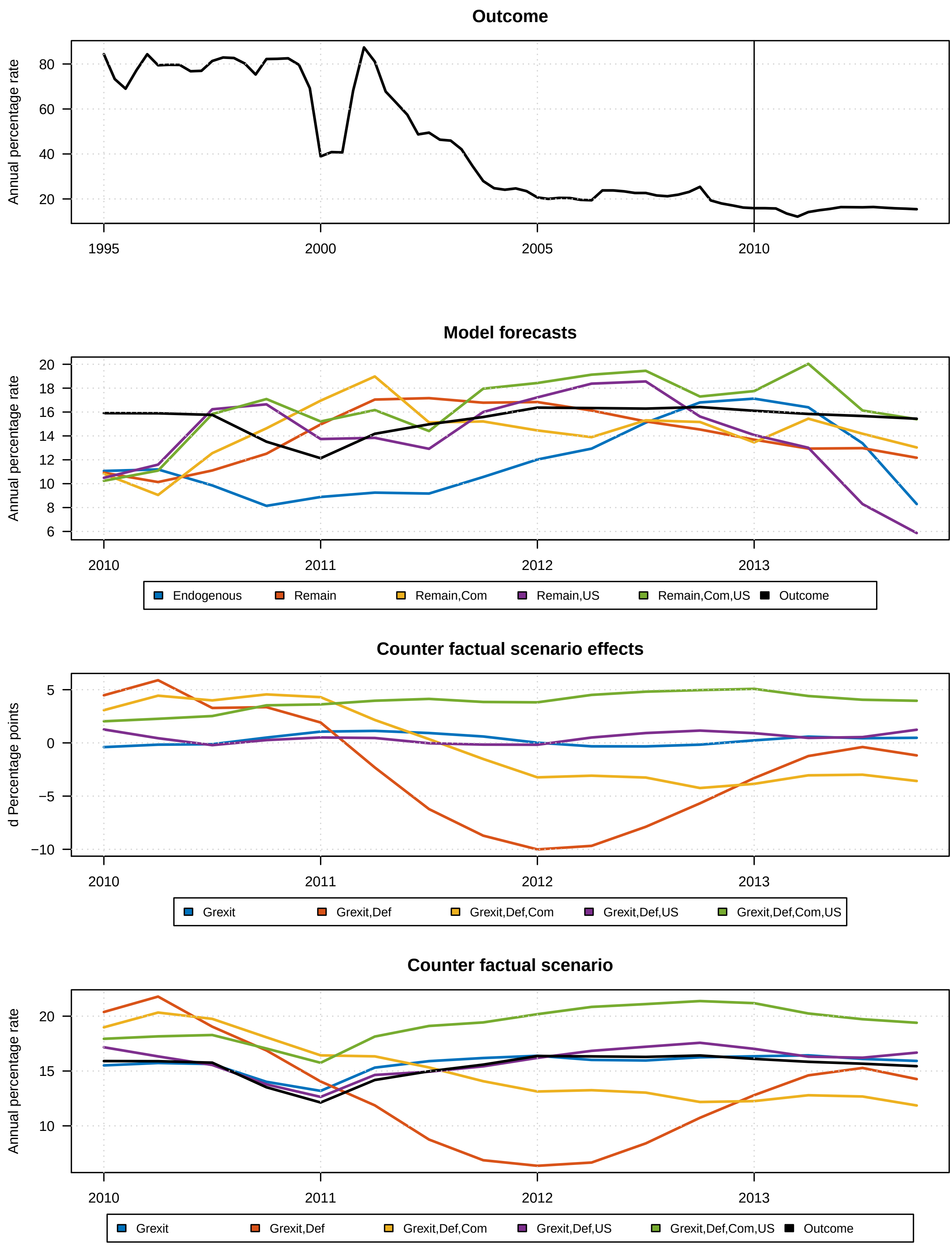


Figure A28: Turkey, Short-term interest rate

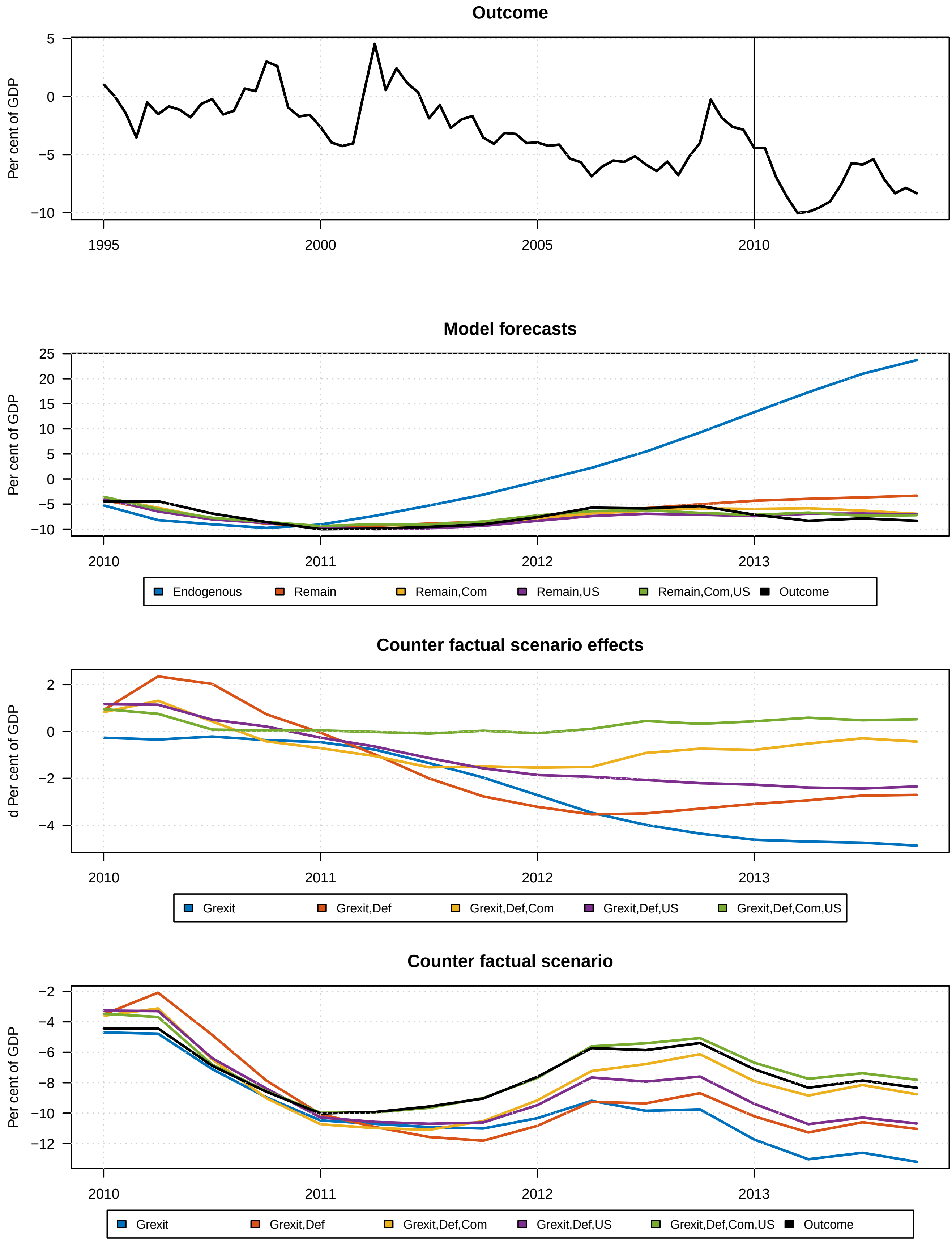


Figure A29: Turkey, Current account

