Final report (short version)

Mints in Europe EU28 from an Economist's View

Four Dimensions of Economic Effects

INDUSTRIE WISSENSCHAFTLICHES INSTITUT

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Preface

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Mints in Europe (EU28) are part of the production economy and intensely integrated into the networks of their national economies and of the European economy. At the same time, they are closely linked to the institutional infrastructure of Europe. Therefore, the effects they exert on the economy go far beyond those of a conventional production enterprise. In the present study, the research team of IWI managed to account for the particular role of mints within a comprehensive analytical approach that was based both on detailed data collected from a sample of mints and on innovative concepts.

Executive Summary:

Mints in Europe EU28 from an Economist's View: Four Dimensions of Economic Effect

Mints in Europe form an integrated part of their respective national economies and of the economy of Europe (EU28). They are at the core of the production economy and, at the same time, closely linked to the institutional infrastructure of the economy and economic policy.

The present study analyses the mints in Europe (EU28) and models their economic impacts covering not only macroeconomic effects as dealt with by classical input-output analysis but also associated effects that arise in other, less obvious ways. The study is based on a sample of twelve mints from eleven European countries. The economic effects are reported for individual mints and for the aggregate of EU28.

The study uses input-output-analytical methods and has detailed data on the twelve mints as an empirical basis. The mint-specific data are prepared and harmonized with the classification system of official input-output tables (Eurostat). The data sources are, first, publicly available information and annual reports, second, data from a questionnaire of the Mint Directors Working Group (MDWG) sent out to its members in 2016 and third, data provided directly by the mints concerning specific relevant production structures. The reference time for most analyses is the average of 2014/2015.

A sample of twelve European mints

The sample of the twelve mints covered in this study is (sorted by alphabetical order of their home country):

- Austrian Mint (Münze Österreich), Austria
- Royal Mint of Belgium (Koninklijke Munt van België, Monnaie Royale de Belgique), Belgium
- Czech Mint (Česká Mincovna), Czech Republic
- Mint of Finland (Suomen Rahapaja), Finland
- Monnaie de Paris, France
- State Mints of Baden-Wuerttemberg (Staatliche Münzen Baden-Württemberg), Baden-Württemberg, Germany
- Bavarian State Mint (Bayerisches Hauptmünzamt), Bavaria, Germany
- Royal Dutch Mint (Koninklijke Nederlandse Munt), Netherlands
- Mint of Poland (Mennica Polska), Poland
- Casa da Moeda (Imprensa Nacional – Casa da Moeda), Portugal
- Real Casa de la Moneda (Fábrica Nacional de Moneda y Timbre – Real Casa de la Moneda), Spain
- The Royal Mint, United Kingdom

The aggregated economy of the home countries of the mints in the sample covers approximately 63 percent of the economy of the EU28.[1]

1 Since Germany has four mints supplying euro circulating coins of which two are contained in the sample, in this calculation the German economy is taken into account with 50 percent.

Four dimensions of economic impact of European mints

To present a complete picture of the economic impacts of European mints, in this study a model to quantify the economic impacts has been developed that goes beyond the classical input-output model and considers not only the direct, indirect and induced effects (=macroeconomic effects, 1st, 2nd and 3rd dimension) but the associated effects as well (4th dimension):

- **Direct effects**: the production, value added, and employment taking place in the mints themselves (1st dimension)
- **Indirect effects**: the production, value added, and employment caused along the chain of intermediate demand (production that is necessary, so the mints can uphold their manufacturing processes) (2nd dimension)
- **Induced effects**: the production, value added, and employment generated via the wages – income – consumption – production cycle (3rd dimension)
- **Associated effects**: the production, value added and employment that is fostered by way of other channels associated with mints and the production of coins and dependent on their continued existence in our economies (4th dimension)

With the consideration of the associated effects this study developed new approaches. Two groups of associated effects are considered. The first group comprises various forms of crossover and spillover effects. The second group of associated effects, termed *support effects* considers that the production activities of mints support growth of the national economy through various channels:

- **Crossover and spillover effects**:
  - *Culture and tourism effects*: the positive effect of coins on tourism that stems from the advertisement effect that coins have.
  - *Culture and creative industries effects*: the stimulating effect that mints have on areas within the culture and creative industries with whom they interact and who take up their ideas and knowledge.
- **Support effects**:
  - *Small purchases effects*: the volume of transactions and the associated economic activity that hinges on the existence of coins as a means of payment.
  - *National budget financing effects*: making cautious and conservative assumptions on what governments do with the revenues from mints in public ownership and from seigniorage, this is the effect of growth-supporting public investments enabled by those revenues.

As to the small purchases effects we can assume a narrower or a wider perspective. When the focus is on the mints and their impact on the economy, a model of attribution of small purchases effects to the production activities of mints is applied. We define the *mint-related* small purchases effects as the volume of transactions and associated economic activity that hinges on the existence of coins and is attributed to the share of newly issued circulating coins in the stock of circulating coins. This share is assumed to be the same for all European countries and has been set at 3%. If the focus is on the existence of coins and their impact on the economy, we seek to determine the transaction volume of small purchases that depends on the existence of coins, termed in this study as *coin-related* small purchases effects. In an even wider perspective the whole volume of small purchases that would be jeopardized in a transformation to a cashless economy

can be asked for, called the *cash-related* small purchases effect, which is assumed to depend on the share of cash-based consumer transactions observed for a country. A share of 8% of cash-based consumer transactions is assumed to be lost in the case of the abolition of cash and coins. According to the share of coins in cash-holdings of consumers the size of the coin-related small purchases effect is assumed to be about 5.5% of the cash-related purchases.[2] In this study our primary focus is on the narrower focus (focus on mints) but we also report the coin-related small purchases effects and summarize the associated and total effects for the wider focus.

Economic impact of European mints: Results

In this study the economic impacts of the twelve mints in the sample are calculated in considerable detail. A comparison of these results shows that the overall effects of individual mints cover a range from EUR 59.9 million to EUR 875.8 million of production generated in the economy of the EU28. The individual mints generate a total employment between 431 and 6,175 persons.

The total economic impact of mints in the EU28 was estimated through aggregation over the sample and projection from the sample of twelve mints to the whole of EU28. Fig ES1 summarizes the economic impact of European mints on the economy of EU28 in terms of production, value added and employment.

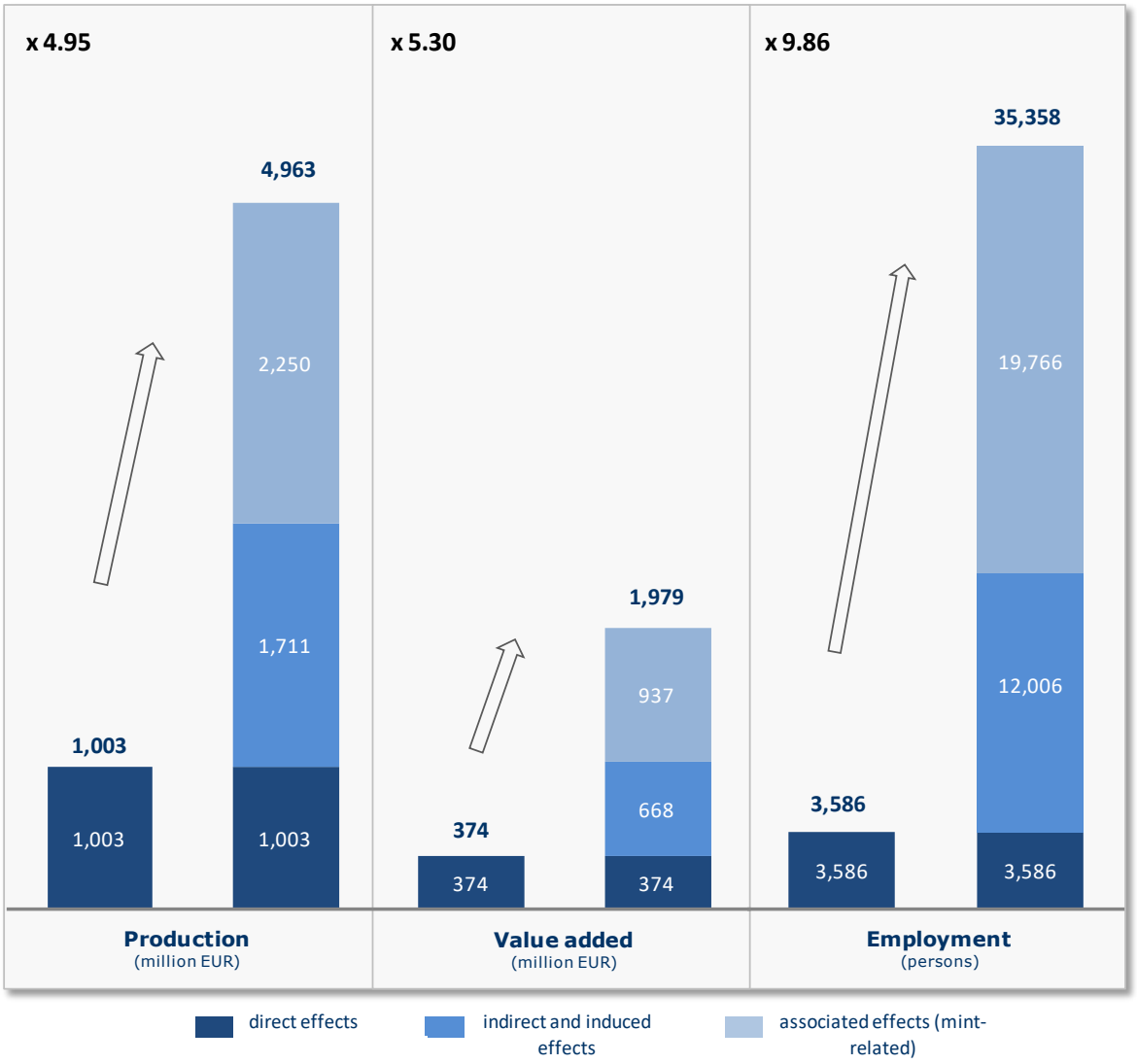
European mints, i.e. mints in EU28, are estimated to have a direct production of EUR 1,003 million and a value added of EUR 374 million. 3,586 persons are directly employed at one of the European mints. Through indirect, induced and associated effects the production activities of mints stimulate the economy of the EU28. All in all, a production of EUR 4,963 million and a value added of 1,979 is generated in the EU28. 35,358 persons have a job that is linked to the production activities of European mints through direct, indirect, induced and associated effects.

