Executive Summary

Compiling the Industrial Production Index for short-term statistics is burdensome and cumbersome however, this index, which is free of influences of price changes, is essential to measure volume changes in the production of an economy. This short-term indicator plays an important role when comparing economic performance over time and is a fundamental requirement for policy-making. The overall quality assessment of the Production Index depends on several factors related to the sampling techniques, the suitability of the data variables used, the quality and accuracy of the data collected, the imputation methods used to cope with missing data and the estimation methods used to compile the indices. The manual of International recommendations for the Industrial Production Index (2010) makes several provisions to enhance relevance, accuracy, credibility, accessibility, coherence, interpretability and timelessness of the complete production process of this Index. This report will assess the methodological design used by the Short-term Statistics (STS) Unit to compile the Production Index by assessing the sampling techniques, sample size calculation, data collection methods, imputation techniques and estimation procedures and compare them to the international recommendations. Moreover, the reliability and validity of the Industrial Production indices and year-on-year growth rates are assessed via external measures, namely Employment indices and growth rates in export volumes and other sources.

The STS Unit uses a disproportionate stratified sampling technique. The main advantage of this sampling method is that all Main Industrial Groupings (MIGs) are represented in the sample, irrespective of their size. Further-more, this method allows oversampling from large enterprises, thus guaranteeing high percentage coverage of the total production volume. Another approach is to use a proportionate stratified sampling technique where all enterprises have equal probability of being selected in the sample. Given that 94.7% of all businesses are small, 4.3% are medium and 1% are large enterprises, proportionate stratified sampling would exclude most of the large companies which contribute most to the industrial production index. Weighing the merits and demerits of proportionate and disproportionate stratified sampling techniques it is highly recommended that the STS Unit retains the latter sampling method because it increases the percentage production volume coverage. A proportionate stratified sampling method is expected to yield a sample that provides a low percentage production coverage (around 7%), which is less likely to provide robust estimates of short-term statistics

The STS Unit uses two methods to calculate stratum sample sizes, namely the Neyman allocation and the Stratified disproportionate random allocation techniques. The first method increases the sampling rates where the standard deviation of the production volume of enterprises within the stratum is large. This ensures that the net sample is not distributed entirely on the basis of the stratum size, but also on the variability of the production volume within each stratum. The second method allows the selection of varying proportions of large, medium and small-size enterprises from the population of companies by setting different values for the margin of error. For large companies STS sets the margin of error at 1% guaranteeing that almost all large companies are represented in the global sample. For small companies employing less than 10 employees the margin of error is increased to reduce their over-representation in the global sample. Both techniques are appropriate and statistically sound for disproportionate stratified sampling and should be retained. Moreover, correlation analysis shows a strong positive relationship between the two sample size calculation methods.

The three types of data collected by the STS unit, namely data on physical quantities (46.0%), deflated turnover (18.5%) and number of hours worked (35.5%) comply with international recommendations. However, these recommendations suggest more the use of measures of output (physical quantities and deflated turnover) than measures of input (Hours worked) for compiling the industrial production index. This is primarily due to the fact that labour input variables tend to be stable and changes in the labour force composition may not necessarily reflect the true size of productivity changes.

The moving average and growth rate imputation methods used by the STS Unit to cater for missing data are both valid statistical procedures and follow international recommendations. Furthermore, almost all large companies are compelled to provide the data because of their significant impact on the Industrial Production Index. Missing data are imputed only for small and medium enterprises.

The STS unit uses other non-statistical ways to minimize both item and unit non-response. These include sending reminders to non-respondents and impressing upon respondents the importance of providing the requested data. To ensure correct compilation of questionnaire data clear instructions are provided to reduce the likelihood of errors. Moreover, the STS Unit provides assistance to respondents if they have queries while completing the questionnaires.

To compile the industrial production index, the STS Unit uses aggregation weights to aggregate data for products, product groups, industries, Statistical classification of economic activities in the European Community (NACES) and Main Industrial Groupings (MIGs) and derive a weighted average aggregation index. These product group weights are provided by the Structural Business Statistics Unit, which conducts annual surveys seeking extensive information on business structures by collecting data on several variables, namely turnover, employment, value added and gross wages among others. The Structural Business Statistics unit collects data annually; however, the STS Unit updates these product group weights every five years. Although the STS Unit is in line with this recommendation, a more frequent update of these product weights provides an opportunity to include new products as well as reflect the changing relative importance of product groups within the industrial sector.