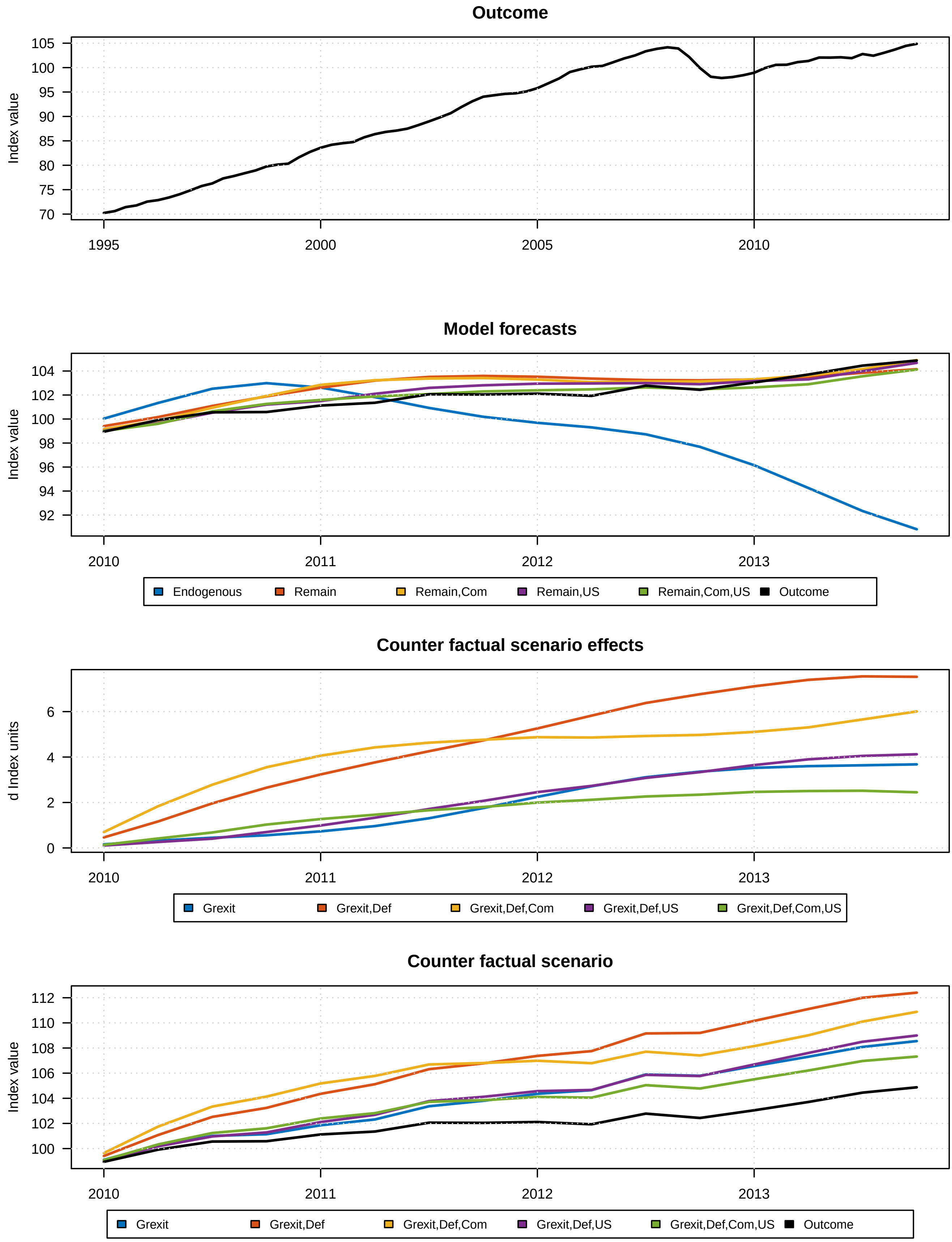


Figure A30: United Kingdom, Real GDP

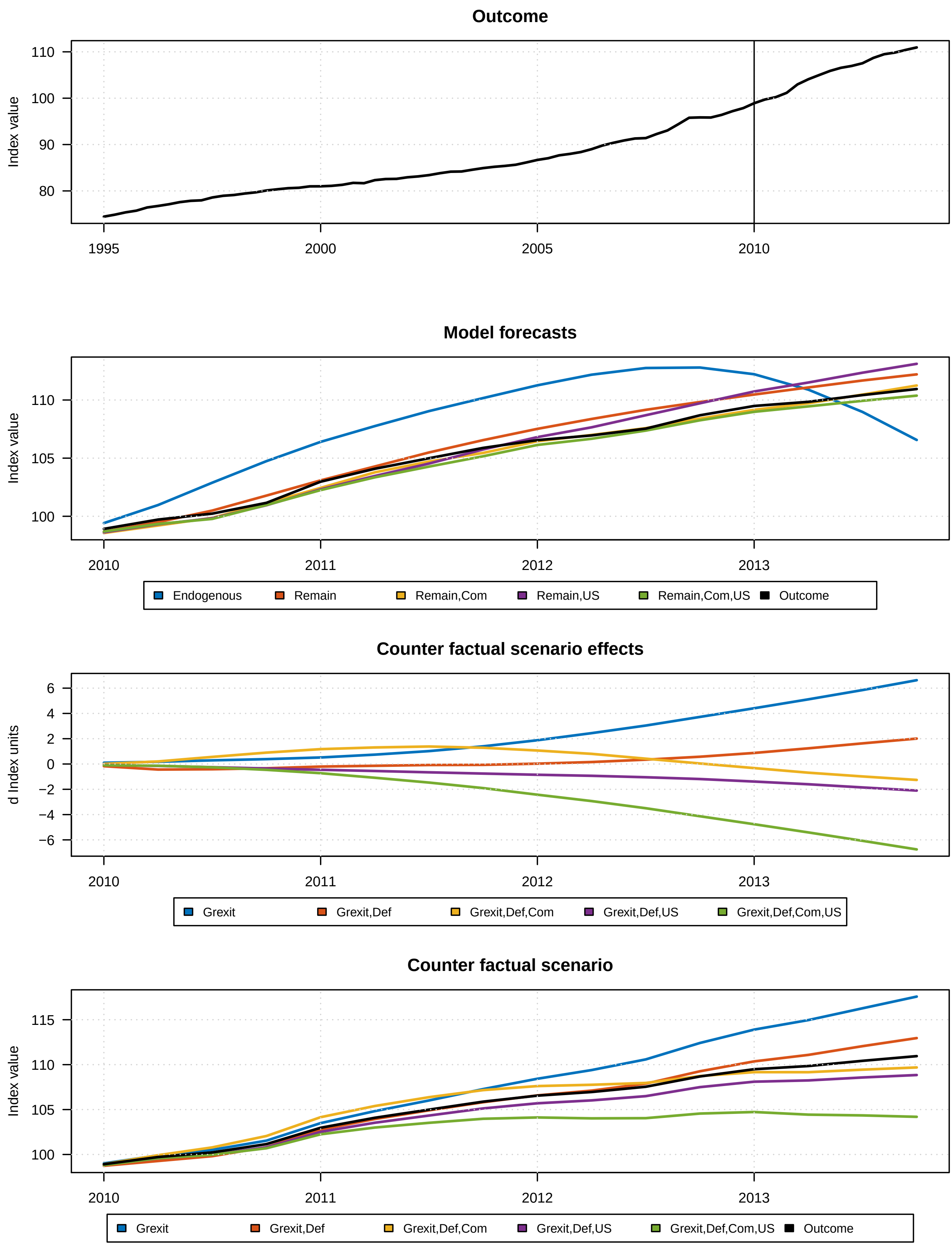


Figure A31: United Kingdom, Consumer price index