Summarizing the results with the help of total-to-direct ratios one can say that

- For every euro of production directly at one of the mints in EU28 EUR 4.95 of production is generated in the whole economy of EU28.
- For every euro of value added at one of the mints in EU28 EUR 5.30 of value added are generated in the whole economy of EU28.
- For every person employed at one of the mints in EU28 on average 9.86 persons are employed in the EU28.

2 More background on the nature of the assumptions relating to the small purchases effect and their empirical foundation is contained in the main text.

Fig. ES1: Economic impacts of mints in EU28 on production, value added and employment, average 2014/2015, projection from the sample



Note: Production (direct effects) corrected for the material value of gold and precious metals.
Source: IWI (2018)

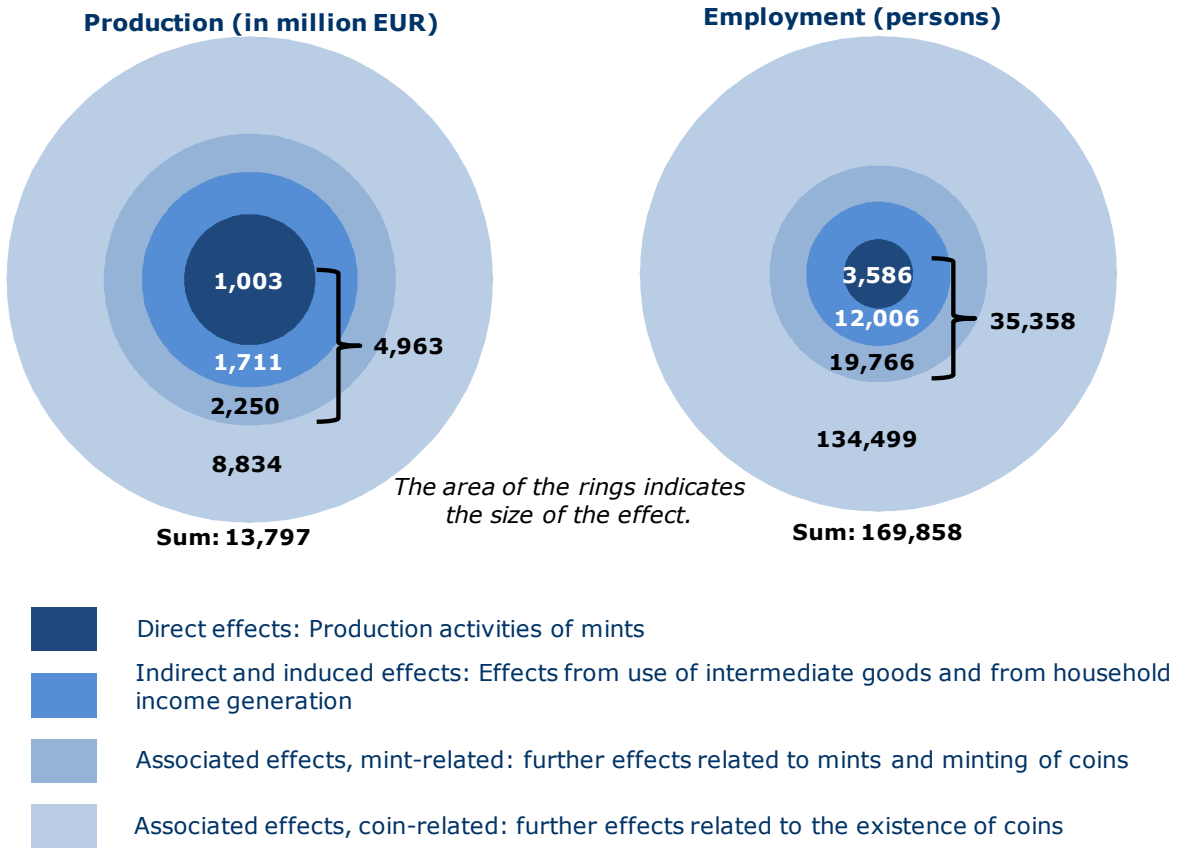
Thus, these total-to-direct ratios measure the **dependence** of the economy of the EU28 on the production activities of European mints and on effects associated with the existence of coins in the economy. The do not, however, form the basis for evaluation or for comparison with other branches of the economy. The ratios, as such, do not indicate desirability nor performance, but reflect only the underlying structures of the mints included in the sample, of the respective national economies and of the European economy.

When a wider perspective is taken that not only considers the effects that can be attributed to the production activities of the mints (focus on mints) we can consider more effects that depend on the existence of coins independently of the mints (focus on coins). Then we observe much larger effects due to coin-related effects.

Fig. ES2 presents a graph of the effects in the form of a succession of concentric rings, starting with the direct effects in the centre, adding indirect effects, induced effects, mint-related associated effects and coin-related associated effects as rings whose areas indicate the size of the effects.

From the wider perspective we can see that coin-related small purchase effects account for a production of EUR 8,834 million and an employment of 134,499 persons. Summing up all mint- and coin related effects, we can conclude that a total of EUR 13,797 million of production and employment for 169,858 persons in the EU28 are generated by the macroeconomic and associated effects of mints of by the effects associated with the existence of coins in the economy.

Fig. ES2: Layer graph of all mint- and coin-related effects of mints in EU28 on production and employment, average 2014/2015, projection from the sample



Note: Production (direct effects) corrected for the material value of gold and precious metals.
Source: IWI (2018)

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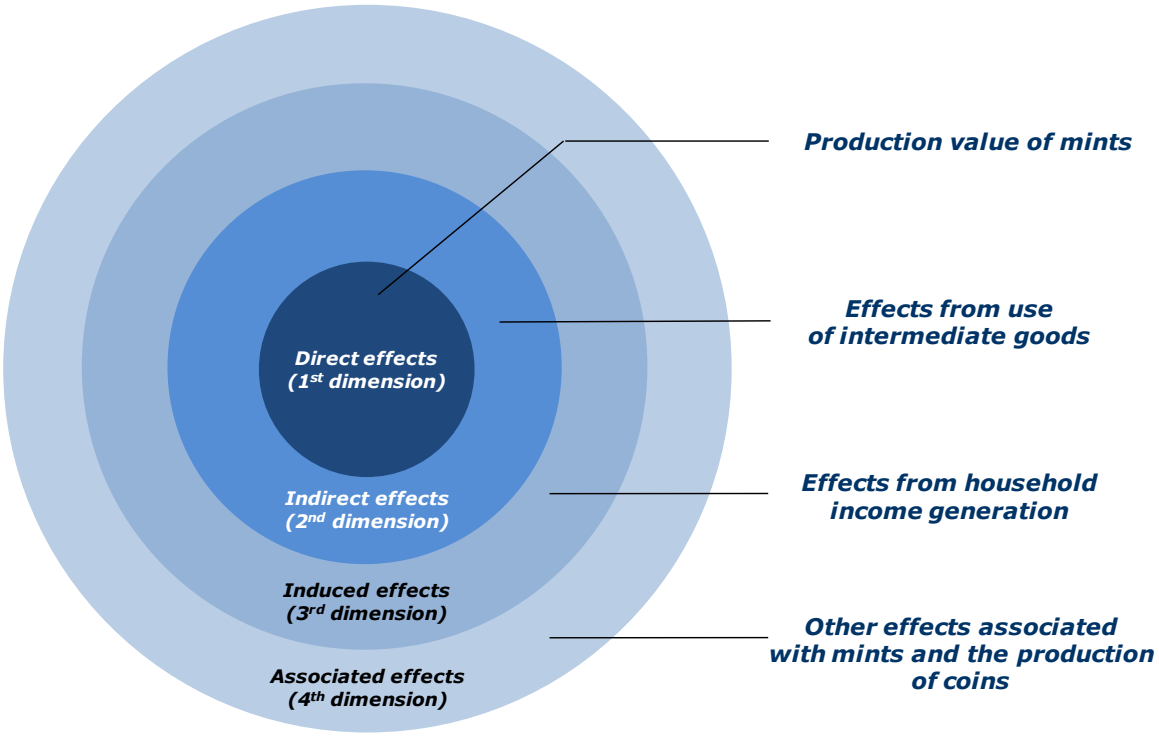
1 Introduction

From a purely economic point of view, mints form an integrated part of their respective national economies and of the economy of EU-Europe (EU28). They are at the core of the production economy and, at the same time, closely linked to the institutional infrastructure of the economy and economic policy. Mints have diverse interrelationships with other industries and, thus, exert effects on the whole economy (production, value added, and employment).

Through their economic activities, mints send impulses into the entire economy. The cooperation with other parts of the economy triggers the following effects:

- **Direct effects**: the production, value added, and employment taking place in the mints themselves (1st dimension)
- **Indirect effects**: the production, value added, and employment caused along the chain of intermediate demand (production that is necessary, so the mints can uphold their manufacturing processes) (2nd dimension)
- **Induced effects**: the production, value added, and employment generated via the wages – income – consumption – production cycle (3rd dimension)
- **Associated effects**: the production, value added, and employment that is fostered by way of other channels associated with mints and the production of coins and dependent on their continued existence in our economies (4th dimension)

Fig. 1: The IWI layer model: input-output calculations



Source: IWI (2017)

The study applies input output analysis. This is a quantitative economic technique that

represents the interdependencies between different branches of a national economy. It is best suitable for answering the research question of this study since it depicts inter-industry relationships within an economy, showing how output from one industrial sector may become an input to another industrial sector.