To compile the industrial production index, the STS Unit uses another set of grossing-up weights to inflate the sample in a particular NACE division to its population size. A grossing-up weight of 1 indicates that the sample data comprises the whole population for that particular NACE division. Due to the huge impact of large enterprises on the Production Index, the STS Unit almost fully exhausts data collection from these companies to augment percentage production coverage. In fact the grossing-up weights of large enterprises are close to 1. Grossing-up weights for medium and small sized enterprises are larger since smaller sized businesses are large in number, generally have simple organizational structures, but are a relatively expensive source from which to collect data in a traditional survey setting. Using the aggregation weights and the grossing-up weights, the Industrial Production Index is then compiled using an annually chain linked Laspeyres algorithm. This is highly recommended by international sources because it provides flexibility in regard to the frequency of weight updates as the weights are not derived from the current period. During the estimation procedure, manual intervention is minimal.

Further checking is conducted by statisticians both at company and index level through the use of directly linked pivot tables and growth rate analysis to identify inconsistencies. These include

unexplained sudden shifts in the time series or impulse outliers caused by one-off economic events. Moreover, the STS Unit carries out monthly revisions of the Industrial Production index based on new data information. On average, the non-response rate to compile the monthly production index is around 17%. This reduces to approximately 8%, 4%, 2% and 1% in the subsequent four months. By the fifth month the non-response rate is less than 1%. As new data becomes available, the STS Unit replaces the imputed values with actual values, updating both the Industrial Production Index and the time series. These revisions are normally very small due to the high response rate for the survey. Moreover, it indicates that the imputation techniques used are quite reliable.

The STS Unit calculates seasonal- and working-day adjusted indices solely through the use of JDemetra+, which are automatically computed using the unadjusted indices. To carry out these adjustments, this software makes use of two leading algorithms (TRAMO-SEATS and X-12/X-13 ARIMA SEATS). Moreover, this tool has the facility to detect outliers and other oddities.

One of the tasks of this study is to examine whether the Industrial Employment index is a good predictor of production volume to measure changes in the Production index. Visual inspection and cointegration analysis both indicate that there is no relationship between the employment and production indices and this applies for all main industrial groupings. Although the Employment index reduces volatility, it is not appropriate to measure changes in the production. The Manual of international recommendations for the Industrial Production Index (2010), cautions against the use of labour input variables to compile the Production Index. This is due to the potential for labour input variables to produce misleading production indices because of the stability of these variables and the difficulty to combine productivity changes and changes in the composition of the labour force into the index. A similar exercise was carried out to determine whether this lack of cointegration between the time series for the Industrial Employment and Turnover indices applies to other European countries using year-on-year growth rates. Visual inspection clearly shows that there is hardly any relationship between the two indices and this applies for all thirteen countries analysed. The volatility of employment indices is much smaller compared to turnover indices.

The second task is to compare time-series trends and volatility of the Production indices and year on year growth rates between two sampling approaches. The first method is the Disproportionate stratified sampling used presently by the STS Unit, which provides larger weight to the data collected from large companies; while the second method excludes large enterprises. This will somewhat mimic the Proportionate stratified sampling since 99% of Maltese enterprises are either medium- or small-sized companies. This task was carried out for all main industrial groupings and for a number of activity strata which have a large aggregate weight and were represented in both large and medium/small classes. The analysis indicated that the aggregation of activity strata into larger industrial groupings stabilizes both the annual means and standard deviations of the industrial production indices.

The third task is to compare growth rates of production volume, with growth rates of export volume. Visual inspection clearly shows that in both cases the time series trends appear closely related and cointegration tests based on Johansen's method show that they are cointegrated.

The adjustment parameters estimates have the correct signs and imply rapid adjustments. This means that when the industrial production growth rate is too high or too low, the growth rates for industrial exports adjust toward the industrial production level. This comparison with external

sources of information is highly recommended because it provides external validity to the Production Index estimates.

The fourth task is to measure the relationship between production and turnover growth rates of 27 European countries and also measure their volatility. Malta's correlation coefficient (0.806) assessing the strength of the relationship is quite large indicating satisfactory compliance between the production and turnover growth rates. Malta's standard deviations for production growth rate (9.12) and Turnover growth rate (10.17) are quite large compared to other countries implying larger volatility. The standard deviations are exceeded by Estonia and Ireland for the production growth rate and by Estonia, Lithuania, Luxembourg, Bulgaria and Belgium for the turnover growth rate. Fluctuations in the time series trends vary between countries; however, Malta's time series trends do not display any oddities vis-a-vis other countries.

The fifth task is to assess the quality (reliability) of the Industrial Production Index by conducting statistical analysis on revisions recorded from a number of releases. Three methods are described to assess bias in the revisions using the sample mean revision. The first method assumes that the revisions are independent; the second method assumes that the revisions are serially correlated and the third method assumes the presence of heteroscedasticity in revisions. All the three methods yield same conclusion that the mean revision is not significantly different from zero, which implies no bias in revisions.