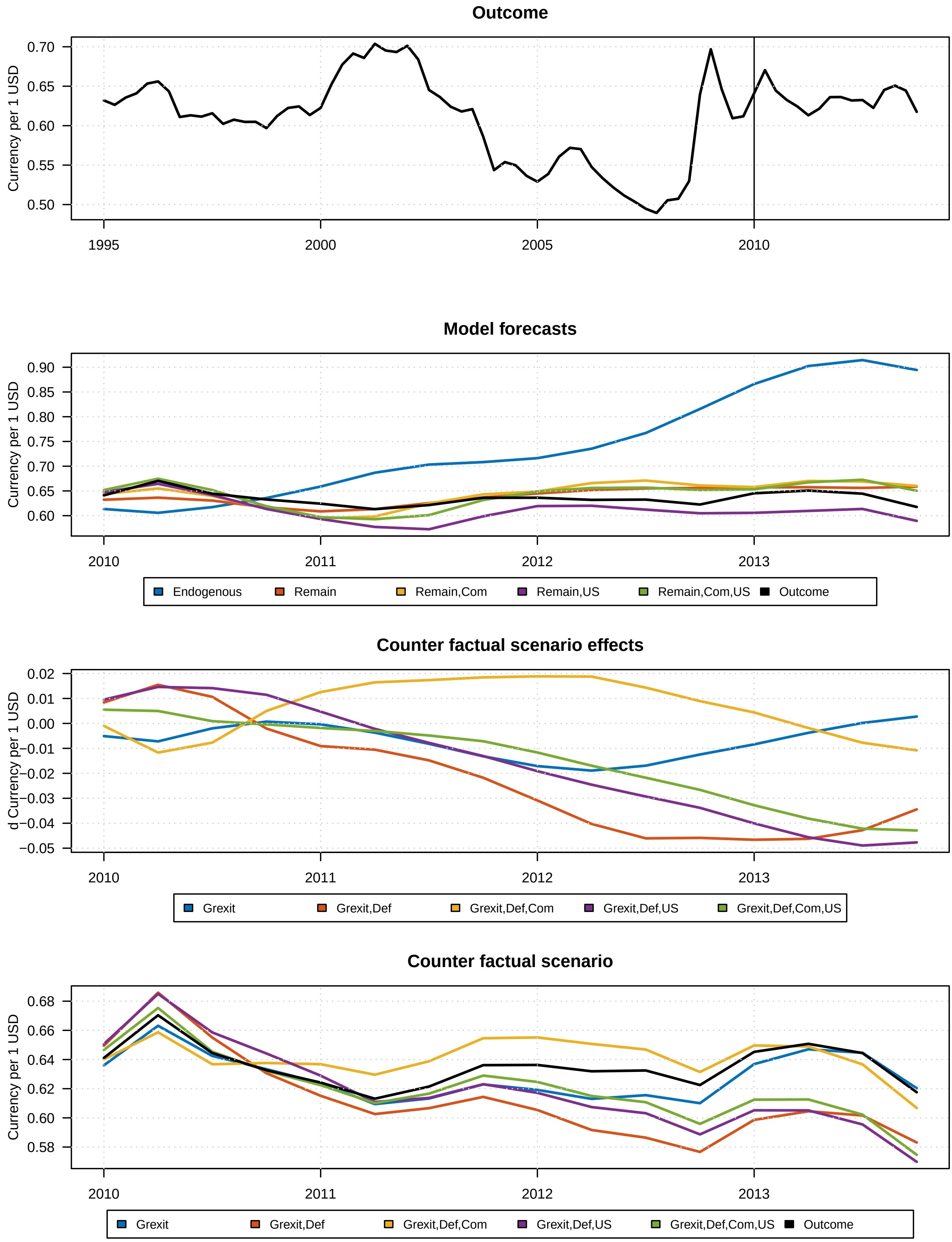


Figure A32: United Kingdom, Nominal exchange rate

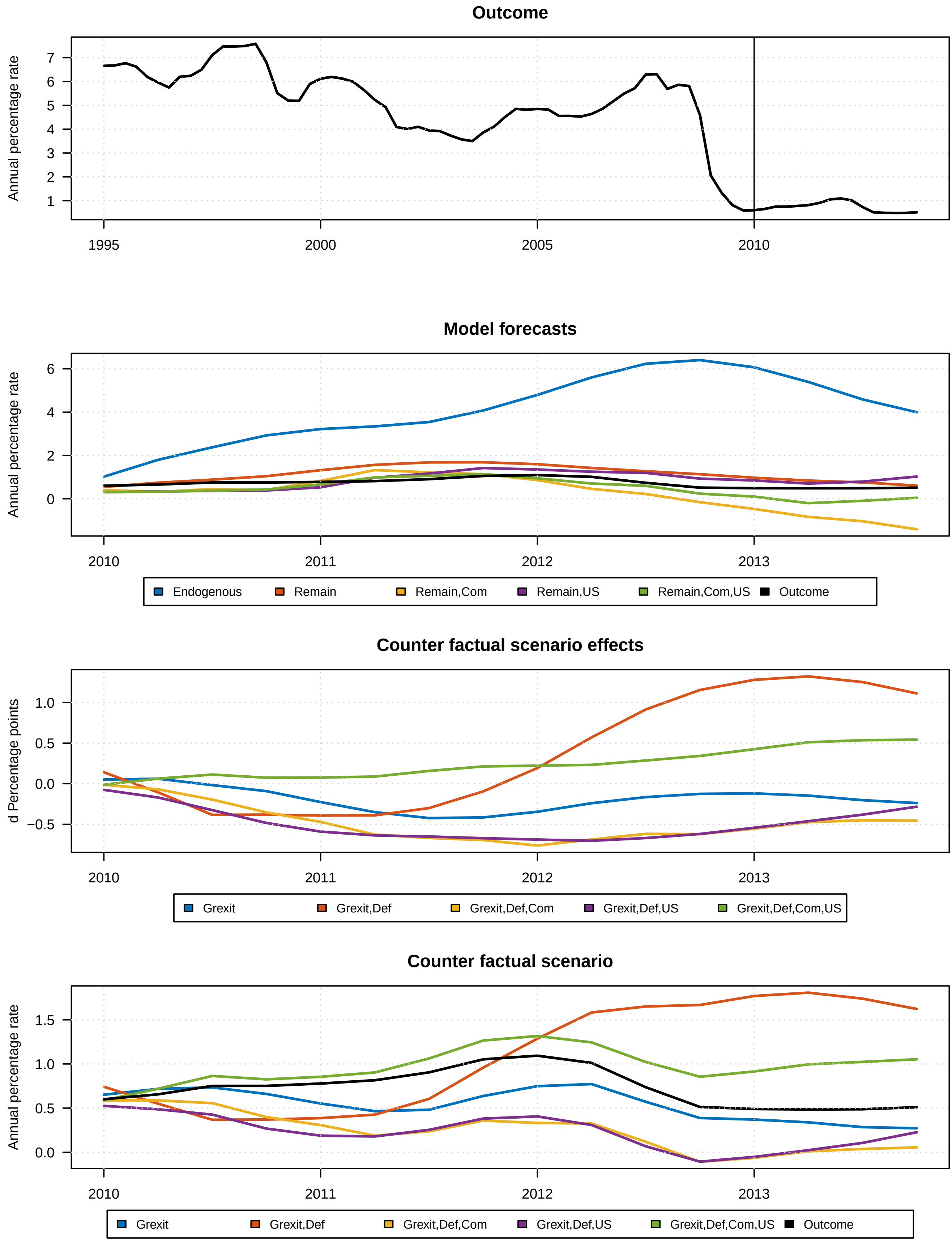


Figure A33: United Kingdom, Short-term interest rate