The study has detailed data on the twelve mints as an empirical basis. The mint-specific data are prepared and harmonized with the classification system of official input-output tables (Eurostat). The data sources are, first, publicly available information and annual reports, second, data from a questionnaire of the Mint Directors Working Group (MDWG) sent out to its members and third, data provided directly by the mints concerning specific relevant production structures.

The study is innovative in many respects and goes far beyond the usual input-output approach. Mints and coin production form a clearly defined economic activity but are not very well represented in official statistics and statistical classifications. As a result, input-output tables do not represent their structure very well. Mints in Europe cover more than only the production of euro coins and differ considerably in the spectrum of their production activities. Mints have a very specific structure of basic inputs whose sourcing is domestic, from EU28 and from sources outside EU28.

Apart from this introduction, the paper is structured in two parts. In the first part, we discuss the conceptual background and data basis of the study. The second part presents the results for the sample of twelve mints from eleven countries and as an aggregation and projection for the European economy as given by EU28. Summary and conclusions finalize this report. Furthermore, an appendix displays detailed information on economic terminology.

2 Economic impacts of mints: Concepts and data

In this chapter we discuss the concepts used to analyse the economic impact of mints along the four dimensions considered. In the first section an overview is given, and the motivation is made clear why we think that it is necessary to take into consideration not only the direct production, value added and employment but all four dimensions of economic impacts, including indirect, induced and associated effects. Two further sections describe the concepts, models and databases of the macroeconomic effects, modelled with input-output analysis and of the associated effects.

2.1 Overview on the four dimensions of economic impact

Our study captures direct effects (1st dimension), indirect effects (2nd dimension), induced effects (3rd dimension), and associated effects (4th dimension). The direct, indirect and induced effects usually caused by the economic activities of the mints can be easily quantified by means of standard economic models. The associated effects consist of effects generated by the existence of coins and can be interpreted as positive external effects, i.e. effects that concern wide and diverse parts of the national economy outside of the firm causing them. These effects are usually not covered by standard economic models and have to be estimated by applying non-standard approaches. In this chapter we first explain the different effects and then we present the data on which this study is based and describe the estimation methods which are used to quantify the effects of each category.

The **direct effects** take place at the mints themselves. These denote the extent of production, value added and employment which is generated directly in the process of the production of coins and related products. The **indirect effects** are caused along the chain of intermediate demand. Thus, production, value added, and employment are triggered at suppliers and suppliers of suppliers of the inputs needed by the production of coins and related products. The **induced effects** (or, more precisely, income-induced effects) are generated via the wages – income – consumption – production cycle. Wages and salaries generated by direct and indirect effects usually are transformed into consumer demand. This demand induces additional production and value added, creating more jobs that are not yet covered by the direct and indirect effects. In this study the direct, indirect and induced effects are summarized under the term of **macroeconomic effects**.

The **associated effects** go beyond the macroeconomic effects. They are fostered by way of other channels associated with mints and the production of coins and related products, reflecting the dependence of parts of the economy on the continued existence of coins in our economies. We distinguish the following two groups:

- crossover and spillover effects
- support effects

Crossover and spillover effects are a form of positive external effects. They arise when the activities of a firm or industry lead to economic benefits in other parts of the economy. While crossover effects come about intentionally as they are linked to a form of cooperation (e.g. delivery of products and services, marketing cooperation) spillover effects, as the more general concept, arise also in an unintended way. In this study we consider two different but closely related versions of crossover and spillover effects:

- effects on culture and tourism
- effects on culture and creative industries

By effects on culture and tourism we mean the positive effect of coins on the tourism industry, e.g. by fostering interest in mint and money museums and through the advertisement effect of collector and circulating coins. By the effects on culture and creative industries we summarize the stimulating effect that the use of concepts, knowledge, designs created by the minting industry has on cultural and creative industries like advertisement and the media. Crossover and spillover effects are difficult to observe or measure, yet they exist. To initiate the discussion on their extent we propose a method that uses reference points to come up with a plausible range.

The **support effects**, in turn, encompass in the following two sub-effects:

- national budget financing effects
- small purchases effect.

The national budget financing effect considers that mints and coin production generate funds that help support the financing of national budgets. The support considered here consists of dividends paid and profits transferred (when the mint is publicly owned) and by the contribution arising from issuing coins at their nominal value, which is higher than the minting costs ("seigniorage effects"). Assuming the additional funds available to the national budgets are invested in public infrastructure and these investments lead to more macroeconomic growth, we can derive the production, value added, and employment thus generated.

The small purchases effect is taking into account that in many areas of the economy, particularly in retail trade and private consumption where the share of cash-based payment is high, a large volume of transaction and associated economic activity hinges on the existence of coins as a means of payment ("small purchases"). As the abolition of coins is of a highly hypothetical nature and the question is hard to separate from general issues of monetary system, it is difficult to determine the contribution of coins to the sustaining of economic activity linked to small purchases. We apply a method based on a chain of proportional attributions.

2.2 Macroeconomic Effects

The macroeconomic effects are modelled with the help of input-output analysis. To be able to provide goods and services for final demand in an economy, it is not only these goods and services that need to be manufactured, but also inputs used up in these production processes. In an economy with specialized players (firms, governmental institutions, etc.), the various sectors of the economy need inputs from other sectors of the economy, which in turn require inputs from other sectors of the economy. These interdependencies give rise not only to the direct effects of final demand, but also to indirect effects that affect the whole supply chain. Thus, in the open static Leontief model (the "classical" model), that is usually applied, final demand is taken as a starting point of the analysis. However, if, as is the case in the present study, not a certain final demand is given but a production output of a compound of economic units, e.g. mints a modified input-output model has to be used, the so-called mixed input-output model. The principal characterisation of direct effects, indirect and induced effects, as stated in the previous section, is identical between the two models (see Miller, Blair, 2009).

The empirical basis of input-output analysis is the input-output table. This is a detailed and comprehensive picture of the supply and use flows between the economic sectors of an economy and with foreign countries. Embedded in the concept of national accounts, this table presents a breakdown of economic activity into the development of gross domestic product and the use of available goods and services not only according to the categories used in national accounts but also according to product groups. In addition, tables show the employment and income generated during production in the individual production areas.

Mints and coin production form a clearly defined economic activity. However, due to its narrow place in statistical classifications, it is not reported separately in most economic statistics and aggregated instead with other, rather heterogeneous economic branches.[3] As a result, input-output tables do not represent their structure very well. Furthermore, mints in Europe cover more than only the production of euro coins and differ considerably in the spectrum of their production activities. Mints have a very specific structure of basic inputs whose sourcing is domestic, from EU-Europe and from sources outside EU-Europe. To avoid biased results, it is necessary to use as much as possible the mint-specific data and integrate them with input-output tables.

A tailor-made model-version of the mixed input-output model makes optimal use of this situation and proceeds in three steps. Because the effects are modelled in two tiers, the model is called the two-tier mixed input-output model (Koller, 2016):

1. Direct production, direct intermediate inputs, direct value added, and direct employment are taken as given and thus define direct production, value added and employment ("first tier").
2. A mixed model is formulated that models the effects of direct intermediate inputs on the economy ("second tier").
3. The indirect effects on production are calculated as the direct and indirect effects on production from this "second-tier" model. The indirect effects on value added and employment are calculated as indirect effects of the second-tier model.

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3 The activity "Striking of coins" (NACE 32.11) is part of activity "Manufacture of jewellery, bijouterie and related articles" (NACE 32.1), which in turn is part of activity "Other Manufaturing" (NACE 32). For explanation of the NACE-system of classification see the footnote further down.

The validity of that model relies on the reliable specification of the direct production output, direct value added and direct intermediate inputs of the economic units. Thus, it is both necessary to adapt the input-output database and the mint-specific data, that are applied in the model, to the needs of our study.

Input-Output database

The input-output analysis is based on most recently available Eurostat input-output tables in the product-to-product dimension. In comparison to other available input-output data bases (e.g., WIOD, the World Input-Output Database) this offers several advantages as to the modelling aims of our study:

- The product-to-product dimension, apart from its general theoretical desirability, offers a more direct interface to the mint specific data, e.g. on intermediate inputs of mints, which are more easily translated into the commodity dimension than into the industry dimension.
- The Eurostat input-output tables are fully compatible with national accounting to ESVG 2010. This feature is desirable because our approach is designed to deliver valid modelling not only on the European level but also on the individual country level.
- The Eurostat input-output tables are based on a relatively detailed commodity structure (64 sectors).

In order to enable the comparison of impacts on production, value added and employment both on the national level of the respective home countries of the mints and on the European level (EU28), the input-output flows must be known differentiated by domestic goods and imports. Furthermore, import tables must be available according to the origin of the imports from EU28 or extra EU28.

Employment data were used in a compatible format. They have been taken from national accounts (Eurostat) and are, in principle, given in number of persons, number of jobs or hours worked. For reasons of data availability, the focus was laid on the number of persons as indicator used in this study.

Starting from the official input-output tables and national account data as published by Eurostat, this involved several steps of data transformation:

- Construction of symmetric input-output tables from supply and use tables, when symmetric input-output tables are not available
- Transformation of employment data from the industry dimension to the commodity dimension
- Construction of import tables separately for imports from EU28 and extra EU28.

The most recent input-output tables were used, in most cases for the year 2013. Though for reasons of data availability, it was not always possible to have 2013 as the reference year for the input output database (exceptions are Belgium, Spain, Poland and United Kingdom, for which 2010 was used). This does not affect the quality of the present study in a significant manner, as input-output coefficients usually remain stable over medium-length time periods.

Mint-specific database

To fulfil the data needs of the input-output model the following mint-specific data sources have been used:

- annual reports and other publicly available sources like web pages
- the MDWG questionnaire (a questionnaire sent out to the members of the Mint Directors working group, collecting data about key figures on business areas, mint performance and capacity)
- additional data provided by the mint directly to the research team

Mints are very different as to their individual data situation. This is as much a consequence of their different organisational setup, structure and business portfolio as of the differences in disclosure of data to the public. For our analysis we needed and asked for a minimum of data on the following variables (all for the reference years):

- revenue, total and differentiated by business area
- sum of intermediate inputs,
- personnel cost, depreciation allowances, net operating profits (before taxes)
- number of persons employed

Other more detailed data, e.g. on import shares, composition of intermediate inputs and on purchases of gold and precious metals were welcome but optional.

In the design of the database we used an approach based on a pioneer case study for Austrian Mint. In the early phases of the project very detailed data have been provided by Austrian Mint, that allowed a more accurate modelling of the mint. Several expert interviews fostered our understanding of the data. This applies mainly to the construction of the vector of intermediate inputs (see more on that point below). The detailed knowledge gained from the pioneering case study was used to generalize for other mints and generate plausible assumptions to fill occasional gaps in the database for other mints.

All in all, the mint-specific data situation can be judged as very good or good in eleven out of twelve cases, as data gaps identified during the data preparation phase were filled by additional data that were directly provided by the mints.

A particular issue of the preparation of the mint specific data concerns the **definition of production in the sense of the study**. In principle, the aim is to have a measure of production, that allows both comparison of the modelled effects over the mints and aggregation to a meaningful total of effects generated in EU28. This involved two steps of data preparation:

- For each mint, only the production activities in its core business areas related to coin minting are considered. In all but three mints this encompasses all production activities of the mint. For Mint of Poland, Casa da Moeda and Real Casa de la Moneda the mint-specific part of production had to be isolated based on available data or estimations.[4] Furthermore, for State Mints of Baden-Wuerttemberg and Bavarian State Mint, an estimation of the full extent of its production activities in the sense of our study required the consideration of production cost that are not borne by the mints themselves but by governmental administration.

4 These three mints are also active in business areas such as security printing and plastic card production.

- The value of the material value of gold and precious metals has been discounted from the production of the mint (and, consequently, also from the inputs of the mint). This procedure accounts for the widely varying degree of the role of gold and precious metals for the mints, depending, e.g., on their focus on bullion coins or production of gold blanks. While this modification does not conform to the definitions of national accounts, it captures its intention. Gold and other precious metals cannot be produced in the usual sense implied by national accounting but are mined. Furthermore, in the case of European mints, most gold and precious metal inputs are imported from extra EU28.

Particular attention was devoted to the construction of the input vector, since the correct modelling of indirect effects depends on it. For the present analysis the composition of the intermediate inputs has been specified in terms of 64 product groups compatible to input-output tables. Furthermore, for each of the 64 input categories, the share of imports must be specified, whereby, additionally, a differentiation of imports according to origin from the member states of the EU28 and from extra-EU28 is necessary. The procedure applied integrated both mint-specific data and general structures as derived from input-output tables.

2.3 Associated effects

In this section we present the concepts of associated effects and the methods used to operationalise them. First, we discuss crossover and spillover effects. Second, we present national budget support effects and, third, small purchases effects.

Crossover and spillover effects

Crossover effects are the result of the cooperation of a firm or industry with related firms or industries. Via crossover effects, solutions, innovations knowledge and ideas are created and passed on in an intentional way to partners in the economy. Typical channels for crossover are the chain of intermediate deliveries ("industry crossover"), clusters and the interaction of players in a common network ("network crossover") and the dispersion of knowledge, innovation and ideas ("knowledge crossover"). Spillover effects are a related, more general concept. While crossover effects come about as intended by the partners, spillover effects arise unintentionally, e.g., by diffusion of knowledge through personnel fluctuation.

Crossover effects play a crucial role in the cultural and creative industries, since the products and services provided by them rely on knowledge, innovation and ideas. The Council of the European Union (2015) defines "...the cross-over effects between the cultural and creative sectors and other sectors [...] as a process of combining knowledge and skills specific to the cultural and creative sectors with those of other sectors in order to generate innovative and intelligent solutions for today's societal challenges."

Mints share many features of the creative industries such as innovativeness, artistic content, strong ties to cultural content and educational role, and cooperation with diverse other sectors of creative industries (e.g. museums and specialized journals). This is the basic motivation to ask for the importance of crossover and spillover effects of mints.

Crossover and spillover effects cannot be observed directly or measured. Yet there is a consent among economists that they are real and significant. In some cases, e.g., crossover and spillover effects of R&D in one sector on the productivity of its customers, indirect methods of measurement are applicable. In the case of the minting industry no such approach is available as the destination sectors of its crossover and spillover effects are distributed very broadly over the economy.

In this study we consider two broad groups of crossover/spillover effects that emanate from the coin minting industry:

- effects on culture and tourism
- effects on culture and creative industries

An example of the first group is the effect of **coins as advertisements for touristic destinations.** Each coin, whether of the collector or of the circulation variety, forms a small instance of advertisement for touristic targets within a country and for the issuing country in general. In sum, this generates a potentially large positive effect of costless advertisement for the tourism industry. In the case of circulating coins many coins bear pictures of touristic targets on their faces. Even less touristic themes such as the head of a king or queen or a national symbol have a positive marketing effect as they arise the awareness and curiosity for the respective country. The effect is reinforced by central banks and official brochures providing information on coins. Even more obvious is the touristic advertisement effect of collector and investor coins, as these often fulfil the role of a flagship for their country and are actively advertised themselves.

An example of effects on culture and creative industries is the **use of concepts related to coins** by retail trade, advertisement industry and the media. With this we mean not only general concepts of cash-based payment systems, but also concrete designs und coins whose recognition value is used by firms of retail trade and advertisements to sell their products or raise attention.

An example of effects that pertain to both groups are the activities of **mint museums, money museums and numismatic collections**. They form an important area of economic and cultural life that is closely related to the production of coins itself. While the economic activity (its production, value added, and employment) at mint and money museums is not directly dependent on the economic activity of mints, it nevertheless presupposes the presence of a meaningful idea of coins and money and a historic understanding of their importance. Several mints in our sample entertain close relationships with such museums. Three of them (FR, ES, UK) operate a mint museum themselves. Via exhibitions, events, scientific cooperation and educational activities, these museums often constitute a lively opportunity for more crossover to other areas of the economy.

A provisional research by IWI shows that in the eleven countries selected there are 62 museums (or departments of museums) with a clearly identifiable focus on minting and money. Aggregating the numbers of visitors reported by these museums, we estimate at least 1.8 million of visitors per year. About 7.7 million of numismatic objects are housed by the museums in these eleven countries. The number of employees has been estimated to be at least 800 persons.

For the **Operationalisation of the concept of crossover and spillover effects** in our study, we use an approach based on reference points. As these effects are not directly measurable we use a modelling concept based on hypothetical channels present in the economy and calibrate the model parameters such that the effects calculated are in a plausible relation to available reference points and general economic reasoning. Thus, the overall size of the crossover and spillover effects is in a plausible range.

The strength of crossover and spillover effects exerted by coin minting is assumed to depend, firstly, on the extent of the economic activity of the mint (production of coins and related products and services) and, secondly, on the size of the respective sectors in tourism and creative industries. To account for this double dependence, we model the effects in the form of crossover/spillover multipliers. These multipliers are determined separately for effects on tourism and creative industry.

The crossover/spillover multiplier of production activity of a mint in country k on tourism is assumed to depend on

- the share of tourism in GDP in country k,
- the share of creative, arts and entertainment activities (NACE 90[5]) in GDP in country k,
- the share of libraries, archives and museums (NACE 91) in GDP in country k.

Similarly, the factors considered to determine the crossover/spillover multipliers relevant for culture and creative industries are

- the share of publishing activities (NACE 58) in GDP in country k,
- the share of advertising and marketing research (NACE 73) in GDP in country k,
- the share of libraries, archives and museums (NACE 91) in GDP in country k.

The exact functional relationship chosen is available upon request from the authors. It is basically a linear relationship that considers the three factors with equal weighting. However, some non-linear interaction between the three factors is also accounted for. Thus, it is assumed to be favourable for crossover and spillover effects when the named industry branches are all strongly developed at the same time in a country.

National budget support effect

Mints and coin production generate funds that help support the financing of national budgets. This effect comes about in a way that is different from ordinary economic activity. The situation for mints is special because there are two channels for that kind of support effect:

- When publicly owned, mints generate funds for the national budget via dividends paid or profits transferred.
- The issuing of coins at a higher nominal value than minting costs generates funds for the issuer ("seigniorage")

For determining the funding of national budgets generated by the twelve mints in our sample, we used the information on profits/dividends generated, publicly available or provided by the mints and estimated the size of the contribution of issuing coins. For

5 NACE is the classification of economic activities used in Europe for economic statistics, in particular for national accounting. The abbreviation stands for Nomenclature statistique des activités économiques dans la Communauté européenne.

both sources of the national budget support we averaged over two years (2014/2015). Thus, all mints that were publicly owned in that time had positive profits/dividends. As for the contribution of sovereign issuing of coins we considered only the issuing of circulation coins. We calculated that part of the national budget support as the difference between nominal value of issued coins and the estimated minting costs.

The economic impact of these contributions to the national budget depends on how much of it and on what areas the government spends additional funds. If governments use additional funds partially for debt service (interests, liquidation of debts) then only the remaining part is available for spending. We make the relatively conservative assumption that 70% of additional funds are available for spending on public infrastructure investment.[6] This investment causes direct, indirect and induced effects, since investment goods and their direct and indirect inputs must be produced, and additional labour must be employed and paid. Furthermore, it can be argued that the public investments, in turn, foster and enable additional macroeconomic growth.