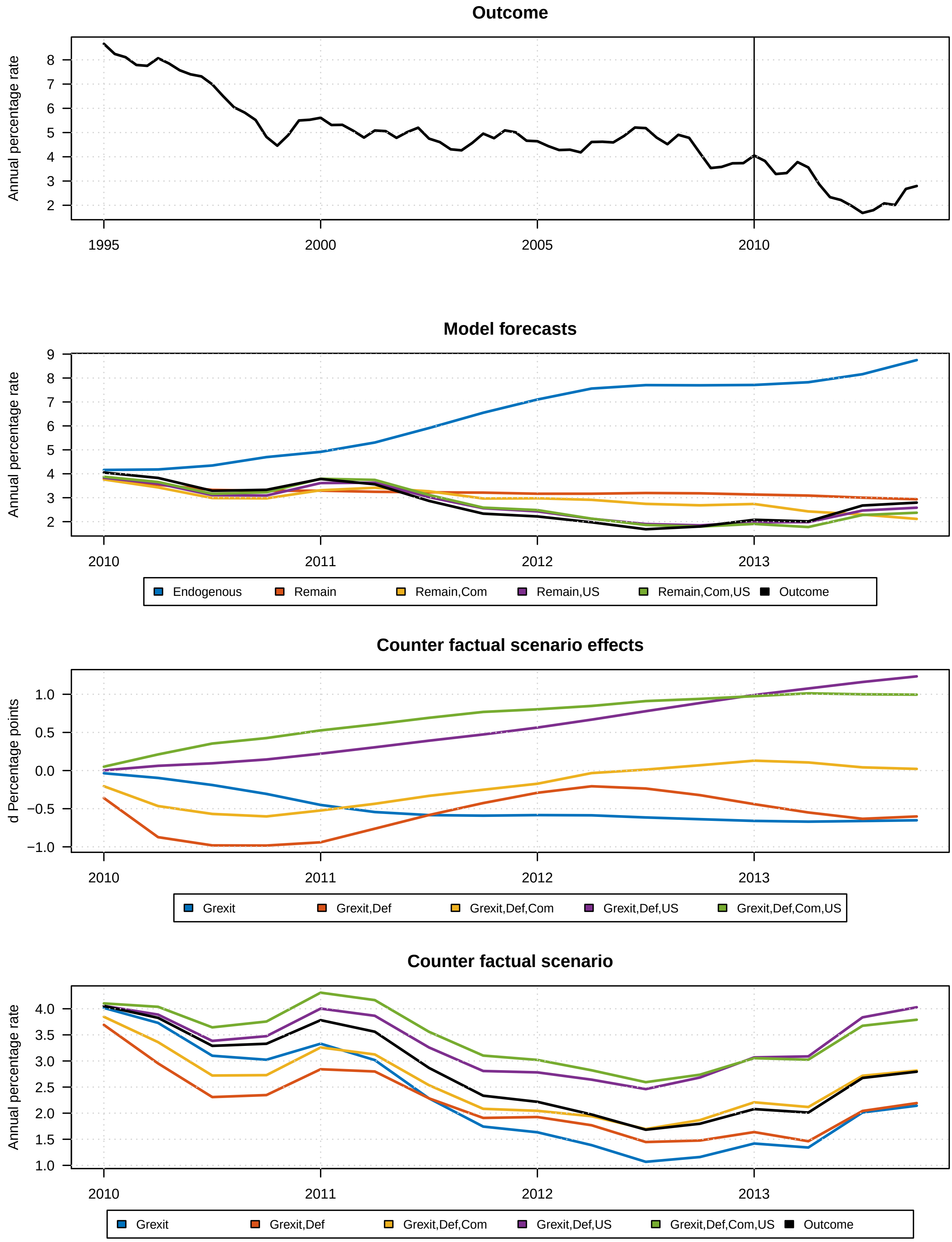


Figure A34: United Kingdom, Long-term interest rate

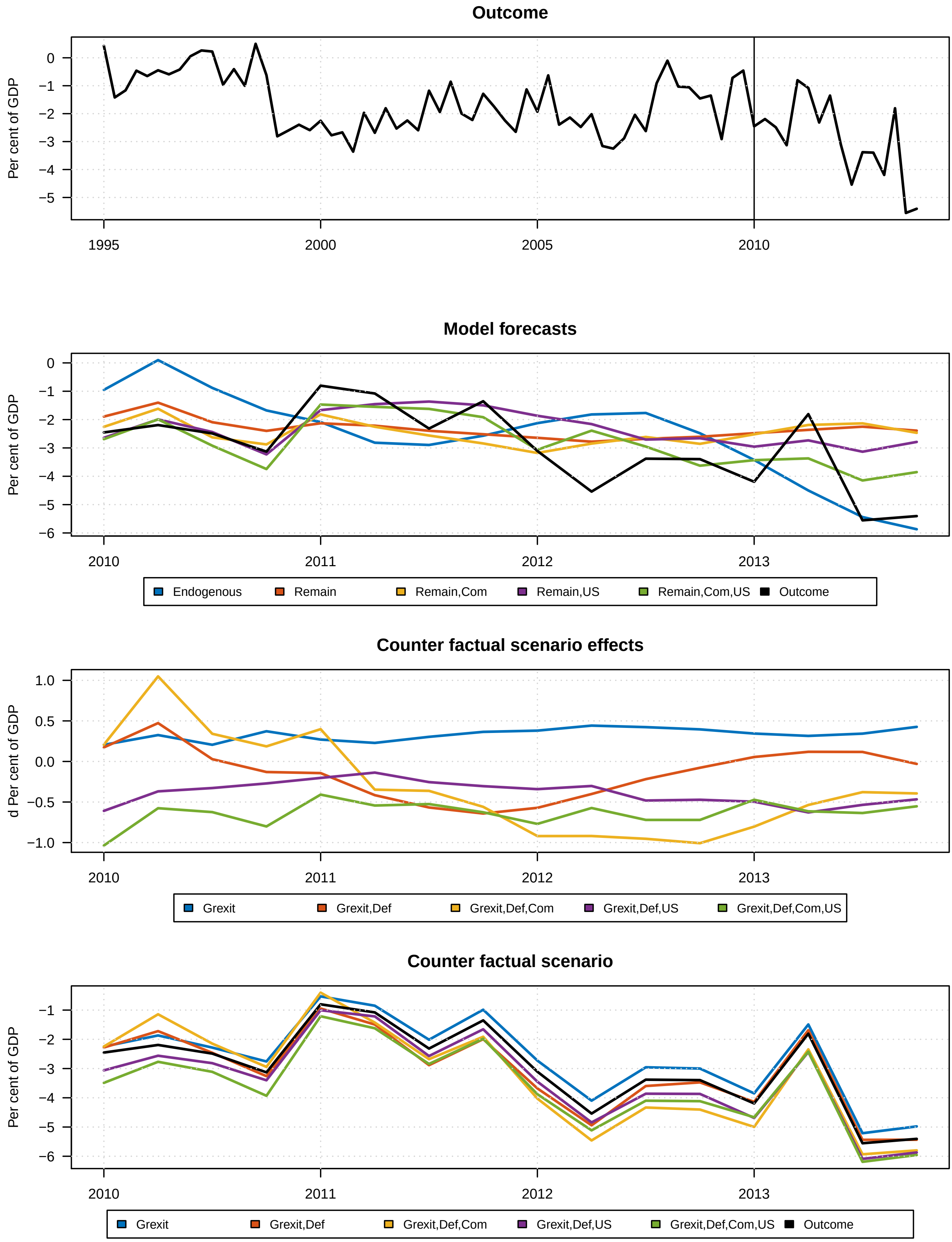


Figure A35: United Kingdom, Current account