Several studies present evidence of the contribution of public investment on macroeconomic growth (Mahoney and Timmer, 2009, Pereira and Andraz, 2013, Abiad, Furceri and Topalova, 2015). In an application to investment in information and communication technology, IWI (2014) translated this mechanism into a multiplier form. Based on the econometric results of Mahoney and Timmer (2009), the investment-to-production multiplier was estimated to be 0.15 (average for EU28).[7]

To model the economic effects of the investment spending from the national budget support generated by the mints in the sample we used input-output-based methods and applied a mixture of EU28-level-based modelling and country-specific fine tuning. The effects on production (direct, indirect, induced) have been calculated using the classical input-output model with the European input-output table (Eurostat) and identical structure of investment goods for all countries. For translating the thus generated production effects into value added and employment effects we also accommodated country specific value added and employment coefficients, thus reflecting that effects are generated partly in the respective country and partly in the rest of the EU28. The effects of additional macroeconomic growth fostered by the public investments are assumed to have the same structure, value added intensity and employment intensity as the national economies.

Small purchases effect

The small purchases effect quantifies the volume of transactions and the associated economic activity that hinges on the existence of coins. We do not enter the discussion on the abolition of cash (Kireyev, 2017) and the subject of monetary policy. Instead, we focus on providing credible first estimations of the economic activity that could not be sustained in a coin-less monetary system. Our approach is based on a chain of reasoning, that discerns cash-related, coin-related and mint-related effects and is sketched in Fig. 2.

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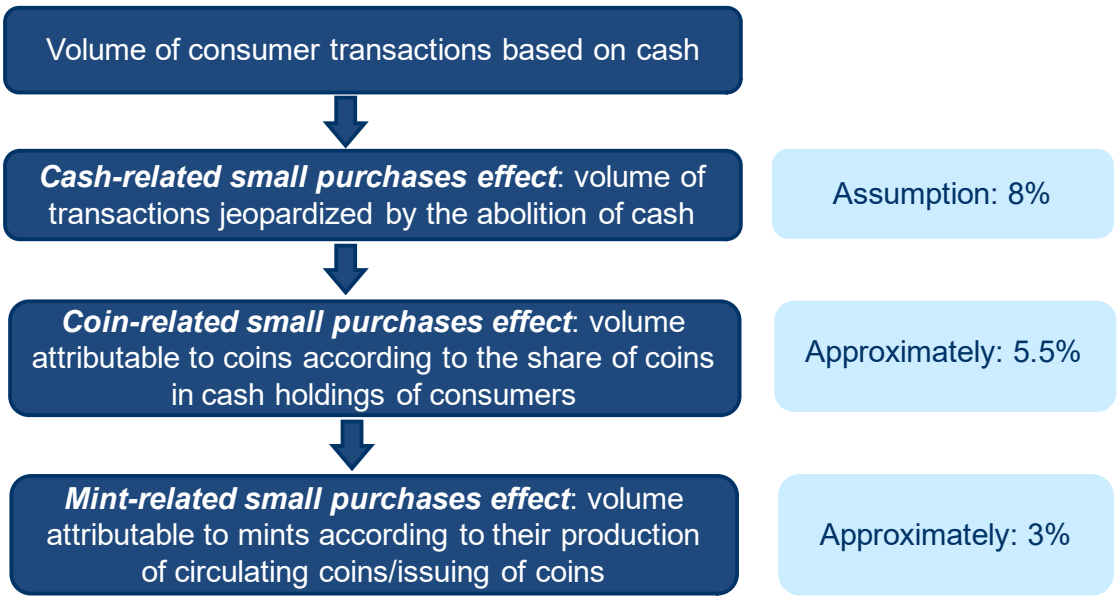
6 Alternative assumptions, e.g., assuming average public spending behaviour, could be used and would imply different size and structure of resulting effects. However, since funds generated by mints are to be considered as separate from public tax income, the governments are probably more disposed to use them for public infrastructure investments than average tax income.

7 These authors estimate the impact of various factors on economic growth via a national production function approach. Applying the set of resulting parameters of this growth model to a period of average growth (4 percent) translates into a investment to (additional) production multiplier of about 0.15.

Fig. 2: Methodological approach for the small purchase effects



Source: IWI (2018)

The general assumption is that with the abolition of cash and coins certain consumer transactions which typically depend on cash (small purchases, purchases at vendor machines, tipping) are jeopardized to be forfeited. To estimate this volume the starting point is the volume of consumer transactions based on cash. Several data sources have been used for this: data on final consumption expenditures of households and the share of consumer payments transacted in cash from Eurostat, shares of private consumption paid in cash taken from Bagnall et al. (2016), Thomas et al. (2013) and Deutsche Bundesbank (2015). The share of cash-based consumer payments varies considerably between the European countries of our sample. Multiplying final consumption expenditures according to Eurostat (COICOP) with the share of transactions paid in cash gives the volume of transaction based on cash.

The *cash-related small purchases effect* is defined as the volume of consumer transactions and relating economic activity that would be jeopardized by the abolition of cash. According to experts the multiplication of the volume of transactions based on cash by 8 % gives a good approximation for the volume of transactions jeopardized by the abolition of cash. In this study we do not report results on the cash-related small purchases effect but need it only as a methodological step.

The *coin-related small purchases effect* is defined as the volume of consumer transactions jeopardized that is attributable to coins according to the share of coins in cash holdings of consumers. According to Deutsche Bundesbank (2015) approximately 5.5 % of cash holdings of consumers are in the form of coins. We apply this percentage to all countries in our sample.

Finally, the *mint-related small purchases* effects is defined as the volume of consumer transactions attributable to mints according to their production of circulating coins or the issuing of coins. The rationale is that by producing circulating coins the mint helps to keep the stock of circulating coins in the monetary system in an orderly condition and on the desired level, thus helping to maintain the economic activity associated with the volume of consumer transactions. In the average about 3% of the stock of coins in circula-

tion (in nominal terms) are newly minted every year. To get the mint-related small purchases effect, we multiply the coin-related small purchases effect with this percentage for all countries in the sample.

It should be emphasized that this model is a model of attribution and not of causation. Though the small purchases effect is real and might, depending on the conditions and environments of the various countries, take on values similar to the ones hypothesized in this study, it is impossible to establish a causal relationship between specifically the existence of coins and the activities of the mints on one hand and economic activity sustained by cash-based consumer payments on the other hand.

3 Economic impact of European mints: Results

This chapter presents the modelling results for the macroeconomic and associated effects of European mints. The results are presented in terms of the effects on production, value added and employment (see the Glossary of economic terms in the Appendix for definitions of these terms). First, we present an overview of the results for the macroeconomic and associated effects of all twelve European mints in our sample. Second, an aggregation and projection for the whole of EU28 is carried out. This step allows to estimate how much production, value added, and employment is sustained in Europe (EU28) due to the activities of all European mints.

3.1 An overview on all mints in the sample

The twelve mints in the sample belong to eleven European countries. Their production in the sense of our study ranges from EUR 7.01 million for Czech Mint (Czech Republic) to EUR 186.23 million for The Royal Mint (United Kingdom).[8] In Tab. 1 the economic effects of the mints on production in the EU28 are presented.

Tab. 1: Macroeconomic and associated effects of all mints in the sample, effects on production in million EUR, average for 2014 and 2015

	direct effects (at mint itself)	overall macroeconomic effects (in EU28)	overall associated effects (in EU28)	total effects (in EU28)	*Ratio total/direct*
Austria	99.41	200.55	97.35	297.90	3.00
Belgium	12.94	38.52	41.61	80.13	6.19
Czech Republic	7.01	18.75	41.12	59.87	8.54
Finland	63.65	213.70	55.42	269.12	4.23
France	112.31	291.68	199.87	491.56	4.38
Germany-Baden-W.	16.09	40.69	186.09	226.78	14.10
Germany-Bavaria	15.03	41.87	106.79	148.66	9.89
Netherlands	40.80	134.47	49.01	183.48	4.50
Poland	48.84	140.09	105.61	245.70	5.03
Portugal	11.51	36.15	48.92	85.08	7.39
Spain	36.00	103.24	117.91	221.15	6.14
United Kingdom	186.23	498.86	376.93	875.79	4.70

Note: Production (direct effects) corrected for the material value of gold and precious metals.
Source: IWI (2018)

The direct effects (1st dimension) are added to the indirect and induced effects (2nd and 3rd dimension) to form the overall macroeconomic effects. Their size varies from EUR 18.75 million for the Czech Mint (Czech Republic) to EUR 498.86 million for The Royal Mint (United Kingdom).

The associated effects cover the small purchases effects, the national budget support effects and crossover effects for tourism and creative industries. Also, the overall associated effects span a large range from a production of EUR 41.12 million for Czech Mint

8 In the case of a diversified enterprise (Poland, Portugal, Spain) the production figure refers only to the mint-specific part of the enterprise. Production in the sense of our study is corrected for the value of the material content of gold and other precious metals. Thus, gold and other precious metals are not considered as part of the production. See section 2.2 for more details on the procedure for this correction.

(Czech Republic) to EUR 376.93 million for The Royal Mint (United Kingdom). As to the total effects on production the mints with the smallest and largest effects are the Czech Mint (Czech Republic) and The Royal Mint (United Kingdom) with EUR 59.87 million and EUR 875.79 million, respectively.

The ratio of total effects to direct effects (see the last column of the table) informs about the effect that each unit of production at the mint itself has on the production in the whole of EU28.[9] These ratios vary between 3.00 (Austrian Mint, AT) and 14.10 (State Mints of Baden-Wuerttemberg, DE). One of the reasons for the relatively low value for the Austrian Mint lies in its unique role as issuer of Austrian euro coins, thus reporting this business area at the nominal value of the coins. For State Mints of Baden-Wuerttemberg and the other German mint in the sample, the large total-to-direct ratio can be explained by the large associated effects, which are mostly due to the high priority of cash-based payments for the German economy and to the size of the German economy.

The ratios of total to direct effects measure the dependence of the economy on the production activity and on effects associated with the existence of coins in the economy and are not meant for a performance evaluation and comparison between mints or countries. They do not indicate desirability or performance, but reflect the underlying structures of the mint, the national economy or the economy of the EU28.