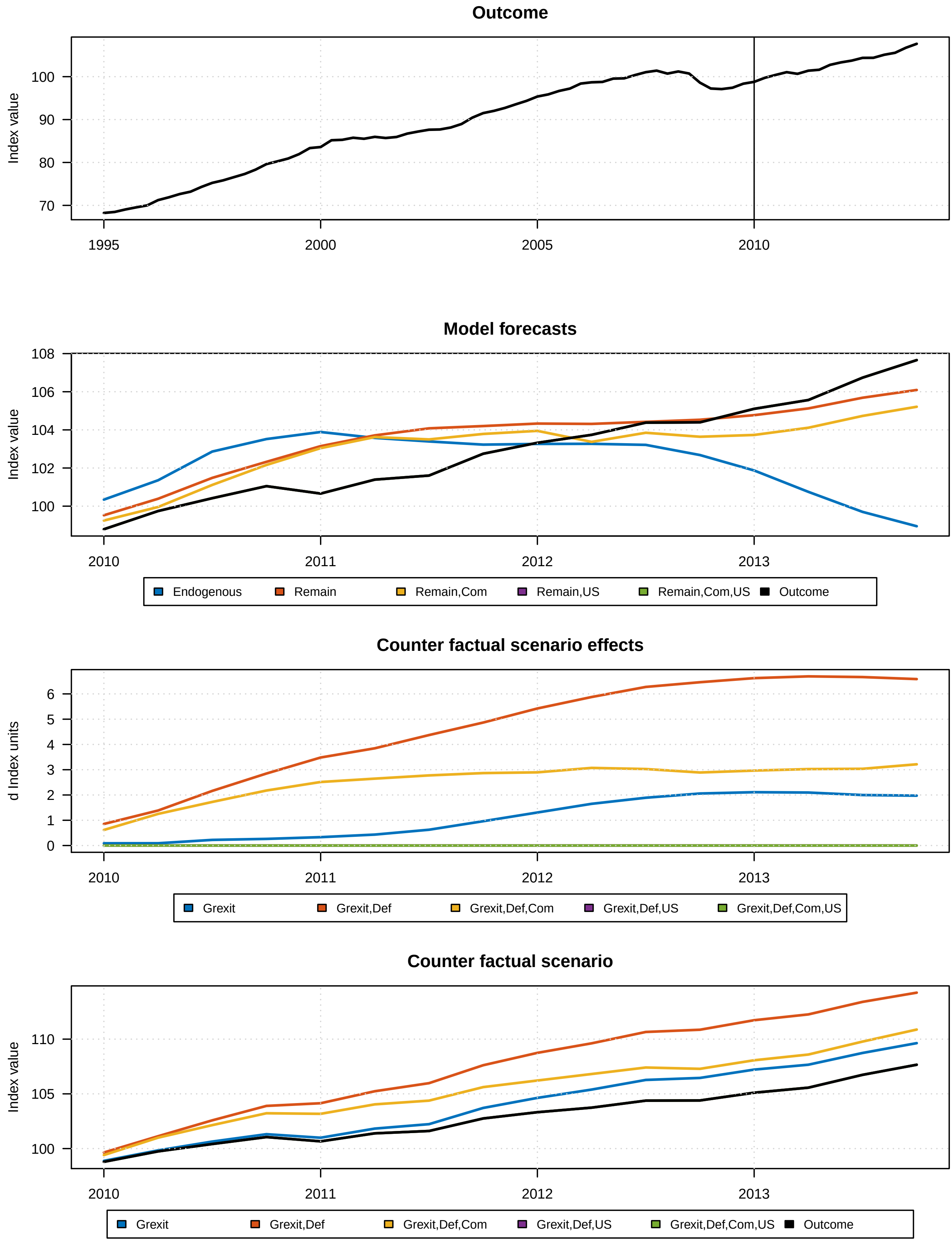


Figure A36: United States, Real GDP

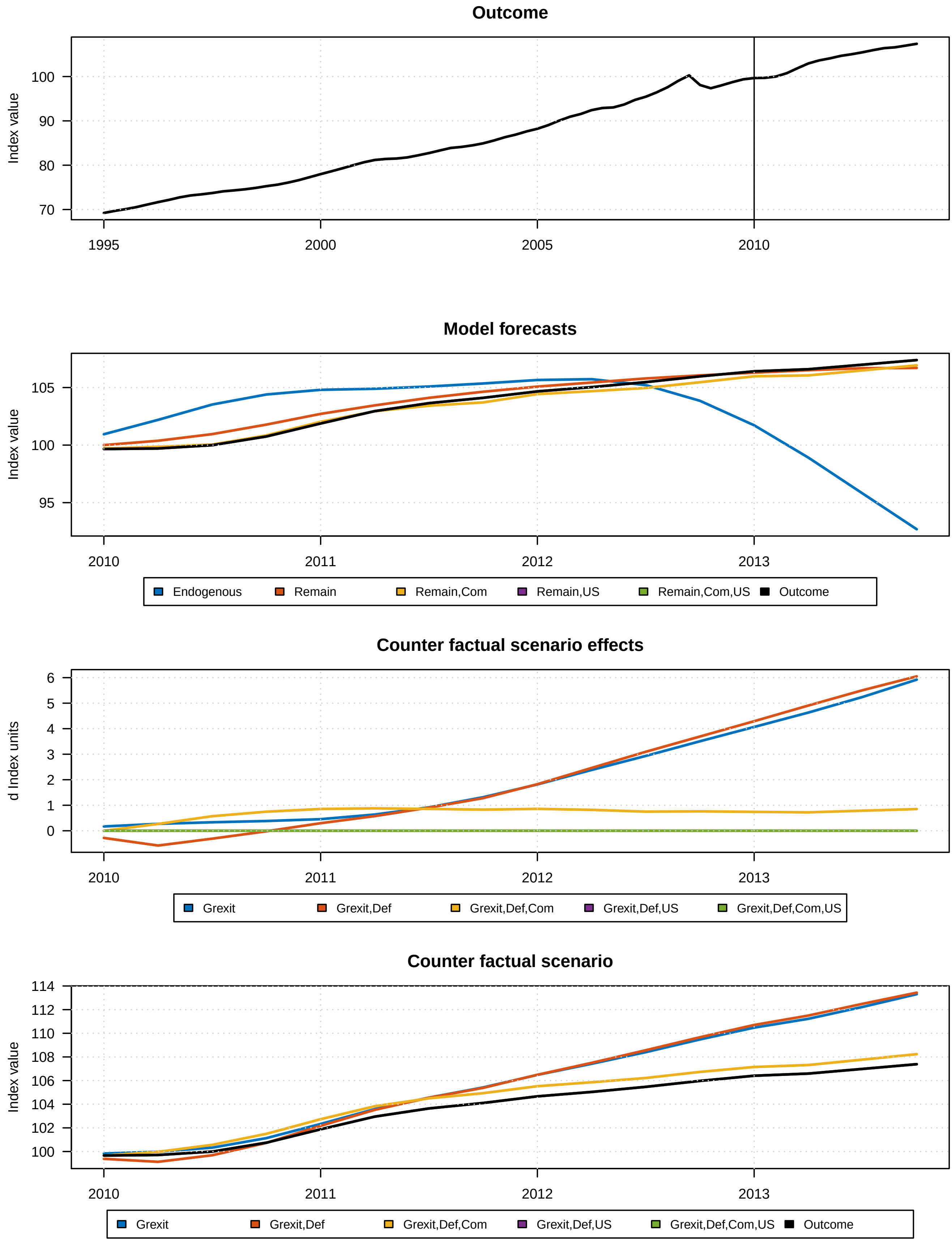


Figure A37: United States, Consumer price index

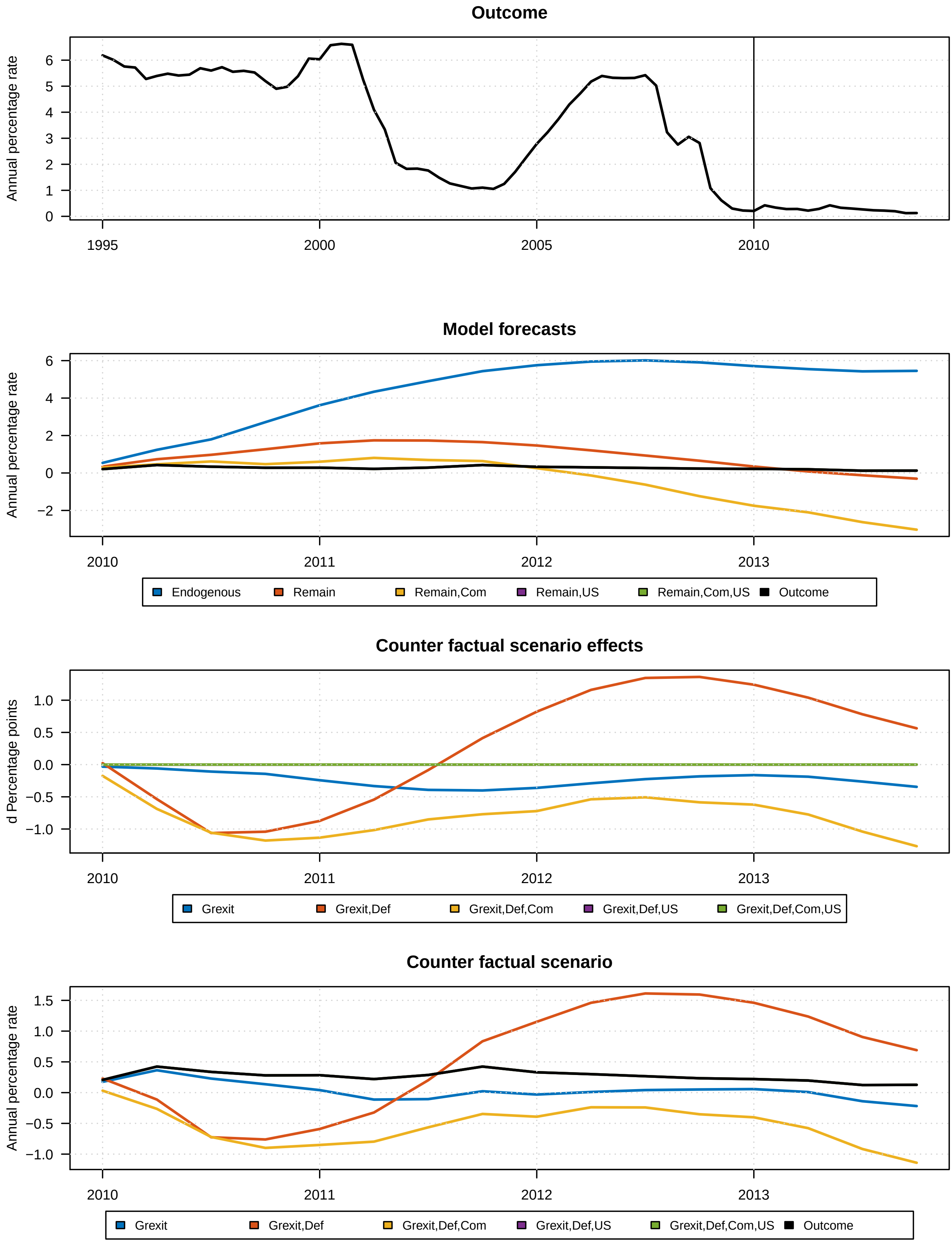


Figure A38: United States, Short-term interest rate

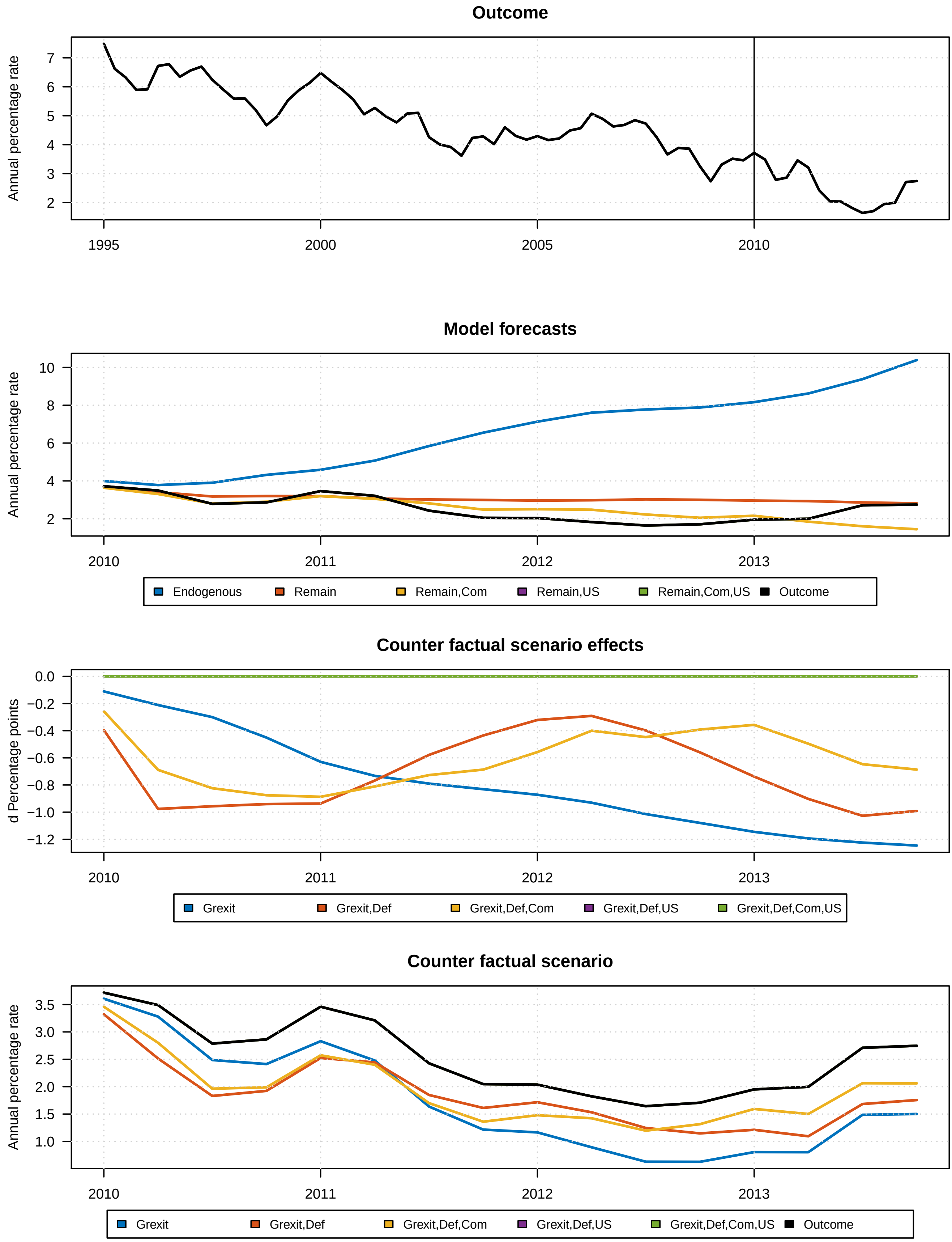


Figure A39: United States, Long-term interest rate