In general, factors that influence the size of the economic effects (apart from mint size itself) are production efficiency, organization of production (e.g., a tendency to insource production processes), wage levels and profit situation of the mint. On the part of the structural influences of the national economy these factors are joined by the value added intensity of the national economy and by its openness to trade.

An overview on the employment effects of the mints in our sample is given in Tab. 2.

Tab. 2: Macroeconomic and associated effects of all mints in the sample, effects on employment in persons, average for 2014 and 2015

	direct effects (at mint itself)	overall macroeconomic effects (in EU28)	overall associated effects (in EU28)	total effects (in EU28)	*Ratio total/direct*
Austria	217	833	771	1,604	7.39
Belgium	35	183	248	431	12.32
Czech Republic	76	185	478	663	8.73
Finland	140	1,035	390	1,425	10.21
France	476	1,535	1,351	2,885	6.06
Germany-Baden-W.	84	245	1,460	1,705	20.42
Germany-Bavaria	56	229	837	1,066	19.21
Netherlands	94	702	377	1,080	11.49
Poland	175	1,288	1,610	2,898	16.56
Portugal	42	252	576	829	19.73
Spain	100	535	1,176	1,711	17.11
United Kingdom	814	3,008	3,167	6,175	7.59

Source: IWI (2018)

9 In the case of the macroeconomic effects on production this ratio can be interpreted as a multiplier, i.e. expressing a causal relationship between the direct production and the overall macroeconomic effects. In all other cases it is more appropriate to interpret the ratio as measuring attribution according to the model assumptions.

While the employment directly at the mint varies between 35 and 814 persons, the total effects cover a range from 413 persons to 6,175 persons. Again, direct effects, overall macroeconomic effects and associated effects are not proportional to each other. For instance, in some countries both groups of effects are of approximately equal size (Austria, Belgium, France, United Kingdom). In most countries the associated effects dominate the macroeconomic effects, particularly in Germany and Spain. There are also two mints, respectively countries, Netherlands and Finland, whose overall associated effects considerably fall below their macroeconomic effects.

The ratio of total-to-direct effects expresses the total employment generated in the EU28 due to the existence of a chosen mint divided by the direct employment in that mint. Thus, in the case of State Mints of Baden-Wuerttemberg for every person employed by the mint itself, there are more than 20 persons with a job in Germany or in the rest of the EU28 (including the one person employed at the mint itself). Besides Germany, i.e. the two German mints in our sample, we find also relatively high total-to-direct ratios for Portugal, Poland and Spain. France, Austria, United Kingdom and Czech Republic have comparatively small total-to-direct ratios (between 6.06 and 8.73).

The ratios of total to direct effects measure the dependence of the economy on the production activity and on effects associated with the existence of coins in the economy and are not meant for a performance evaluation and comparison between mints or countries. They do not indicate desirability or performance, but reflect the underlying structures of the mint, the national economy or the economy of the EU28.

The most important factor that determines the size of the economic effects and ratios in terms of employment is the employment intensity at the mint itself, which is relatively high for (the mints of) Czech Republic, Germany/Baden-Württemberg, United Kingdom and France. A further contributing factor is the employment intensity of the national economy. Furthermore, all considerations mentioned above in the discussion of the production effects also apply.

In the following two tables we extend the analysis to consider also the coin-related small purchases effects. While the mint-related small-purchased effects are small purchases effects that can be attributed to the newly minted and issued circulating coins, the coin-related effects are those small purchases effects that can be attributed to the stock of circulating coins. In our calculations we assume that the former are three percent of the latter. In Tab. 3 the mint- and coin-related effects on the production in the EU28 are presented.

Tab. 3: Mint- and coin-related effects of all mints in the sample, effects on production in EU28, in million EUR, average for 2014 and 2015

	direct effects (at mint itself)	total effects, mint-related	small purchases effects, coin-related	all mint- and coin-related effects	*Ratio all/direct*
Austria	99.41	297.90	249.42	539.84	5.43
Belgium	12.94	80.13	62.42	140.69	10.88
Czech Republic	7.01	59.87	212.38	265.89	37.90
Finland	63.65	269.12	146.23	410.97	6.46
France	112.31	491.56	370.40	850.84	7.58
Germany-Baden-W.	16.09	226.78	970.18	1,167.86	72.60
Germany-Bavaria	15.03	148.66	536.16	668.73	44.49
Netherlands	40.80	183.48	213.46	390.54	9.57
Poland	48.84	245.70	655.95	881.96	18.06
Portugal	11.51	85.08	249.39	326.99	28.40
Spain	36.00	221.15	1,317.32	1,498.95	41.64
United Kingdom	186.23	875.79	791.68	1,643.72	8.83

Note: Production (direct effects) corrected for the material value of gold and precious metals.
Source: IWI (2018)

The coin-related small purchases effect contributes significantly to the overall effect in most of the mints. In absolute terms, the coin-related small purchases effects on production range from EUR 62.42 million to EUR 1,317.32 million. The countries, respectively the mints, for which the coin-related small purchases effects are much higher than all other effects taken together are Germany – Baden-Wuerttemberg, Germany Bavaria, Poland, Portugal and Spain. These tend to be countries with a high preference for cash-based payments. Austria, which also is known for its strong share of cash-based payments forms an exception because of the large size of Austrian Mint relative to the country size. The situation in France can be explained mainly by the large share of cashless payments. The Mint of Finland, for which we also found relatively small coin-related small purchases effects, is a relatively large mint and the minting of circulation coins for its home market forms only a part of its coin-related business. In Belgium and the United Kingdom, the total mint-related effects and the coin-related small purchases effects are more or less in balance.

Taking all mint- and coin-related effects together the effects range from EUR 140.69 million to EUR 1,643.72 million. In its rightmost column, the table also gives the ratios of all effects to direct effects, which widely differ for the different mints or countries. However, care has to be taken with the interpretation of these ratios because they contrast variables that are of a different nature and the former *cannot* be attributed to the latter.

Tab. 4: Mint- and coin-related effects of all mints in the sample, effects on employment in EU28, in persons, average for 2014 and 2015

	direct effects (at mint itself)	total effects, mint-related	small purchases effects, coin-related	all mint- and coin-related effects	*Ratio all/direct*
Austria	217	1,604	2,969	4,484	20.66
Belgium	35	431	582	996	28.45
Czech Republic	76	663	4,357	4,890	64.34
Finland	140	1,425	1,414	2,797	20.05
France	476	2,885	3,697	6,472	13.60
Germany-Baden-W.	84	1,705	12,472	13,803	165.31
Germany-Bavaria	56	1,066	6,892	7,752	139.67
Netherlands	94	1,080	2,891	3,884	41.32
Poland	175	2,898	15,439	17,874	102.16
Portugal	42	829	5,013	5,691	135.51
Spain	100	1,711	19,932	21,046	210.46
United Kingdom	814	6,175	11,619	17,446	21.45

Source: IWI (2018)

In Tab. 4 the mint- and coin-related effects on employment in EU28 are presented for all mints in our sample. The values of the coin-related small purchases effects vary from 582 persons employed to 19,932 persons employed. In all cases except Finland the coin-related small-purchases effect are higher than all mint-related effects, in several cases higher by a factor of five and more. The context for this observation is that the part of the economy stimulated by small purchases effects is particularly employment-intensive. Again, the ratios of all mint- and coin-related effects are given in the last column of the table but should interpreted carefully since, as has been mentioned above, in this case the total effects cannot really attributed to the direct effects.

3.2 Aggregation of the results and projection to EU28

In this section the main results of the economic modelling of the European mints are presented. The results, which have been presented thus far on the level of individual mints, are aggregated to the level of the sample. Furthermore, the results are projected from the sample to give an estimate of the effects on production output, value added and employment of all existing mints in Europe (EU28). The results are summarized with the help of ratios of total-to-direct effects.

Before presenting the aggregated results, a few words must be said on the procedure of aggregation. Aggregation in the case of input-output-analysis of the effects of production activities is not trivial, since double counting of effects, caused by the cross-stimulation of units of a sample, can occur and must be avoided.

Mints in Europe are interrelated with each other by business relations. Seven of the twelve mints in our sample are producing coin blanks, which are then sold to other mints. The buyers of the coin blanks are mostly to be found in the European market (experts estimate a share of between 45 and 75 percent, depending on business area and mint). When aggregating the macroeconomic effects from the level of individual mints to the level of the European level (EU28), one has to take this aspect into account and correct the aggregation for possible double counting of effects.

The procedure of the correction for cross-stimulation is based on the information on *output* of blanks, provided by the mints in annual reports or directly to the study team.[10] The estimated value of all production of blanks by the seven mints sold to other mints in the EU28, after correction for the value of the material content of gold and other precious metals, amounts to EUR 14.0 million. While the share of blanks for collector and bullion coins in this total sum is relatively unimportant with EUR 1.5 million, blanks for circulating coins sold to the European market (EU28) account for approximately EUR 12.5 million. The main producers of blanks for circulating coins in our sample are the Mint of Finland (FI, including also its associated company in Germany), the Royal Dutch Mint (NL) and The Royal Mint (UK).

The aggregation procedure is based on proportionality assumptions. Production effects of the sample of twelve mints (corrected for cross-stimulation) have been projected with the help of the share of the home countries in production of EU28. For value added and employment its share in value added and employment of the EU28 have been used.

Tab. 5 summarizes the result of the aggregation and projection of the economic effects of European mints on production and employment.

Tab. 5: Aggregation of economic effects of all mints in the sample and projection to EU28, effects on production and employment, average for 2014 and 2015

	direct effects (at mint itself)	overall macro-economic effects (in EU28)	overall associated effects (in EU28)	total effects (in EU28)	*Ratio total/direct*
Effects on production, million EUR					
Sum of sample	636	1,721	1,427	3,147	4.95
Rest of EU28	367	993	823	1,816	4.95
EU28 total	1,003	2,714	2,250	4,963	4.95
Effects on employment, in persons					
Sum of sample	2,257	9,815	12,442	22,256	9.86
Rest of EU28	1,329	5,778	7,324	13,102	9.86
EU28 total	3,586	15,592	19,766	35,358	9.86

Note: Production (direct effects) corrected for the material value of gold and precious metals. Rest of EU28 contains also two mints in Germany not in the sample. The sum of sample is corrected for double counting due to cross-stimulation amongst European mints.
Source: IWI (2018)

While the direct production output of the mints in the sample sums up to EUR 636 million, the projection to the total of EU28 is estimated to be EUR 1,003 million. The overall macroeconomic effects of European mints account for EUR 2,714 million. Adding the overall associated effects, EUR 2,250 million, results in an estimate of the total economic effects of all European mints of EUR 4,963 million.