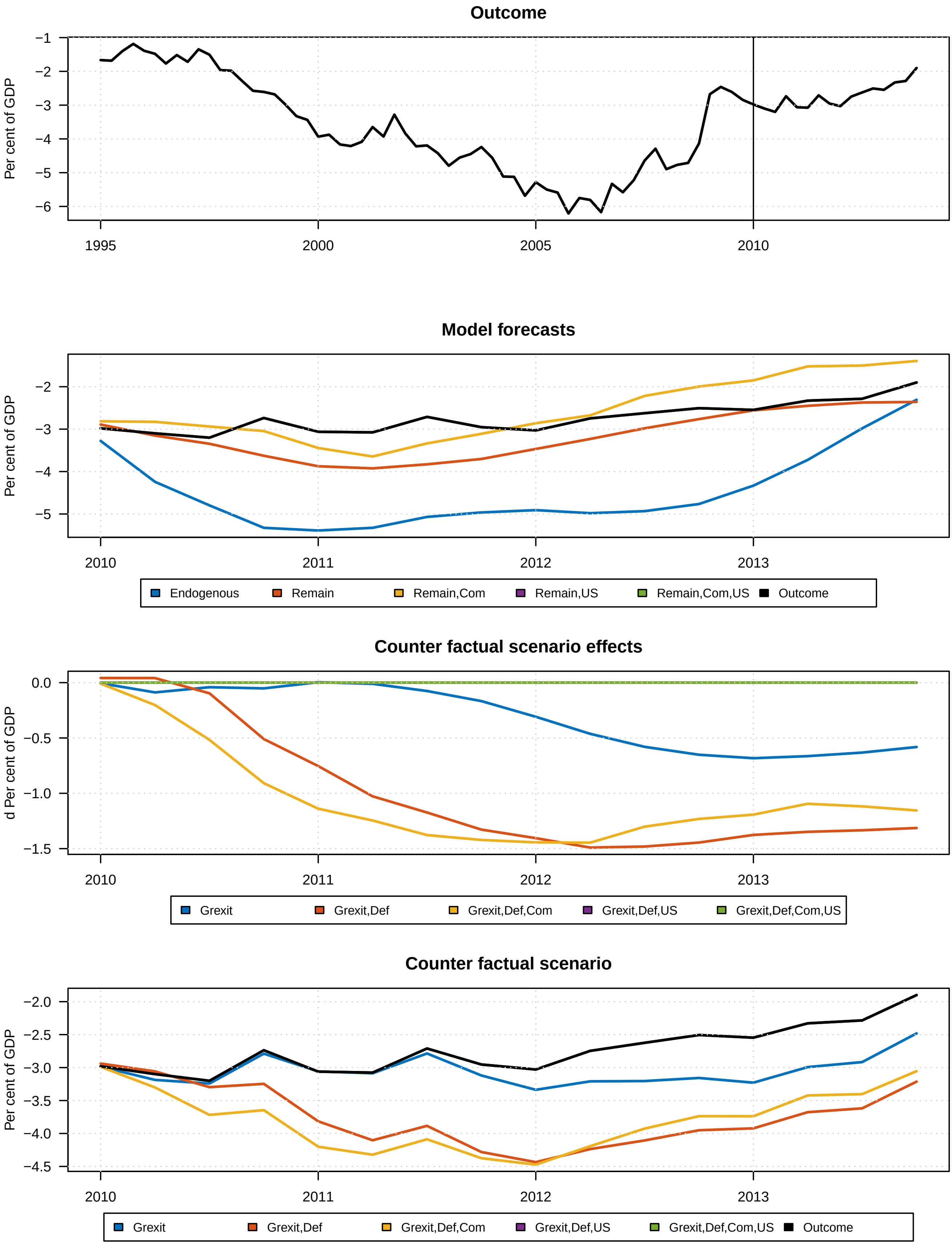


Figure A40: United States, Current account

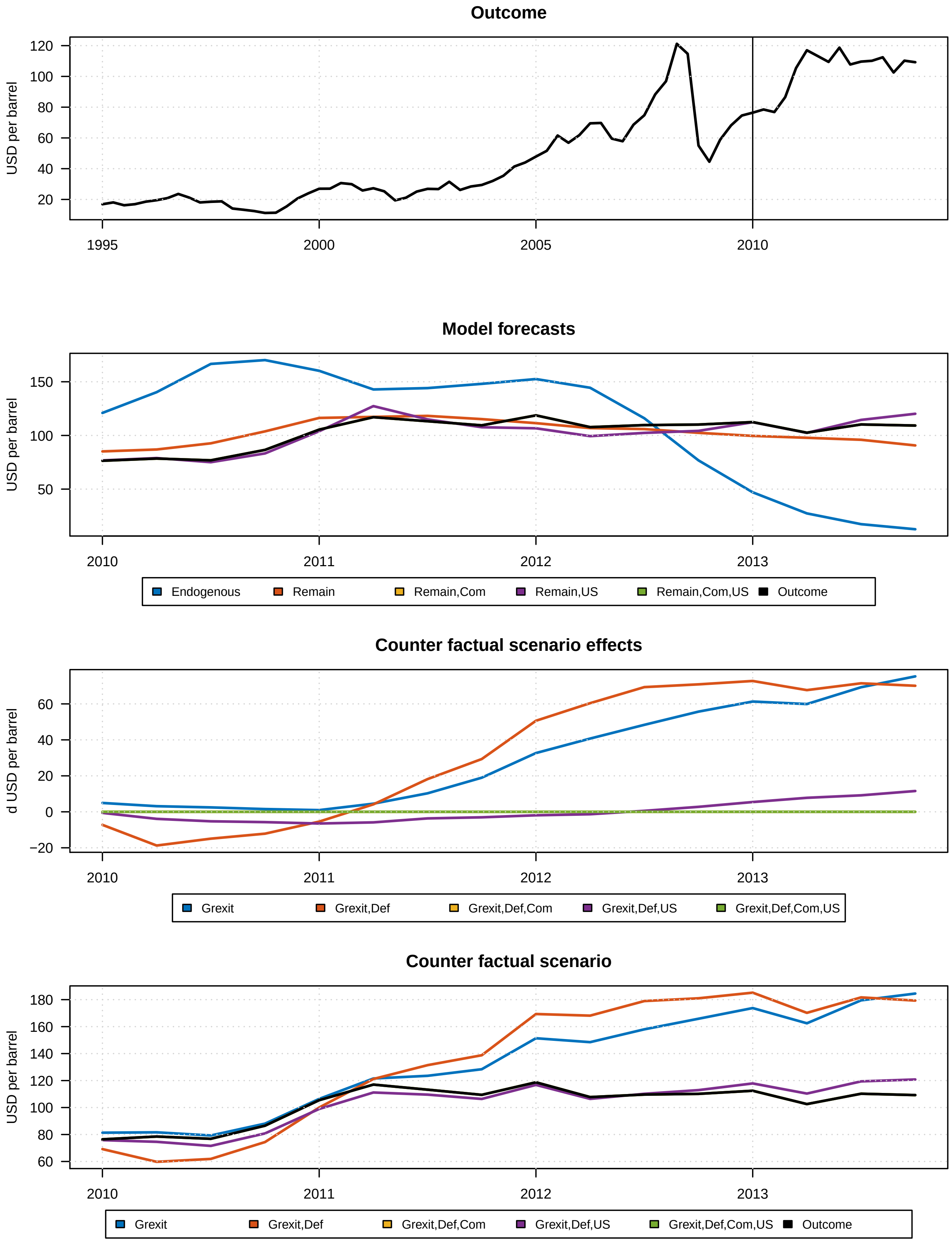


Figure A41: United States, Oil price