The ratio of total-to-direct effects is 4.95. It is the same for the sum of sample, the rest of EU28 and the EU28 total because all effects have been projected with the help of the same factor of proportionality.

In the lower part of the table the effects of European mints on employment can be seen. The analysis shows that adding up the 2,257 persons employed directly at the mints of the sample and the 1,329 persons employed by those European mints (EU28) that are not included in the sample gives a direct employment of 3,586 persons in the EU28. After

10 The alternative procedure, based on reported inputs of (purchased) blanks, proved not to be viable.

taking into consideration all macroeconomic and associated effects the mints in the EU28 are estimated to generate an employment of 35,358 persons in the EU28.

For every person employed at one of the mints in Europe of EU28 all in all 9.86 persons in EU28 have a job that is generated by the production activity of European mints, including also the persons employed directly at the mints themselves.

The aggregated results presented thus far concern those effects that can be attributed to the mints and their production activities (focus on the mint). If we widen the perspective, we can consider also the small purchases effects that hinge not only on the newly minted coins but on the accumulated contributions to the stock of circulating coins (focus on coins). Tab. 6 provides the results according to that perspective.

Tab. 6: Aggregation of mint and coin-related effects of all mints in the sample and projection to EU28, effects on production and employment, average for 2014 and 2015

	direct effects (at mint itself)	total effects, mint-related	small purchases effects, coin-related	all mint- and coin-related effects	*Ratio all/direct*
Effects on production, million EUR					
Sum of sample	636	3,147	5,775	8,749	13.76
Rest of EU28	367	1,816	3,332	5,048	13.76
EU28 total	1,003	4,963	9,107	13,797	13.76
Effects on employment, in persons					
Sum of sample	2,257	22,256	87,279	106,917	47.37
Rest of EU28	1,329	13,102	51,380	62,941	47.37
EU28 total	3,586	35,358	138,659	169,858	47.37

Note: Production (direct effects) corrected for the material value of gold and precious metals. Rest of EU28 contains also two mints in Germany not in the sample. The sum of sample is corrected for double counting due to cross-stimulation amongst European mints.
Source: IWI (2018)

The table shows that the coin-related small purchases effects, aggregated and projected in the same way as the mint-related effects, amount to a production in EU28 of EUR 9,107 million and an employment of more than 138,000 persons. Therefore, they comprise the largest part of all mint- and coin-related effects. All in all, a production of EUR 13,797 million takes place in the economy of EU28 thanks to mint-and coin-related effects. Nearly 170,000 persons have a job that can be linked to the production activities of mints or to the existence of coins in the economy.

In Tab. 7 we present the results in a slightly more detailed way. While restricting the perspective to the projection of the economic effects to the whole of mints in the Europe of EU28 we show more detailed results for the different associated effects and differentiate between effects on production, value added and employment. Furthermore, as an extension of the analysis we also include the coin-related effects in the table.

Tab. 7: Macroeconomic and associated effects of European mints in the EU28, average 2014/2015, projection from sample

		production	value added	employment
		million EUR		persons
Macro-economic effects	Direct effects (at the Mint itself)	1,003	374	3,586
	Indirect and induced effects (in the EU28)	1,711	668	12,006
	Overall macroeconomic effects (in the EU28)	2,714	1,042	15,592
Associated effects	Small purchases effects (mint-related)	273	130	4,160
	National budget support effects	1,815	729	13,896
	Crossover effects tourism	64	32	820
	Crossover effects creative industries	98	46	891
	Overall associated effects	2,250	937	19,766
Focus on mints	All macroeconomic and associated effects	4,963	1,979	35,358
	Ratio of all effects to direct effects	4.95	5.30	9.86
Focus on coins	Small purchases effects (coin-related)	9,107	4,334	138,659
	All mint- and coin-related effects	13,797	6,183	169,858
	Ratio of all effects to direct effects	13.76	16.54	47.37

Note: Production (direct effects) corrected for the material value of gold and precious metals. Rest of EU28 contains also two mints in Germany not in the sample. The sum of sample is corrected for double counting due to cross-stimulation amongst European mints.
Source: IWI (2018)

When aggregated to the whole of EU28 the overall associated effects amount to a production output of EUR 2,250 million, a value added of EUR 937 million and an employment of 19,766 persons. From the table it can be seen that national budget effects contribute the most to the associated effects, followed by small purchases effects, crossover effects for creative industries and crossover effects for tourism. The same ranking can also be observed for value added and employment. In the focus on mints, all macroeconomic and associated effects together amount to a production of EUR 4,963 million, a value added of EUR 1,979 million and employment of 35,358 persons. For every euro produced directly at one of the mints and for every euro of value added directly at one of the mints a production of EUR 4.95 and a value added of EUR 5.30 is generated in the whole of EU28. For every person employed directly at one of the mints 9.86 persons are employed somewhere in EU28 that can link their job to the production activities of European mints and to the associated effects.

Taking on the focus on coins, the mint- and coin-related effects sum up to a production of EUR 13,797 million, a value added of EUR 6,183 million and employment of 169,858 persons. The ratios of all mint- and coin-related effects to the direct effects are given in the last row. But, as has been said before, these ratios have to be interpreted with care, as the relationship between the direct and the total of mint- and coin related effects is not even one of attribution. However, the analysis makes clear, that the coin-related small purchases effect dominates pure mint-related effects by far.

4 Summary and conclusions

Mints in Europe form an integrated part of their respective national economies and of the economy of EU-Europe (EU28). They are at the core of the production economy and, at the same time, closely linked to the institutional infrastructure of the economy and economic policy. All mints have furthermore in common that they entertain diverse interrelationships with other industries and economic institutions, not only via the classic supply chain, but also in a broader sense, by other forms of cooperation and links. Thus, the mints exert effects on the whole economy in terms of production output (gross output), value added and employment.

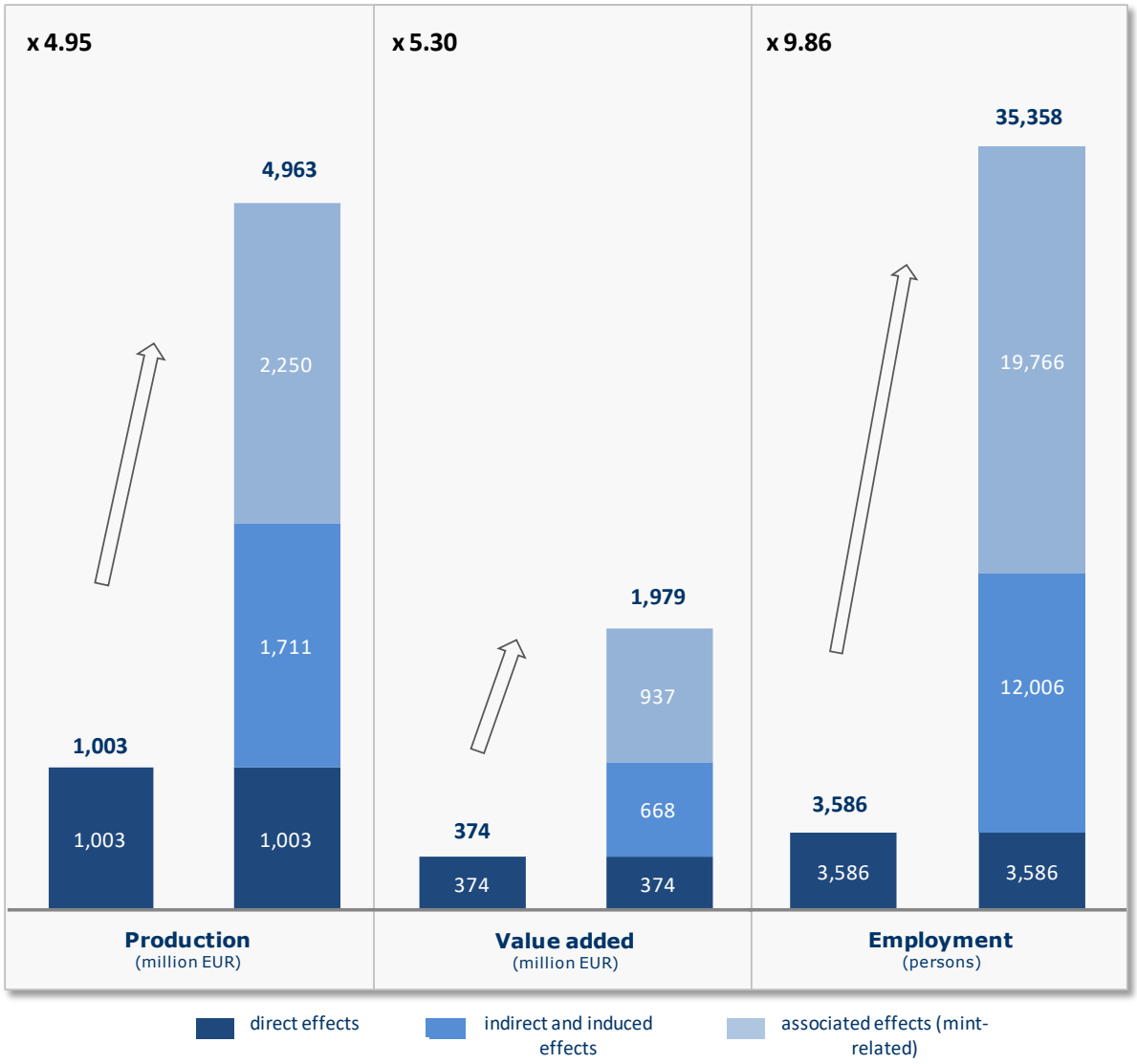
The aim of this study is to estimate the economic effects of European mints in terms of production output, value added, and employment. The analysis is based on a sample of twelve mints, belonging to eleven European countries.

To present a complete picture of the economic impacts of European mints, in this study a model to quantify the economic impacts has been developed that goes beyond the classical input-output model and considers not only the direct, indirect and induced effects (=macroeconomic effects, 1st, 2nd and 3rd dimension) but the associated effects as well (4th dimension).

The associated effects modelled in this study cover the effects of sustaining small purchases in the economy, the effects generated when European mints support the national budget and the crossover and spillover effects benefitting creative industries and tourism. While associated effects are real, they are more difficult to quantify than macroeconomic effects, since the causal link is less stringent and no or only indirect data and observations are available. The present study takes the position that the estimates for the associated effects presented here are lower bounds and that true associated effects could be much higher.

European mints, i.e. mints in EU28, are estimated to have a direct production of EUR 1,003 million and a value added of EUR 374 million. 3,586 persons are directly employed at European mints. Through indirect, induced and associated effects the production activities of mints stimulate the economy of the EU28. All in all, a production of EUR 4,963 million and a value added of 1,979 is generated in the EU28. 35,358 persons have a job that is linked to the production activities of European mints through direct, indirect, induced and associated effects. Fig. 3 summarizes these results in graphical display.

Fig. 3: Economic impacts of mints in EU28 on production, value added and employment, average 2014/2015, projection from sample



Note: Production (direct effects) corrected for the material value of gold and precious metals.
Source: IWI (2018)

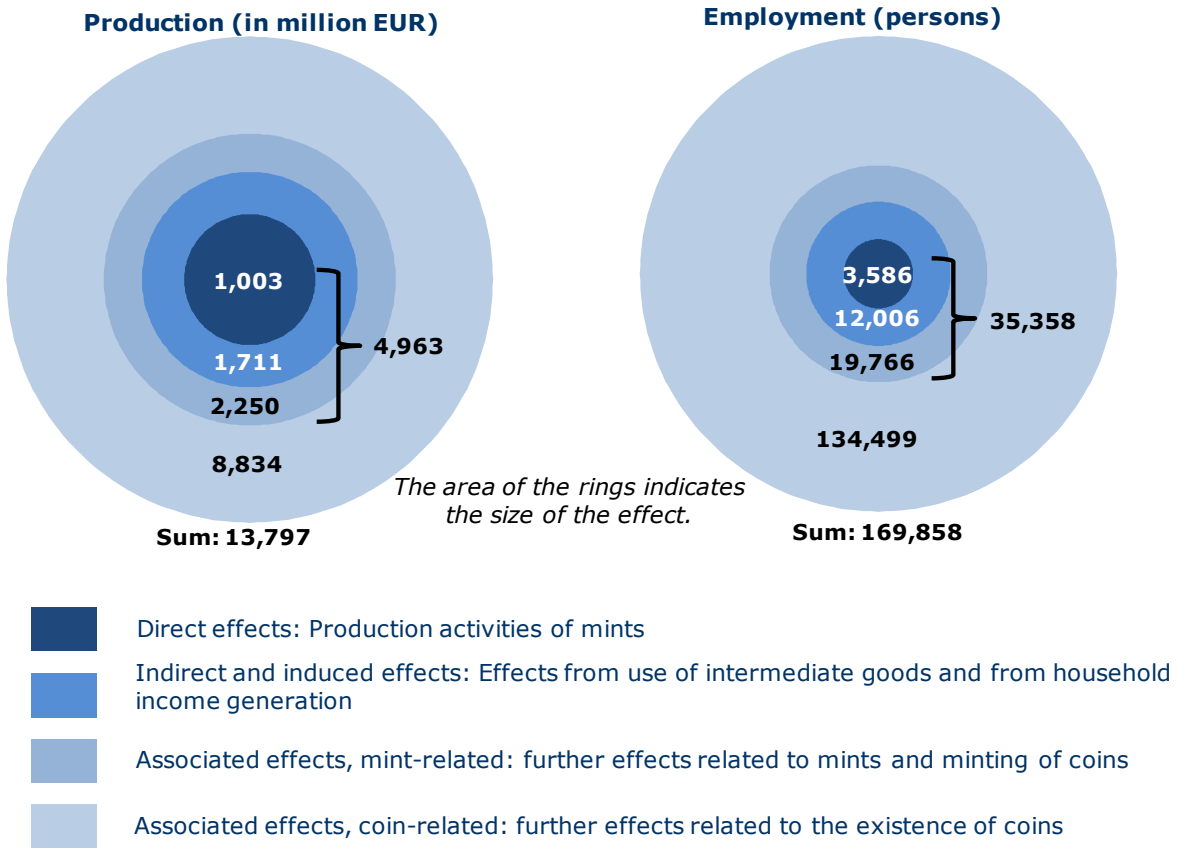
Summarizing the results with the help of total-to-direct ratios one can say that

- For every euro of production directly at one of the mints in EU28 EUR 4.95 of production is generated in the whole economy of EU28.
- For every euro of value added at one of the mints in EU28 EUR 5.30 of value added are generated in the whole economy of EU28.
- For every person employed at one of the mints in EU28 on average 9.86 persons are employed in the EU28.

Thus, these total-to-direct ratios measure the dependence of the economy of the EU28 on the production activities of European mints and on effects associated with the existence of coins in the economy. The do not, however, form the basis for evaluation or for comparison with other branches of the economy. The ratios, as such, do not indicate desirability nor performance, but reflect only the underlying structures of the mints included in the sample, of the respective national economies and of the European economy in general.

When a wider perspective is taken that not only considers the effects that can be attributed to the production activities of the mints (focus on mints) we can consider more effects that depend on the existence of coins independently of the mints (focus on coins). Then we observe much larger effects due to coin-related effects. In Fig. 4 we graph the effects in the form of a succession of concentric rings, starting with direct effects in the center, adding indirect and induced effects, mint-related associated effects and coin-related effects as rings whose areas indicate the size of the effects.

Fig. 4: Layer graph of all mint- and coin-related effects of mints in EU28 on production and employment, average 2014/2015, projection from sample



Note: Production (direct effects) corrected for the material value of gold and precious metals.
Source: IWI (2018)

From the wider perspective we can see that coin-related small purchase effects account for a production of EUR 8,834 million and an employment of 134,499 persons. Summing up all mint- and coin-related effects, we can conclude that a total of EUR 13,797 million of production and employment for 169,858 persons in the EU28 are generated by the macroeconomic and associated effects of mints of by the effects associated with the existence of coins in the economy.

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Appendix: Glossary of macroeconomic terms

Gross output (production output): *Production output measures the actual production of goods and services by an economic area or unit. For a firm pertaining to the production economy it comprises the following items: revenue (sales) from production of goods and services, inventory changes in half-finished and finished goods, sales of merchandises minus purchases of merchandises minus inventory changes of merchandises (= trade margin) and activation of facilities of own production.*

Production output is a broad measure of economic performance. On the level of national accounting, i.e. summed over all economic units of a national economy, it gives a far higher value than the more commonly used GDP because it sums not only over final products but also intermediate products that enter the production process of other units. On the level of the enterprise production output will usually be closely aligned with revenues (sales, turnover), since in ordinary cases inventory changes, sales of merchandises and activation of facilities that have been produced by the unit itself play a minor or even negligible role.

There are two basic relationships relating gross output (production output) to other essential terms of national accounting and input-output economics:[11]

- Gross output = intermediate consumption + final demand
- Gross output = intermediate consumption + value added

The first relationship basically says that what is produced in an economy is either used as intermediate input by other economic units or by final demand. The second relationship expresses the fact that the value of a product is composed of the value of the intermediate inputs that are needed for its production and the value added in the course of production.

Intermediate inputs (intermediate consumption): *Intermediate consumption consists of the value of the goods and services consumed as inputs by a process of production. The goods and services may either be transformed or used up by the production process.*

Value added: *Value added measures the value created by a process of production, i.e. the difference between the value of production output and the value of intermediate inputs. It includes the following components: wages and salaries, employers' social contributions, net taxes on production (i.e. taxes on production minus subsidies on production), consumption of fixed capital (=depreciation), net operating surplus*

As a measure of economic performance of a unit and because of its link to GDP, value added is of high analytic interest. When the net taxes on products (i.e. taxes on products minus subsidies on products) are separated out of intermediate inputs and added to the value added and aggregation over all resident units is performed this results in the gross domestic product (GDP).

[11] This is a slightly simplified exposition that serves mainly pedagogical purposes as the role of taxes and subsidies on products and of imports is not considered here.

Another analytical interest of value added follows from viewing it as the compensation of capital and labour. Once the amount of value added that is appropriated by government in the form of net taxes on production is deducted from value added the compensation of labour and capital is revealed. However, capital in the form of fixed capital has a finite life. Some part of value added should therefore be regarded as the reduction in the value of fixed capital due to its use in production (consumption of fixed capital).

Final demand (final output): *Final demand captures that part of production output of goods and services and of imports that is not needed for intermediate consumption and thus is available for final demand. It contains three major categories: final consumption expenditures, gross capital formation and exports.*

Final consumption expenditure is the amount of expenditure on consumption of goods and services by individual households, government and non-profit organisations to satisfy their individual or collective needs. Gross capital formation indicates the acquisition less disposal of produced assets for purposes of fixed capital formation, inventories or valuables. Exports of goods and services consist of sales, barter, or gifts or grants, of goods and services from residents to non-residents.

Final demand is not of immediate relevance for this study. It is treated here primarily because of its central role for input output economics (see next subsection).

Employment: *Employment is defined as all persons who, by agreement, work for the respective unit and receive remuneration.*