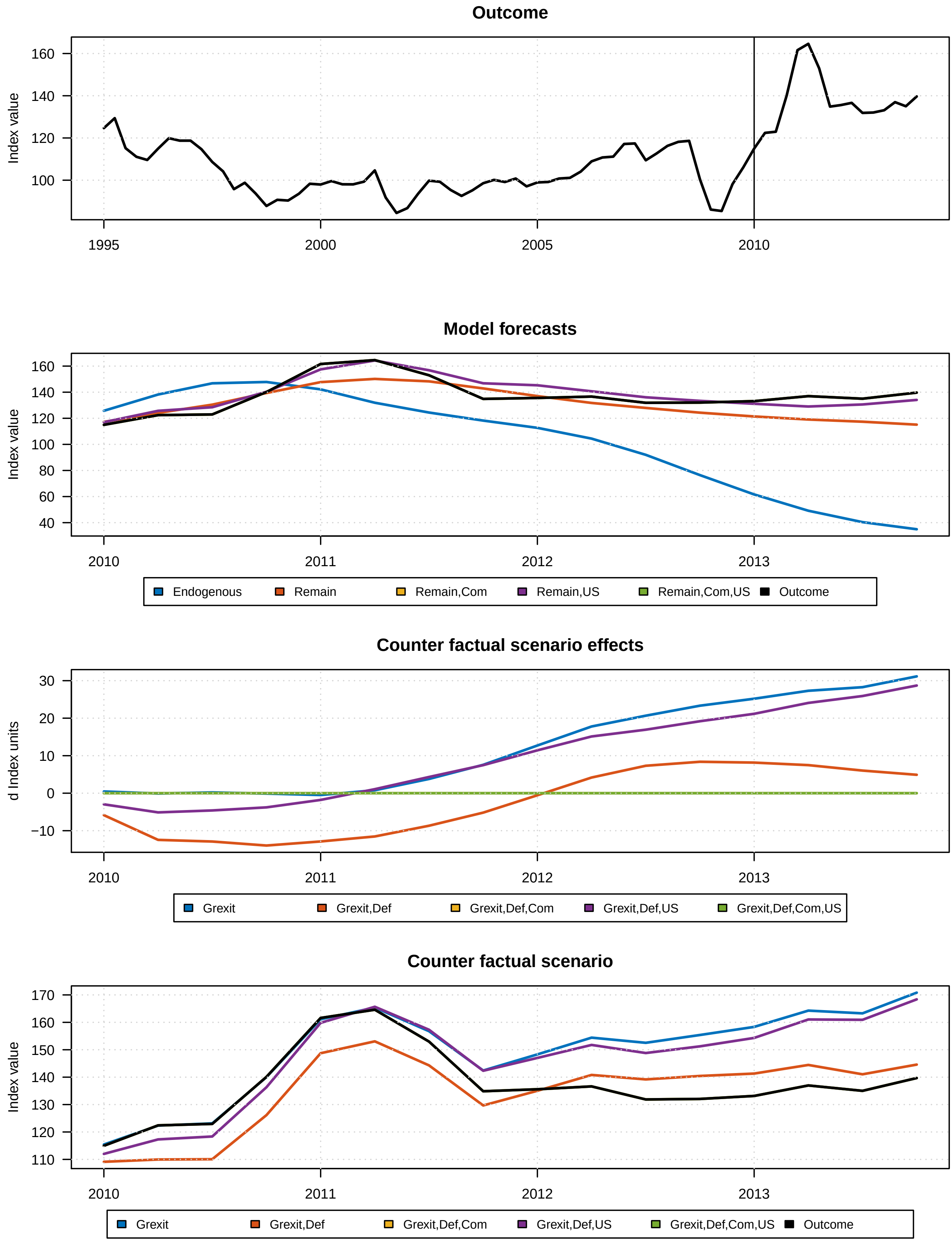


Figure A42: United States, Raw material price

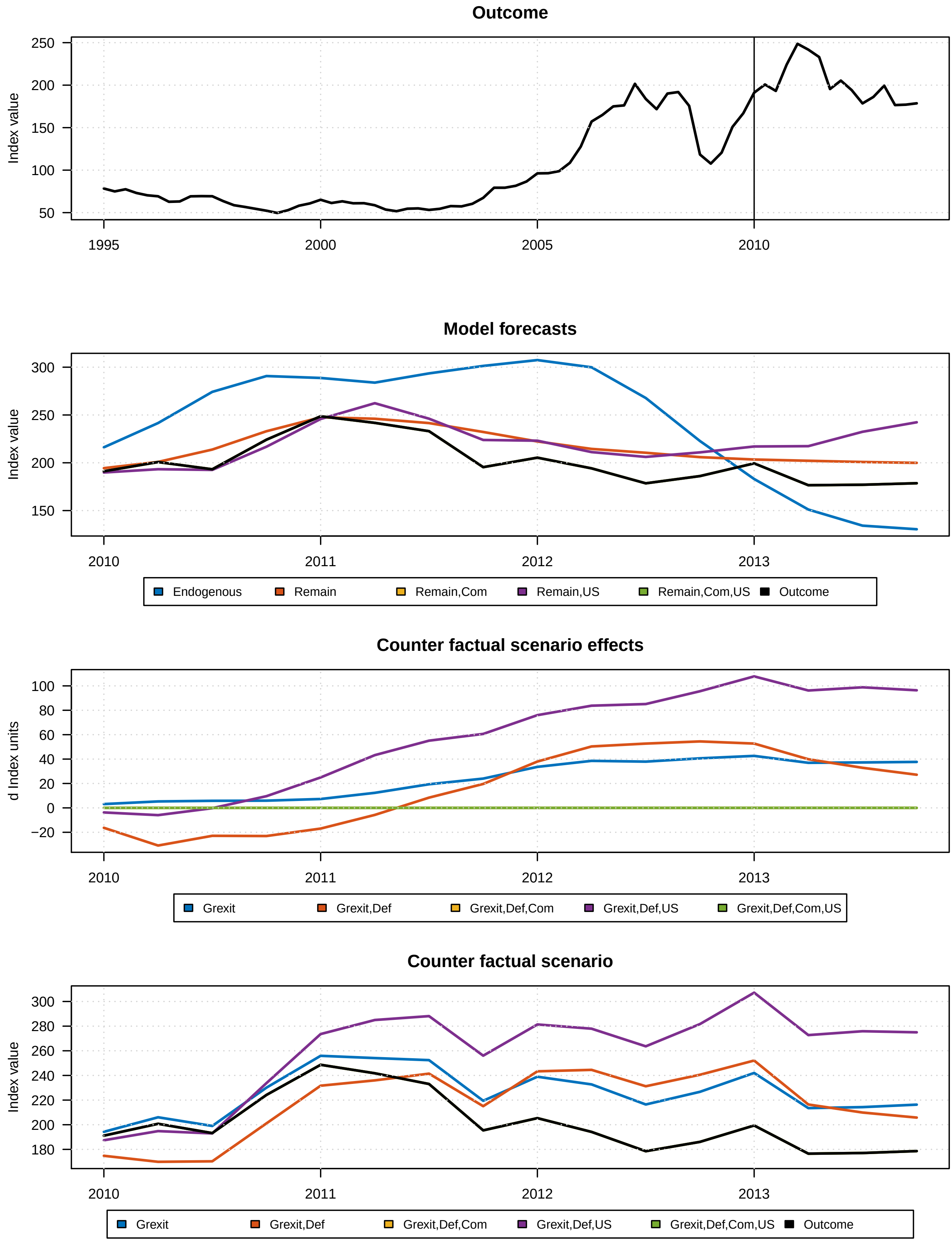


Figure A43: United States, Metal price